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A physico-chemical analysis of different brands of diclofenac-sodium tablets found in the Gaborone market

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Abstract

Background: Diclofenac sodium (DCF), a widely used nonsteroidal anti-inflammatory drug (NSAID), exhibits analgesic, antipyretic, and anti-inflammatory properties and is commonly used in Botswana's healthcare system both as over the counter and prescription medication.

Aim: This study aimed to evaluate the physicochemical properties, pharmaceutical equivalence, and compliance of three DCF 50 mg tablet brands (S1, S2, S3) with pharmacopeial standards to ensure quality, safety, and efficacy.

Methodology: Eighty coated tablets per brand were assessed for weight variation, hardness, friability, disintegration time, and active ingredient content as stipulated by compendial standards.

Results: All brands complied with USP weight uniformity standards, with significant variations among brands ($P<0.05$). Friability was within acceptable limits (<1%) for all brands. Active ingredient content ranged from 99.6% (S1) to 104.7% (S3), with no significant purity differences among brands ($P>0.05$). Disintegration times were 11.42 min (S1), 22.12 min (S2), and 6.44 min (S3), meeting USP limits. Overall, all tested brands complied with USP quality standards, with S1 demonstrating superior physicochemical properties compared to S2.

Conclusion: These findings affirm the quality of diclofenac sodium tablets available in Botswana, supporting their safe and effective use in public health.

Keywords: NSAIDs; Quality control; Potentiometric titration; United States Pharmacopoeia; Diclofenac sodium

1. Introduction

Diclofenac (DCF), chemically named 2-(2-(2,6-dichlorophenyl) amino) phenyl) acetic acid, is a nonsteroidal anti-inflammatory drug (NSAID) known for its analgesic, antipyretic, and anti-inflammatory effects [1]. It is widely used to relieve pain, inflammation, and stiffness associated with conditions such as osteoarthritis, rheumatoid arthritis, menstrual cramps, and ankylosing spondylitis. In Botswana, diclofenac is commonly sold as an over-the-counter pain reliever, particularly for elderly patients experiencing symptoms of gouty arthritis. The mechanism of action of DCF involves inhibiting both cyclooxygenase enzymes, COX-1 and COX-2. This inhibition disrupts the synthesis of prostanoids, particularly prostaglandin E2 (PGE2), which plays a key role in inflammation. The suppression of PGE2 production is considered the primary reason for the potent analgesic and anti-inflammatory effects of NSAIDs. From a pharmaceutical standpoint, diclofenac sodium is classified as a Biopharmaceutical Classification System (BCS) Class II drug [2], characterized by high permeability but low solubility. Other essential pharmaceutical properties of DCF include hardness, friability, weight uniformity, disintegration time, assay, impurity profile, and dissolution rate.

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Ensuring these parameters comply with pharmacopeial standards is crucial to maintaining the drug's safety, efficacy, and quality for patient use. In recent years, concerns about the quality and authenticity of medications among both patients and healthcare professionals have grown. A recent study by the World Health Organization (WHO) found that one in ten medical products in developing countries is either substandard or falsified. Emphasizing the seriousness of this issue, research conducted in African pharmaceutical markets revealed that while available diclofenac sodium brands may be chemically equivalent [5], they are not pharmaceutically (physically) equivalent. As a result, generic brands cannot be interchangeably substituted for one another or for the innovator brand to achieve the same therapeutic effects [6]. The objectives of this study were twofold: first, to assess and compare the physicochemical properties, including weight variation, hardness, friability, disintegration time, and active ingredient content—of three commercially available diclofenac sodium tablet brands in the Gaborone market. Secondly, to evaluate the pharmaceutical equivalence and compliance of these brands with official pharmacopeial standards, ensuring their quality, safety, and efficacy for consumer use.

2. Materials and methods

Perchloric acid (70%) was sourced from Minema Chemicals (South Africa), while glacial acetic acid and potassium hydrogen phthalate were obtained from Rochelle Chemicals (South Africa). Distilled water was supplied by the Faculty of Sciences, University of Botswana. Hydrochloric acid (32%) and acetic anhydride (ACS reagent, ISO) were procured from Aldrich.

