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Assessment of Aloe vera Mucilage as a Natural Disintegrant in Direct Compression Paracetamol Tablets

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Abstract: Tablet disintegration is essential for immediate-release oral dosage forms because it facilitates tablet breakup and subsequent drug dissolution. This study assessed Aloe vera mucilage as a natural disintegrant in 100 mg direct-compression paracetamol tablets. Seven formulations were prepared: one negative control without a disintegrant, Aloe vera mucilage formulations containing two, five, and ten percent by weight, and carboxymethyl starch formulations at corresponding concentrations. The extracted mucilage was characterized by percentage yield, organoleptic properties, qualitative solubility or dispersion behavior, swelling index, moisture content, and Fourier transform infrared spectroscopy. Powder blends were evaluated for flow and packing properties, while tablets were assessed for weight variation, dimensions, breaking force, friability, disintegration, dissolution, and drug content. Mean mucilage yield was 0.17 percent with a standard deviation of 0.07 percent. The mean swelling index was 120.00 percent with a standard deviation of 52.92 percent, and mean moisture content was 16.90 percent with a standard deviation of 3.34 percent. Among the Aloe vera formulations, the ten percent formulation showed the strongest disintegrant performance, with a mean disintegration time of 40.83 seconds and a standard deviation of 4.54 seconds, and 99.00 percent drug release at 45 minutes. All formulation means fell within the 90 to 110 percent drug-content range used in the study. Carboxymethyl starch generally produced better powder flow and faster disintegration. Aloe vera mucilage therefore demonstrated concentration-dependent and promising natural-disintegrant activity, although optimization of powder flow, drying, moisture control, and manufacturing consistency is required before scale-up.

Keywords: *Aloe Vera Mucilage; Natural Disintegrant; Paracetamol Tablets; Direct Compression; Tablet Disintegration; Dissolution; Pharmaceutical Excipient*.

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I. INTRODUCTION

Tablet disintegration is a critical early step in the performance of immediate-release oral dosage forms. Disintegrants promote the entry of fluid into the compact and facilitate breakup through mechanisms that include wicking, swelling, particle repulsion, and recovery from deformation. The resulting fragments provide a larger surface area for dissolution of the active pharmaceutical ingredient [1,2].

Plant-derived gums and mucilages are increasingly investigated as pharmaceutical excipients because their hydrophilic polysaccharide networks can absorb water, swell, and form dispersions or gels. Their functionality, however, depends on botanical source, extraction method, particle size, residual moisture, and formulation concentration [3, 4]. These factors make direct evaluation necessary before a plant mucilage can be proposed for tablet manufacture.

The accepted botanical name of the plant used in this study is *Aloe vera* (L.) Burm.f.; *Aloe barbadensis* Mill. is a taxonomic synonym [5]. *Aloe vera* inner-leaf mucilage contains polysaccharide-rich material associated with water binding and swelling. Acemannan, an acetylated glucomannan reported in *Aloe vera*, has been widely studied for its structural and hydration properties [6,7]. Aloe-derived polymers have also been investigated as release-modifying matrices and other dosage-form excipients [8].

Previous work has shown that *Aloe vera* mucilage can function as a tablet binder, demonstrating that it can be incorporated into paracetamol formulations without preventing tablet formation [9]. Nevertheless, evidence directly evaluating *Aloe vera* mucilage as the primary disintegrant in direct-compression paracetamol tablets remains limited. A disintegrant must not only shorten

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disintegration but also maintain workable powder flow, mechanical integrity, drug release, and drug content.

This study therefore assessed *Aloe vera* mucilage at 2%, 5%, and 10% w/w as a natural disintegrant in 100 mg direct-compression paracetamol tablets. The *Aloe vera* formulations were compared with a formulation without disintegrant and with carboxymethyl starch (CMS) at corresponding concentrations. Mucilage characteristics, powder-flow properties, tablet physical quality, disintegration, dissolution, and drug content were evaluated to identify the concentration that provided the most favorable balance between manufacturability and immediate-release performance.