Eighty (80) tablets of three different diclofenac sodium (50 mg) brands (S1, S2, S3) were analyzed, with S1 and S2 being enteric-coated and S3 film-coated. The tablets were purchased from WHO-qualified pharmaceutical wholesalers in Gaborone, Botswana, licensed by the Botswana Medicines Regulatory Authority (BOMRA). The study was completed in June 2023. [3][4]

2.1. Determination of uniformity of weight

A sample of twenty (20) tablets was randomly selected from each brand for analysis. The tablets were weighed using an analytical balance (BA 2204B) to determine their average weight. The weight variation for each brand was calculated as a percentage of the average weight, with standard deviation quantifying dispersion. The average weight and percentage deviation for each tablet were recorded (Table 3). The weight variation was computed using the formula:

Weight Variation (%) = (Initial weight – Average weight) / Average weight × 100

2.2. Assay

Following established research methodology, 20 tablets from each brand were randomly selected for analysis. The tablets were weighed using an analytical balance and finely crushed using a ceramic mortar and pestle. A precisely measured 0.25 g aliquot of the powder was dissolved in 30 ml of glacial acetic acid. The solution was titrated with 0.1 M perchloric acid, using crystal violet as an indicator, following the potentiometric determination method. outlined in the British Pharmacopeia.

Assay Purity (%) Calculation: $\text{Purity}\% = (V \times 0.03181 \times 100 \times M) / (0.1 \times W)$

Where:

V = Volume of perchloric acid (cm^3) used for neutralization
M = Molality of perchloric acid (0.125N)
W = Mass of equivalent diclofenac sodium used (0.25g)

2.3. Determination of tablet friability

In this study, 10 tablets from each brand were weighed and placed into a friabilator (DBK Instrument, England, 40 FTA01). The friabilator operated at 25 revolutions per minute for 4 minutes, subjecting the tablets to repeated vertical drops of 6 inches per revolution. After completion, the tablets were dusted, and their final weight was recorded to assess friability.

Friability (%) Calculation: $\text{Friability}\% = ((W1 - W2) / W1) \times 100$

Where:

W1 = Initial weight
W2 = Final weight

2.4. Determination of tablet hardness

Sample tablets (10) of each brand were taken; a tablet was placed between the spindle of the hardness tester (Monsanto type handheld version) and pressure was applied until the tablet broke. The crushing strength of tablets was determined at room temperature by diametrical compression using a tablet hardness tester (Monsanto type handheld version). Sample tablets (10) of each brand were taken; a tablet was placed between the spindle of the hardness tester (Monsanto type handheld version) and pressure was applied until the tablet broke. The mean crushing strength was evaluated with its standard deviations and 95% confidence intervals.

2.5. Disintegration studies

The Tablet Disintegration Apparatus Model-901 (USP/IP STD) was used to assess the disintegration times of diclofenac sodium tablets (50 mg). Each dosage unit was placed in one of six tubes in the disintegration basket. The test began with 0.1 M hydrochloric acid (HCl) as the immersion fluid at 37±2°C for 2 hours to simulate gastric conditions. If no disintegration, cracking, or softening occurred, the test proceeded to the buffer stage using pH 6.8 phosphate buffer at 37±2°C until all tablets disintegrated. If one or two tablets failed, the test was repeated per USP monograph. Results were expressed as mean ± standard deviation.

Preparation of Buffers: Phosphate Buffer (pH 6.8): Dissolve 28.20g disodium hydrogen phosphate and 11.45g potassium dihydrogen phosphate in water to make 1000ml. Adjust pH to 6.8 using 0.1 M HCl. 0.1 M Hydrochloric Acid: Dilute 9.86ml of 32% HCl in water to make 1000ml.

2.6. Ethical considerations

This study did not deal with any human samples. The risks of this study include leaking. information about the Manufacturers. It was mitigated by coding the brand names. E.g. (S1, S2, S3)

2.7. Statistical analysis

The results obtained were analyzed as mean ± standard deviation. The statistical differences in the physicochemical parameters were further analyzed using ANOVA and t-test.

3. Results and discussion

Table 1 Documentation of three brands of diclofenac sodium tablets

Brand Name	Expiry date	Color	Shape	Coating	Registration status	Manufacture date	Country of Origin
S1	30/06/2024	Brown	Biconvex round	Enteric	Registered	01/07/2021	Germany
S2	30/10/2024	Orange	Biconvex round	Enteric	Registered	01/11/2021	India
S3	30/07/2024	caramel	flat round	film	registered	01/08/2021	South Africa

This table contains a detailed summary of the expiry, color, coating, registration status, manufacture, and Country of origin for each Formulation used in this study.

Table 2 Physico-chemical properties of three brands of diclofenac sodium tablets

Brand	Uniformity of weight, g (mean ± sd)	Friability, % loss (mean ±sd)	Drug content % w/w (mean± sd)	Crushing strength, Kg/cm ^{2}(mean± sd)	Crushing strength friability ratio (CSFR)	Disintegration Time (Mean Min ± SD Min)
S1	0.2049 ± 0.0031 (1.51%) *	0.00942 ± 0.00314	99.6% ± 0.000001	11.55 ± 0.483	1226.11	11.42 ± 0.564
S2	0.1977 ± 0.0044 (2.22%) *	0.012 ± 0.001	102.4% ± 3.70	19.15 ± 0.394	1595.83	22.12 ± 3.680
S3	0.1853 ± 0.00334 (1.80%)	0.239 ± 0.027	104.7% ± 2.40	10.83 ± 0.667	45.31	5.275 ± 0.6440

*Coefficient of variation

This table summarizes Uniformity of weight, Friability, crushing strength, disintegration time, crushing strength Friability ratio (this was obtained by dividing crushing strength by friability) data evaluated as per USP in this study and displayed by the results followed by its standard deviation.

Table 3 Raw data for percentage weight variation for the different brands

Tablet Number	Brand S1 weight variation %	Brand S2 weight variation %	Brand S3 weight variation %
1	-0.73	-1.87	0.566802
2	-0.73	-2.78	-0.72874
3	-1.90	1.97	-0.40486
4	3.66	-0.05	1.538462
5	-1.07	-2.22	-2.18623
6	2.34	-1.87	2.995951
7	0.39	0.81	-4.45344
8	-0.63	3.89	2.780027
9	0.83	3.79	-0.83671
10	-1.32	-0.81	-3.31984
11	-0.98	-3.34	-0.5668
12	-0.54	1.01	0.728745
13	0.54	2.07	0.404858
14	0	2.07	0.99865
15	-1.12	0.51	1.592443
16	0.98	2.02	-0.35088
17	2.54	-2.12	0.296896
18	1.76	1.72	0.728745

19	0.63	-2.28	0.080972
20	-1.61	2.28	0.026991
Mean ± SD weight	0.2049 ± 0.0031	0.1977 ± 0.0044	0.18525 ± 0.00334
95% Confidence Interval	(0.20625,0.203542)	(0.19962,0.19577)	(0.18671,0.183789)

This table summarizes the percentage difference between the mean average weight of each formulation's tablets from their individual tablet weight Variation = (Initial weight – Average weight)/Average weight * 100%, in addition it also displays the 95% confidence interval of each formulation used in this study.

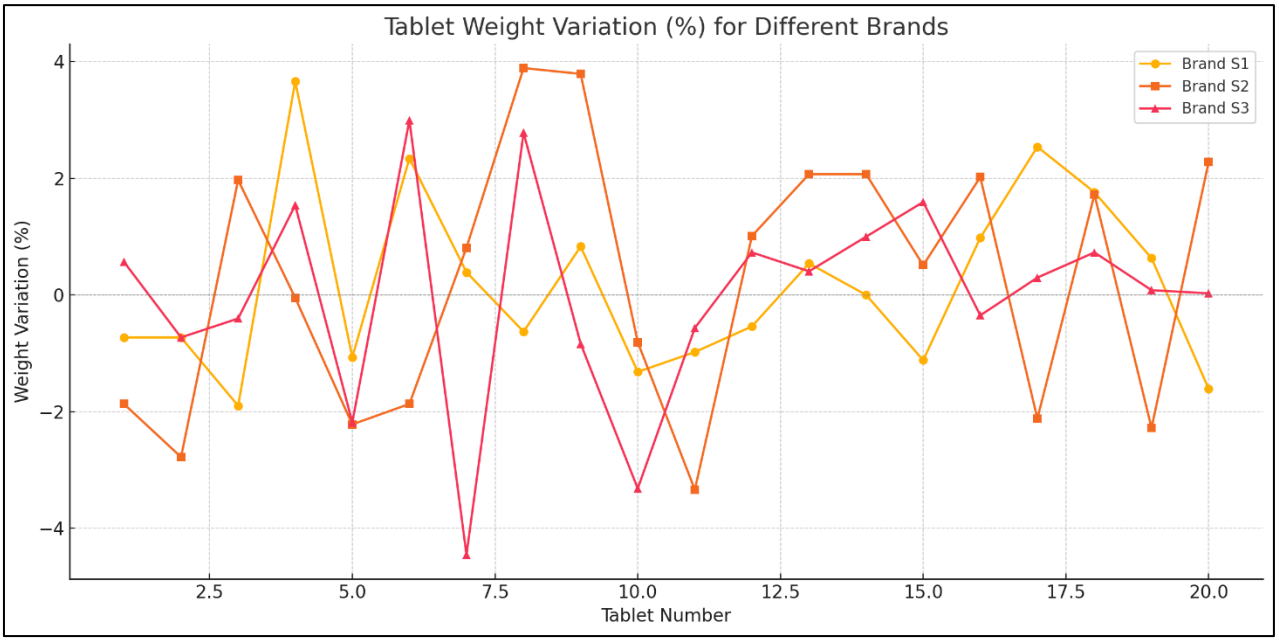

Figure 1 Graphical analysis of the percentage weight variance in Brand S1, S2 and S3