II. MATERIALS AND METHODS

➢ *Study Design and Materials*

An experimental quantitative design was used. Seven 100 mg direct-compression tablet formulations were evaluated: ND, a negative control without disintegrant; AD1, AD2, and AD3 containing *Aloe vera* mucilage at 2%, 5%, and 10% w/w, respectively; and CD1, CD2, and CD3 containing CMS at 2%, 5%, and 10% w/w, respectively. Each tablet contained 80 mg paracetamol. The other ingredients were microcrystalline cellulose, talc, and magnesium stearate. Paracetamol, microcrystalline cellulose, talc, and magnesium stearate were reported as USP grade, while CMS was reported as analytical grade. Manufacturer, lot, and instrument model information was not provided in the final thesis and should be supplied before journal submission.

➢ *Plant Material Collection and Authentication*

Fresh mature *Aloe vera* leaves were obtained from cultivated plants at The Aloe Vera Garden in Davao City, Davao del Sur, Philippines. Botanical authentication was completed by the Department of Plant Biology, Mindanao State University-Iligan Institute of Technology (MSU-IIT).

➢ *Extraction of Aloe vera Mucilage*

The leaves were washed with distilled water, the outer rind was removed, and the inner gel was collected and homogenized. Three volumes of 95% ethanol were added to precipitate the mucilage-rich fraction. The precipitate was filtered, dried in a hot-air oven at 40-45 °C, pulverized, passed through a No. 60 mesh sieve, and stored in an airtight container protected from moisture and light. Percentage yield was determined in triplicate using 10 g of fresh Aloe material per trial [6,8].

➢ *Mucilage Characterization and Fourier Transform Infrared Spectroscopy*

The dried powdered mucilage was evaluated for color, odor, texture, and appearance. Qualitative solubility or dispersion behavior was observed in distilled water, 95% ethanol, 0.1 M hydrochloric acid, and 0.1 M sodium hydroxide. Swelling index and moisture content were determined in triplicate. Fourier transform infrared spectroscopy (FTIR) was performed through the Center of Sustainable Polymers, MSU-IIT, to identify functional groups associated with polysaccharide-rich material [10].

➢ *Tablet Formulation and Preparation*

The formulation was adapted with modification from a published natural-disintegrant paracetamol study [11]. Paracetamol, microcrystalline cellulose, and the assigned disintegrant were blended until uniform. Talc was added as a glidant, followed by magnesium stearate, which was mixed briefly to minimize over-lubrication. The blends were compressed using a single-punch tablet press. Exact blending times, compression force, machine settings, and the quantity prepared per trial were not reported.

Table 1 Composition of Direct Compression Paracetamol Tablet Formulations

Ingredient (mg)	ND	AD1	AD2	AD3	CD1	CD2	CD3
Paracetamol	80	80	80	80	80	80	80
Microcrystalline cellulose	18.5	16.5	13.5	8.5	16.5	13.5	8.5
Aloe vera mucilage	-	2	5	10	-	-	-
Carboxymethyl starch	-	-	-	-	2	5	10
Talc	1	1	1	1	1	1	1
Magnesium stearate	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100	100

ND = No Disintegrant; AD1-AD3 = Aloe Vera Mucilage at 2%, 5%, and 10% w/w; CD1-CD3 = CMS at 2%, 5%, and 10% w/w.

➢ *Pre-compression Evaluation*

Each formulation blend was evaluated in triplicate for angle of repose, bulk density, tapped density, Carr's index, and Hausner ratio. The tests were conducted using standard funnel and graduated-cylinder procedures. These measures were interpreted collectively because no single test fully characterizes powder flow [12,13].

➢ *Post-compression Evaluation*

Weight variation was evaluated using 20 tablets per formulation per trial. Thickness and diameter and tablet breaking force were measured using 10 tablets per formulation per trial. Breaking force was reported in kilogram-force. Tensile strength was calculated as $2F/(\pi DT)$, where F was breaking force and D and T were tablet diameter and thickness in centimeters, yielding kgf/cm². Friability was evaluated using 20 tablets per trial at 25 rpm for 4 min, corresponding to 100 rotations. Six tablets per formulation per trial were evaluated in 900 mL distilled water at 37 ± 2°C using a basket-rack disintegration apparatus. These tests were performed in triplicate [14,15,16,17].