Table 4 Raw data for Friability results for the different brands

Test No.	**S1(change in mass, g)**	**S2 (change in mass, g)**	**S3 (change in mass, g)**
1	0.009428	0.011937	0.008097
2	0.006286	0	0.161961
3	0.012573	0.023876	0.548856
Mean Friability % ± SD	(0.00942 ± 0.00314)	(0.012 ± 0.001)	(0.239 ± 0.027)

This table summarizes the friability data obtained from this study by using this formula. Friability % = (W1-W2/ W1) *100%. Where W1 = initial weight, W2 = final weight. Each Formulation had three tests of friability conducted and the average was calculated.

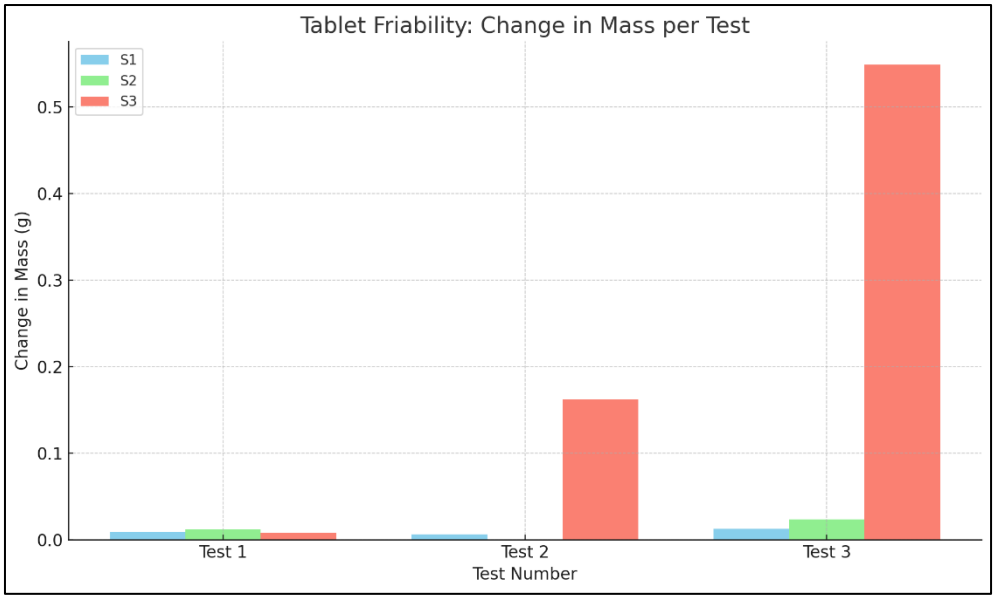

Figure 2 Graphical analysis of Friability data for brands S1, S2 and S3.

Table 5 Raw data for assay results for the different brands

Formulation	**Titre value ml**			**Average titre**	**Amount of diclofenac mg**	**% Purity**	**Amount of diclofenac in 1 tablet**
	T1	T2	T3	(AT) ml			
S1	6.5	6.5	6.5	6.5	50	99.6±0.0001	49.80
S2	6.5	7	6.5	6.7	50	102.4±3.70	51.2
S3	7	7	6.5	6.8	50	104.7±2.40	52.35
95% Confidence Interval					S1 (99.6000,99.5999)	S2 (104.6932,100.1068)	S3 (106.1875,103.2125)

This table summarizes the following: the tablets were weighed using an analytical balance and subsequently crushed into a fine powder using a ceramic mortar and pestle. From this powder, a precise measured 0.25 g aliquot was obtained and dissolved in 30 ml of glacial acetic acid. The resulting solution was then titrated with 0.1 M perchloric acid, employing crystal violet as the indicator, in adherence with the potentiometric determination method. The table also shows the % Purity and 95% Confidence Interval.