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➢ *Dissolution and Drug Content Analysis*

Dissolution testing used USP Apparatus 1 at 50 rpm with 900 mL simulated gastric fluid at pH 1.2 and 37 ± 0.5 °C. Samples of 2.5 mL were withdrawn at 5, 10, 20, 30, 45, and 60 min and replaced with equal volumes of prewarmed medium. Samples were analyzed at 243 nm. Standard paracetamol solutions of 2, 4, 6, 8, and 10 µg/mL produced the calibration equation $y = 0.059517x + 0.076300$ with $R^2 = 0.996556$. Dilution factors were 3 at 5 and 10 min, 5 at 20 and 30 min, and 11 at 45 and 60 min; cumulative release was corrected for withdrawn samples [18].

For drug-content analysis, 10 tablets per formulation were assayed individually per trial. Each tablet was dissolved in 100 mL distilled water and filtered. A 1 mL aliquot was further diluted to 100 mL and analyzed at 243 nm using the same calibration curve. The theoretical paracetamol content was 80 mg per tablet, and results were compared with the 90%-110% range in the USP acetaminophen-tablet monograph [19].

➢ *Statistical Analysis*

Results were summarized as mean ± standard deviation. The source tables indicate three trial-level values per formulation for inferential analysis, consistent with the reported residual degrees of freedom. Shapiro-Wilk and Levene tests were used to assess normality and variance homogeneity. Depending on assumptions, analyses used one-way analysis of variance (ANOVA) with Tukey honestly significant difference, Welch ANOVA with Games-Howell comparisons, or Kruskal-Wallis tests with Bonferroni-adjusted Dunn comparisons. Statistical significance was set at $p < .05$. Effect sizes were reported as η^2 or ε^2.

III. RESULTS AND DISCUSSION

➢ *Mucilage Yield and Physicochemical Characteristics*

The dried-mucilage yields were 0.12%, 0.14%, and 0.25%, giving a mean of 0.17 ± 0.07%. The material was an odorless, off-white to pale-brown, fine to slightly coarse, fibrous, amorphous powder. It was slightly soluble in distilled water, 0.1 M hydrochloric acid, and 0.1 M sodium hydroxide, where it formed swollen or gel-like dispersions, and it was insoluble in 95% ethanol. This hydration behavior is consistent with plant mucilage, which commonly swells and disperses rather than dissolves completely [3,4].

Swelling-index values were 180%, 80%, and 100%, with a mean of 120.00 ± 52.92%. The large standard deviation indicates limited repeatability, possibly related to particle packing, trapped air, hydration time, and the visual identification of the swollen boundary. Moisture contents were 13.9%, 20.5%, and 16.3%, with a mean of 16.90 ± 3.34%. This result was treated as residual moisture rather than a pharmacopeial pass criterion. The relatively high and variable moisture underscores the need for improved drying, humidity control, microbial-limit testing, and stability evaluation.

Table 2 Yield and Physicochemical Characteristics of *Aloe vera* Mucilage

Characteristic	Trial or Medium	Result
Percentage yield	Trials 1, 2, and 3	0.12%, 0.14%, and 0.25%; mean 0.17 ± 0.07%
Organoleptic properties	Dried powder	Off-white to pale brown; odorless; fine to slightly coarse and fibrous; amorphous
Dispersion behavior	Distilled water	Slightly soluble; viscous gel-like mass with partial swelling
Dispersion behavior	95% ethanol	Insoluble; settled with visible phase separation
Dispersion behavior	0.1 M HCl	Slightly soluble; thick brownish swollen mass
Dispersion behavior	0.1 M NaOH	Slightly soluble; swollen semi-gelatinous dispersion
Swelling index	Trials 1, 2, and 3	180%, 80%, and 100%; mean 120.00 ± 52.92%
Moisture content	Trials 1, 2, and 3	13.9%, 20.5%, and 16.3%; mean 16.90 ± 3.34%

Values are Reproduced from the Revised Final Thesis. No Acceptance Specification was Assigned To Mucilage Yield, Swelling Index, or Moisture Content.

➢ *Fourier Transform Infrared Spectral Characteristics*

The FTIR spectrum showed a broad band at 3200-3600 cm^{-1} assigned to O-H stretching, a weaker region at 2850-3000 cm^{-1} assigned to C-H stretching, a band at 1600-1700 cm^{-1} associated with bound water or carbonyl-related vibration, and strong absorption at 1000-1200 cm^{-1} assigned to C-O and C-O-C stretching. These regions support the presence of hydroxyl-rich and carbohydrate-related functional groups in the extracted material [6,10]. FTIR did not quantify acemannan or glucomannan and did not establish purity or drug-excipient compatibility.

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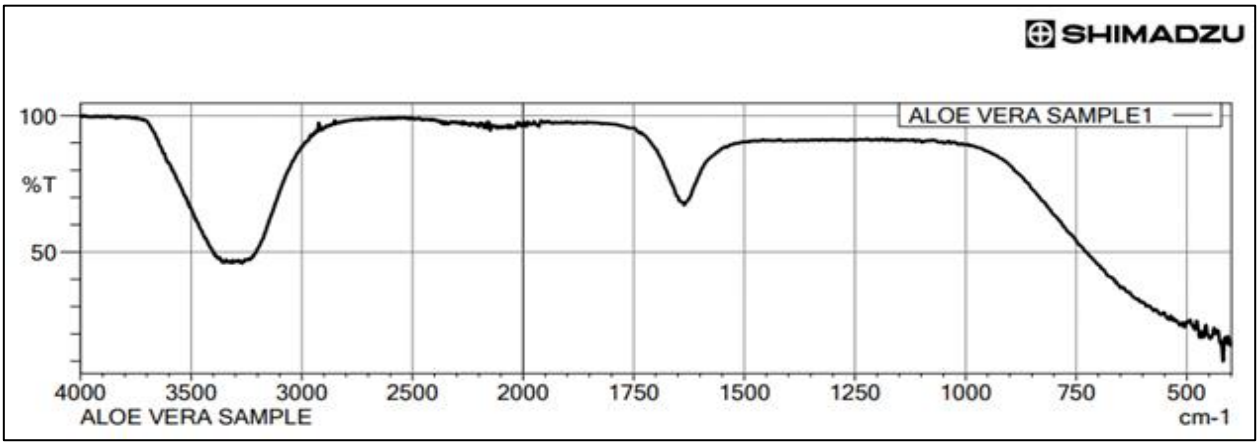

Fig 1 Fourier Transform Infrared Spectrum of Extracted *Aloe vera* Mucilage.

Table 3 Major Fourier Transform Infrared Absorption Regions of *Aloe vera* Mucilage

Observed Region (cm^{-1})	Assignment	Interpretation
3200-3600	O-H stretching	Hydroxyl-rich groups associated with hydrophilicity and hydrogen bonding
2850-3000	C-H stretching	Aliphatic components of the natural polymer
1600-1700	Bound-water or C=O region	Moisture-associated or acetyl/carbonyl-related vibration; not structurally definitive
1000-1200	C-O and C-O-C stretching	Glycosidic and carbohydrate-backbone region

➢ *Pre-compression Properties*

The powder blends were workable at laboratory scale, but flow differed among formulations. CD3 showed the most favorable overall profile, with a Carr's index of 14.62 ± 1.87% and Hausner ratio of 1.17 ± 0.03. AD2 showed fair-to-passable flow, whereas AD3 showed poor flow by Carr's index and Hausner ratio despite a passable angle of repose.