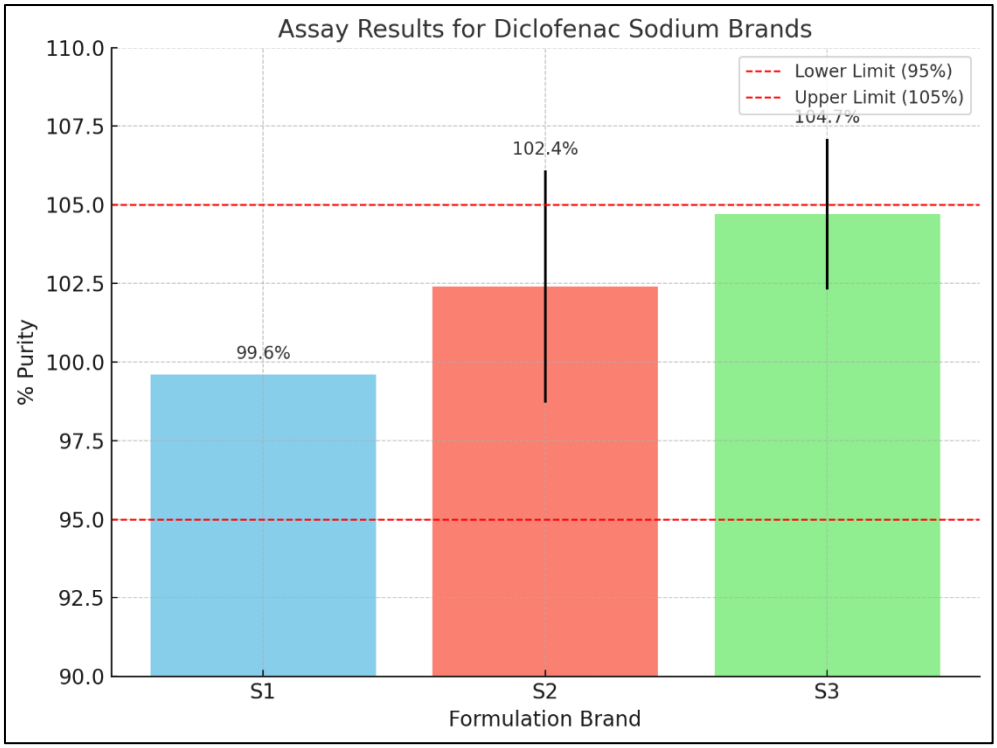

Figure 3 Graphical analysis of Assay data for brands S1, S2 and S3.

Table 6 Raw data for Hardness test for the different brands

Tablet No.	S1 (kg/cm²)	S2 (kg/cm²)	S3 (kg/cm²)
1	12	19	10.75
2	11	19.25	12
3	11.75	19.5	10.25
4	12	18.5	10.5
5	11	19.5	10.25
6	11.75	19	11
7	11	19.25	10.75
8	12	19.5	12
9	12	18.5	10.25
10	11	19.5	10.5
Mean Crushing Strength ± SD	11.55 ± 0.483	19.15 ± 0.394	10.83 ± 0.667
Confidence Interval	(11.849,11.251)	(19.394,18.901)	(11.2434,10.4166)

This table summarizes the following results from the hardness test for each of the formulation. Sample tablets (10) of each brand were taken; a tablet was placed between the spindle of the hardness tester (Monsanto type handheld version) and pressure was applied until the tablet broke. The mean crushing strength was evaluated with its standard deviations and 95% confidence intervals.

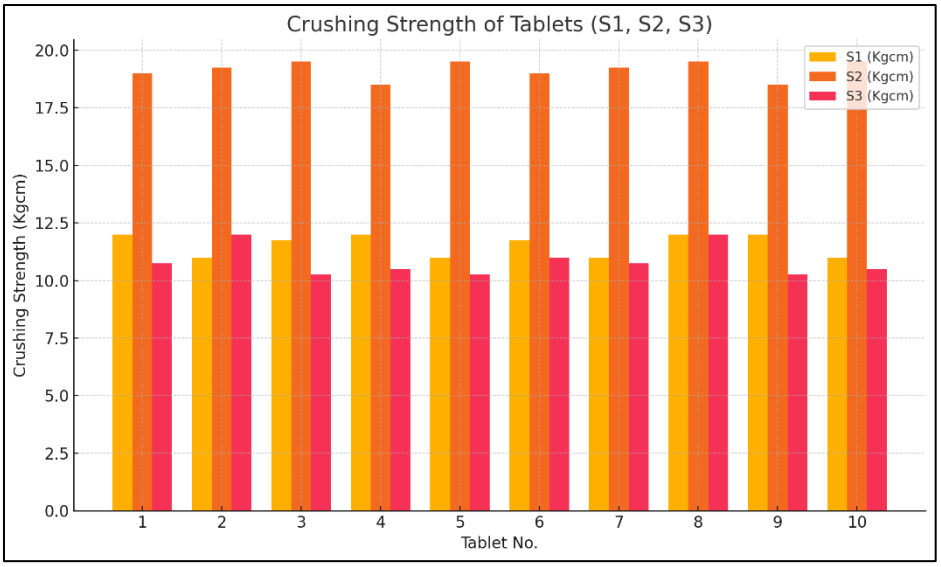

Figure 4 Graphical analysis of crushing strength of Brands S1, S2 and S3.