Thus, AD2 offered a better processing balance, while the higher mucilage content in AD3 appeared to increase cohesiveness. Angle of repose did not differ significantly, $F(6, 14) = 1.71$, $p = .192$. Bulk density, tapped density, Carr's index, and Hausner ratio differed significantly across formulations, with η^2 values of 0.84-0.90.

Table 4 Precompression Properties of the Formulation Blends

Code	Angle of Repose (°)	Bulk Density (g/mL)	Tapped Density (g/mL)	Carr's Index (%)	Hausner Ratio	Overall Flow
ND	34.46 ± 3.85	0.2971 ± 0.0051	0.4414 ± 0.0114	32.68 ± 0.56	1.49 ± 0.01	Poor
AD1	37.45 ± 1.26	0.3533 ± 0.0148	0.4624 ± 0.0239	23.50 ± 3.62	1.31 ± 0.06	Passable
AD2	38.33 ± 1.81	0.3622 ± 0.0203	0.4552 ± 0.0207	20.36 ± 4.82	1.26 ± 0.08	Fair-passable
AD3	38.47 ± 1.35	0.3451 ± 0.0119	0.4921 ± 0.0137	29.88 ± 1.24	1.43 ± 0.03	Poor
CD1	35.85 ± 2.42	0.3192 ± 0.0058	0.3803 ± 0.0171	15.89 ± 5.18	1.19 ± 0.08	Fair
CD2	35.94 ± 0.77	0.3297 ± 0.0058	0.4111 ± 0.0096	19.76 ± 2.96	1.25 ± 0.05	Fair
CD3	35.05 ± 1.72	0.4004 ± 0.0161	0.4690 ± 0.0125	14.62 ± 1.87	1.17 ± 0.03	Good

Values are mean ± SD of Three Trial-Level Measurements. Formulation Codes are Defined in Table 1.

➢ *Post-compression Physical Quality*

All formulations produced tablets with a constant diameter of 8.00 mm and mean thicknesses of 2.52-2.68 mm. Thickness showed a significant omnibus ANOVA, $F(6, 14) = 2.87$, $p = .049$, but no Tukey-adjusted pairwise comparison was significant. Breaking force ranged from 2.89 ± 0.04 to 3.29 ± 0.02 kgf across trial-level summaries. The tensile-strength values calculated from breaking force and tablet dimensions ranged from 8.64 ± 0.19 to 9.84 ± 0.26 kgf/cm^2. These mechanical values were interpreted together with friability and release performance rather than against an unsupported universal hardness range [14,15].

All mean friability values were below 1.00%, ranging from 0.69 ± 0.10% for AD3 to 0.81 ± 0.11% for AD1, and Welch ANOVA was not significant, $F(6, 6.08) = 1.72$, $p = .262$. Mean tablet weights exceeded the nominal 100 mg target and showed considerable within-formulation variability, particularly in the *Aloe vera* groups. Weight variation did not differ significantly among formulations, $H(6) = 1.45$, $p = .963$, suggesting that the variation was more consistent with operator-controlled die filling and compression than a formulation-specific effect.

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Table 5 Post-Compression Physical Quality and Drug Content of the Tablet Formulations

Code	Tablet Weight (mg)	Thickness (mm)	Breaking Force (kgf)	Tensile Strength (kgf/cm²)	Friability (%)	Drug Content (%)
ND	118.62 ± 13.42	2.67 ± 0.19	3.29 ± 0.02	9.84 ± 0.26	0.72 ± 0.09	96.77 ± 4.09
AD1	122.03 ± 18.81	2.59 ± 0.22	3.07 ± 0.02	9.15 ± 0.21	0.81 ± 0.11	100.88 ± 3.04
AD2	120.75 ± 17.85	2.68 ± 0.21	3.00 ± 0.03	8.64 ± 0.19	0.76 ± 0.08	101.60 ± 2.79
AD3	123.47 ± 18.76	2.56 ± 0.20	2.89 ± 0.04	8.76 ± 0.31	0.69 ± 0.10	104.08 ± 4.62
CD1	112.58 ± 7.63	2.59 ± 0.20	3.09 ± 0.03	9.22 ± 0.28	0.74 ± 0.07	103.12 ± 1.89
CD2	120.70 ± 14.21	2.52 ± 0.23	3.02 ± 0.02	9.34 ± 0.35	0.78 ± 0.09	103.90 ± 4.01
CD3	115.45 ± 10.09	2.52 ± 0.20	2.97 ± 0.02	9.15 ± 0.23	0.71 ± 0.06	106.08 ± 3.76