Table 7 Disintegration time of sodium diclofenac tablet brands.

Brand	**Disintegration time in simulated gastric fluid (SGF)**	**Disintegration time in simulated intestinal fluid (SIF)(Min:)**
S1	No disintegration after 120 minutes	11.42 ± 0.564
S2	No disintegration after 120 minutes	22.12 ± 3.68
S3	11:43 ± 0.35	5:275 ± 0.644

Table 8 Descriptive statistical analysis for disintegration time test.

	S1	**S2**	**S3**
Mean (Mins)	11.42	22.12	5.275
Standard Deviation (Mins)	0.564	3.68	0.644
Minimum (Mins)	11.02	19.53	4.52
Maximum (Mins)	12.5	29.5	6.44

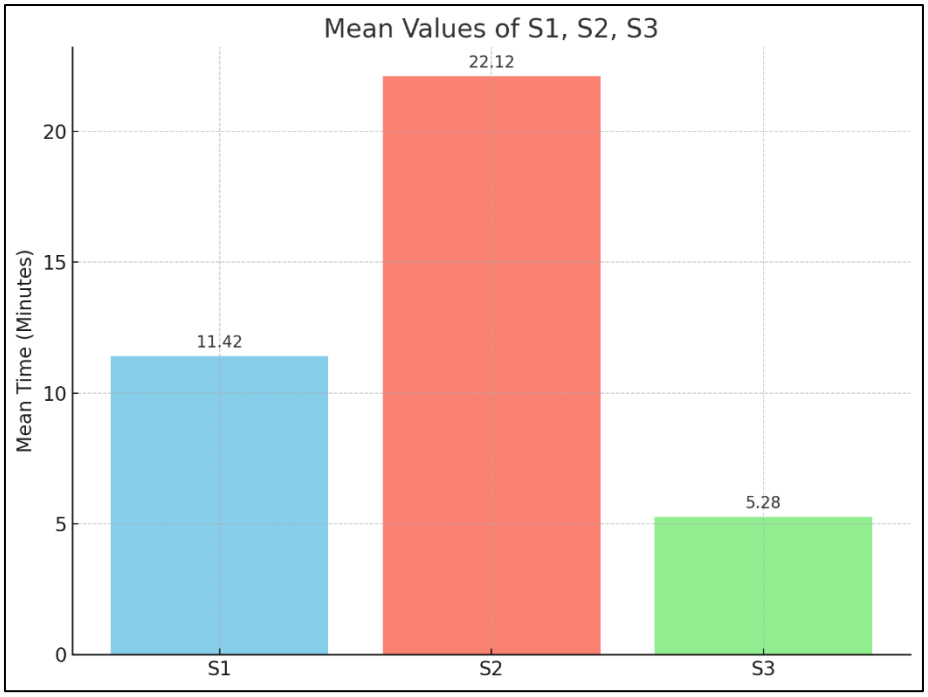

Figure 5 Graphical analysis of disintegration time test of Brands S1, S2. And S3

4. Discussion

We assessed the physicochemical quality of three generic 50 mg diclofenac sodium tablet brands that were commercially available in the Gaborone market (as of the time of this study). All brands passed the in-vitro quality analysis testing according to USP. The formulations were further classified into sustained release (S1 and S2) and immediate release tablets (S3).

4.1. Uniformity of weight

This test ensures that tablets within each batch fall within the appropriate size range, as variations can impact chemical content. According to USP pharmacopeia, no more than two tablets should deviate from the average weight by more than 10% for tablets weighing less than 130 mg. Maximum deviations: S1 (3.66%), S2 (3.89%), S3 (4.45%). All brands met USP weight uniformity standards. Significant differences in weight variation were observed among brands *(P<0.05)*. Excessive weight variation is typically due to poor granule flow, improper die filling, or air pockets in the granule bed. Variations may arise from high press speeds limiting homogeneous die filling, which can be improved using forced feeding, a feature available in modern tablet presses to enhance material flow consistency. [7][8].

4.2. Friability

Friability measures a tablet's resistance to chipping and breakage. A maximum weight loss of 1% is considered acceptable. All brands in this study met compendial standards, with friability values below 1%. S1: 0.00942% (Lowest friability, robust formulation) S2: 0.0120% (Consistent and low friability) S3: 0.239% (Highest friability, potential formulation issues). ANOVA revealed significant differences *(P < 0.05)* in friability among brands. S1 and S2 exhibited consistent, low friability, indicating strong interparticle bonding and optimal compression force during manufacturing. However, S3's significantly higher friability and variability suggest possible formulation inconsistencies. Potential Issues in S3: Insufficient binder concentration: Leads to weak tablet cohesion. Inadequate compression force: May cause tablets to crumble easily. Excipient variability: Differences in excipient properties could contribute to inconsistent results. Recommendations for S3: Optimize binder concentration and excipient quality. Ensure consistent tablet compression during manufacturing. Implement stricter quality control measures to minimize variability.

4.3. Crushing strength

Crushing strength evaluates a tablet's ability to withstand mechanical stress during handling, manufacturing, packaging, and shipping. It is a critical quality parameter alongside friability for consumer acceptance. Various manufacturing processes, including milling, blending, granulation, and coating, can influence tablet hardness. Recommended Range:

Acceptable crushing strength: 40 – 150N, Values outside this range require formulation or manufacturing adjustments. Results: S1: Consistent and within the acceptable range. S2: 191.5N (Exceeds recommended limits, may hinder disintegration). S3: Lowest and most variable hardness, indicating inconsistencies in manufacturing. ANOVA revealed significant differences *(P < 0.05)* among brands. S1 and S2 displayed low standard deviations, suggesting uniform manufacturing, whereas S3 exhibited variability. S2's excessive hardness may delay disintegration and dissolution, requiring further investigation. Potential Causes for High Hardness (S2): Wet granulation techniques: Impacting compactness. Excessive compression force: Leading to harder tablets. Excipients (binders & granulating agents): Strengthening tablet cohesion. Recommendations include adjusting compression force and granulation techniques for S2 while improving formulation consistency for S3.

4.4. Drug content uniformity (assay)

Diclofenac Sodium Tablets are stipulated to contain not less than 90.0% and not more than 110.0% of the labeled amount of Diclofenac sodium. The different brands ranged from 99.6% to 104.7% in purity. The results indicate that all the brands had high and acceptable contents of the active ingredient. It is essential for tablet formulations to pass the drug content test because even good mechanical properties of tablets cannot make up for insufficient drug content [6]. Furthermore *(P>0.05)* showed that there are no significant differences between the brands when it comes to purity. S1 is the most consistent and pharmacopeial compliant formulation, demonstrating high-quality manufacturing processes. S2 and S3, while meeting pharmacopeial standards, show greater variability and a tendency toward over-dosing, highlighting the need for process improvements to enhance batch consistency and safety. The tighter confidence intervals and low variability in S1 highlight superior quality control measures. The broader variability in S2 and S3 suggests the need for stricter process validation and in-process testing to improve batch consistency.[9]

4.5. Crushing strength friability ratio (CSFR)

CSFR provides a measure of tablet strength and weakness and has been described as a useful index for tablet quality. [10] It is reported that the higher the value of this index, the stronger the tablet. If the tablet has abnormally high CSFR values, there is a high chance it may not disintegrate efficiently or worse not to be able to disintegrate in the required period to meet compendial specifications. In this study S2 had the highest CSFR score followed by S1 then S3, confirming that S2 had the highest quality in respect to tablet mechanical strength, these values also coincided with the theory that high CSFR will increase disintegration time. Various factors influence CSFR, including binder type and concentration, and binders improve tablet cohesion. Too little binder reduces crushing strength, while excessive binder may decrease friability excessively. We would recommend that Formulation S2 re-evaluate on this parameter and investigate other factors that can cause CSFR e.g. binder type and concentration, thereby improving not only CSFR but also friability and disintegration time.

4.6. Disintegration time

All brands (S1, S2, S3) passed the disintegration test per USP limits. Complete disintegration was defined as the absence of residue, except for insoluble coating fragments. S1 and S3 fully disintegrated without residue, while S2 left behind light brown fragments and paper-like structures, suggesting variability in coating composition. Significant differences in disintegration times were observed across brands (Table 7), despite two being enteric-coated and one film-coated. The variation may be attributed to differences in polymer types used for coating, which manufacturers select based on preference. Table 8 provides descriptive statistics for disintegration time, showing S2 exhibited inconsistencies, with a disintegration time difference exceeding 10 minutes within the same batch. Some tablets disintegrated fully, while others retained their coating, indicating potential batch-to-batch variability. Quality control factors, including packaging, granulation, and compression, likely contributed to these discrepancies. Manufacturers should assess and refine production processes to enhance batch uniformity.