Diameter was 8.00 ± 0.00 mm for Every Formulation. Breaking-Force and Tensile-Strength SD Values are SDs of the Three Trial Means.

➢ *Disintegration Performance*

Disintegration decreased markedly with increasing *Aloe vera* mucilage concentration. ND required 870.78 ± 67.09 s, whereas AD1, AD2, and AD3 required 312.33 ± 44.73, 128.61 ± 30.22, and 40.83 ± 4.54 s, respectively. CMS was faster overall, with CD3 disintegrating in 7.06 ± 0.64 s. Welch ANOVA showed a significant formulation effect, $F(6,5.64) = 17{,}829.43$, $p < .001$. Games-Howell comparisons found no statistically significant difference between AD3 and CD1 (mean difference 4.44 s, $p = .609$); this indicates that no difference was detected under the study design, not that the formulations were formally equivalent. All other reported pairwise comparisons were significant.

Table 6 Disintegration Time of the Paracetamol Tablet Formulations

Code	Mean ± SD (s)	Mean (Min)	Interpretation
ND	870.78 ± 67.09	14.51	Within the ≤15 min criterion
AD1	312.33 ± 44.73	5.21	Within the ≤15 min criterion
AD2	128.61 ± 30.22	2.14	Within the ≤15 min criterion
AD3	40.83 ± 4.54	0.68	Within the ≤15 min criterion
CD1	36.39 ± 5.14	0.61	Within the ≤15 min criterion
CD2	19.22 ± 2.46	0.32	Within the ≤15 min criterion
CD3	7.06 ± 0.64	0.12	Within the ≤15 min criterion