Abbreviations

- **NSAIDS**- non-steroidal anti-inflammatory drugs
- **BOMRA**- Botswana Medicines Regulatory
- **IHS**- Institute of Health Sciences
- **HPLC**- High-performance liquid chromatography
- **QC**- Quality Control
- **WHO**- World Health Organization
- **USP**- United States Pharmacopeia
- **BP**- British Pharmacopeia
- **DCF**- Diclofenac

- **S1 –** Sample 1
- **S2-** Sample 2
- **S3-** Sample 3

5. Conclusion

All the tested brands of Diclofenac Sodium 50 mg tablets (S1, S2, S3) complied with the official quality specifications (USP). This study encourages the need for constant surveillance on marketed drug products, to continually ensure that medicines in the Gaborone markets align with the Pharmacopeial standards. In addition, tablet S1 had superior pharmaceutical formulation to that of tablet S2 after comparing assay, friability, disintegration, hardness and uniformity of weight as computed on table 8. The brands were chemically equivalent but not pharmaceutically equivalent (S1 and S2).

Limitations

The Limitations of this study can be attributed to firstly a shortage of medicines in Botswana because of financial impact that Covid-19 had on procurement of medicines, which led to only the use of only three brands in this study, lastly the absence of dissolution and release studies from the selected formulations due to the absence of an operational dissolution apparatus.

Compliance with ethical standards

Disclosure of conflict of interest

This work was carried out in collaboration among all authors. Author SAK designed the study, performed data analysis, and wrote the manuscript, performed the experiments, and co-analyzed data. Author MOT supervised and critically reviewed the research proposal, the data analysis, the manuscript construction and was instrumental in guiding and mentoring, the research project and author BAM also designed the study, performed data analysis, and wrote the manuscript, performed the experiments, co-analyzed data (for the disintegration studies). All authors agree to be accountable for all aspects of the work and approved the final version of the manuscript

References

[1] Costa-Rama, E., Nouws, H. P. A., Delerue-Matos, C., Blanco-López, M. C., & Fernández-Abedul, M. T. (2019). Preconcentration and sensitive determination of the anti-inflammatory drug diclofenac on a paper-based electroanalytical platform. Analytica Chimica Acta, 1074, 89–97. https://doi.org/10.1016/j.aca.2019.04.056

[2] Chuasuwan B, Binjesoh V, Polli JE, Zhang H, Amidon GL, Junginger HE, et al. (.2009). Biowaiver monographs for immediate release solid oral dosage forms: Diclofenac sodium and diclofenac potassium. J. Pharm. Sci;1;98(4):1206-19. (https://jpharmsci.org/article/S0022-3549(16)32922-7/abstract)

[3] United States Pharmacopeia and National Formulary USP 39-NF 34; The United States Pharmacopeial Convention, Inc: Rockville MD. 2016;25 93-94. (https://www.uspnf.com/official-text/proposal-statuscommentary/usp-39-nf-34)

[4] British Pharmacopoeia (2010), Vol. 1. The Pharmaceutical Press, Her Majesty Stationery Office, London.

[5] Hassen HK, Mekasha YT, and Tegegne AA: A narrative review on problems in product quality, regulatory system constraints, and the concept of quality by design as a solution for quality assurance of African medicines. Front. Med. 2024 Oct 3; 11. doi: 10.3389/fmed.2024. 1472495..

[6] Ayorinde JO, Odeniyi MA, and Itiola AO: Evaluation of pharmaceutical and chemical equivalence of selected brands of diclofenac sodium tablets. East and Central African Journal of Pharmaceutical Sciences 2012; 15:3-9.

[7] Abdullah Al Ragib, Tariqul Islam, et al (2018). Comparative Study on Quality analysis on marketed Diclofenac sodium tablets of different brands available in Bangladesh. (DOI: 10.26479/2018.0404.32)

[8] Gupta M, Khoorban A, Ali A, et al. (2020) Comparative Quality Control Study of Different Brands of Diclofenac Sodium Tablet Available in Local and Government Pharmacies by In-Vitro Testing. Cureus 12(11): e11348. DOI 10.7759/cureus.11348 (https://pmc.ncbi.nlm.nih.gov/articles/PMC7720920/)

[9] Muhammad M. Hammami, Reem Alswayeh and Rajaa F. Hussein. (2020) Pharmaceutical quality of seven brands of diclofenac tablet on the Saudi market. (https://bmcresnotes.biomedcentral.com/articles/10.1186/s13104-020-05385-8)

[10] Chandrasekaran AR: Tablet assessment tests in the pharmaceutical industry. *Analytical Chemistry: An Indian Journal* 2011; **10**(9):581-589.