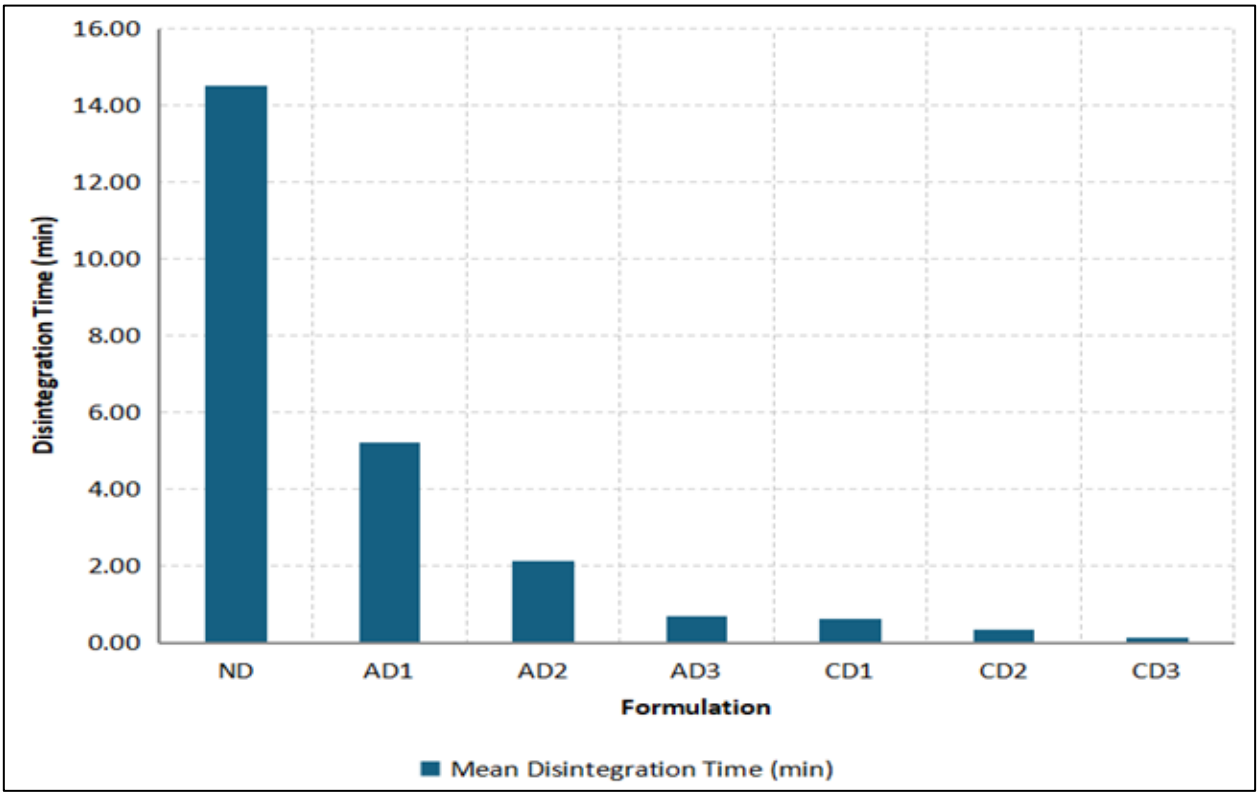

Fig 2 Mean Disintegration Time of the Paracetamol Tablet Formulations.

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➢ *Dissolution Profile*

All formulations reached at least 70% paracetamol release by 45 min under the criterion used in the study. Release increased across the *Aloe vera* series, and AD3 reached 99.00 ± 0.67% at 45 min and 103.01 ± 0.79% at 60 min. Kruskal-Wallis tests were significant at each sampling time ($p = .003$). After Bonferroni correction, only CD3 versus ND remained significant at each time point. Accordingly, the *Aloe vera* and CMS profiles indicate concentration-related numerical trends, but they do not demonstrate statistical superiority or formal equivalence.

Values above 100% were retained exactly as measured. They should not be interpreted as enhanced biological performance and may reflect calibration, dilution, cumulative-sampling correction, tablet-content variation, or other analytical variability. An audit of the raw absorbance values and calculation workbook should be completed before submission. Comparable quality-control studies emphasize that dissolution interpretation depends on the complete analytical method and the applicable product specification [20].

Table 7 Dissolution Profiles of the Paracetamol Tablet Formulations

Code	5 Min (%)	10 Min (%)	20 Min (%)	30 Min (%)	45 Min (%)	60 Min (%)
ND	7.50 ± 0.51	14.55 ± 0.52	26.50 ± 0.50	38.50 ± 0.61	72.00 ± 0.67	79.51 ± 0.79
AD1	10.50 ± 0.51	17.05 ± 0.52	31.00 ± 0.50	42.50 ± 0.61	84.50 ± 0.67	90.01 ± 0.79
AD2	14.50 ± 0.51	22.55 ± 0.52	40.50 ± 0.50	50.00 ± 0.61	92.00 ± 0.67	97.51 ± 0.79
AD3	18.50 ± 0.51	28.55 ± 0.52	50.00 ± 0.50	60.00 ± 0.61	99.00 ± 0.67	103.01 ± 0.79
CD1	19.50 ± 0.51	29.55 ± 0.52	52.00 ± 0.50	62.00 ± 0.61	101.00 ± 0.67	104.51 ± 0.79
CD2	21.50 ± 0.51	31.85 ± 0.52	55.50 ± 0.50	65.00 ± 0.61	103.50 ± 0.67	106.51 ± 0.79
CD3	23.20 ± 0.51	34.05 ± 0.52	58.50 ± 0.50	67.50 ± 0.61	105.50 ± 0.67	109.01 ± 0.79

Values are Reported Cumulative Paracetamol Release (mean ± SD). Results Above 100% were not Truncated or Normalized.

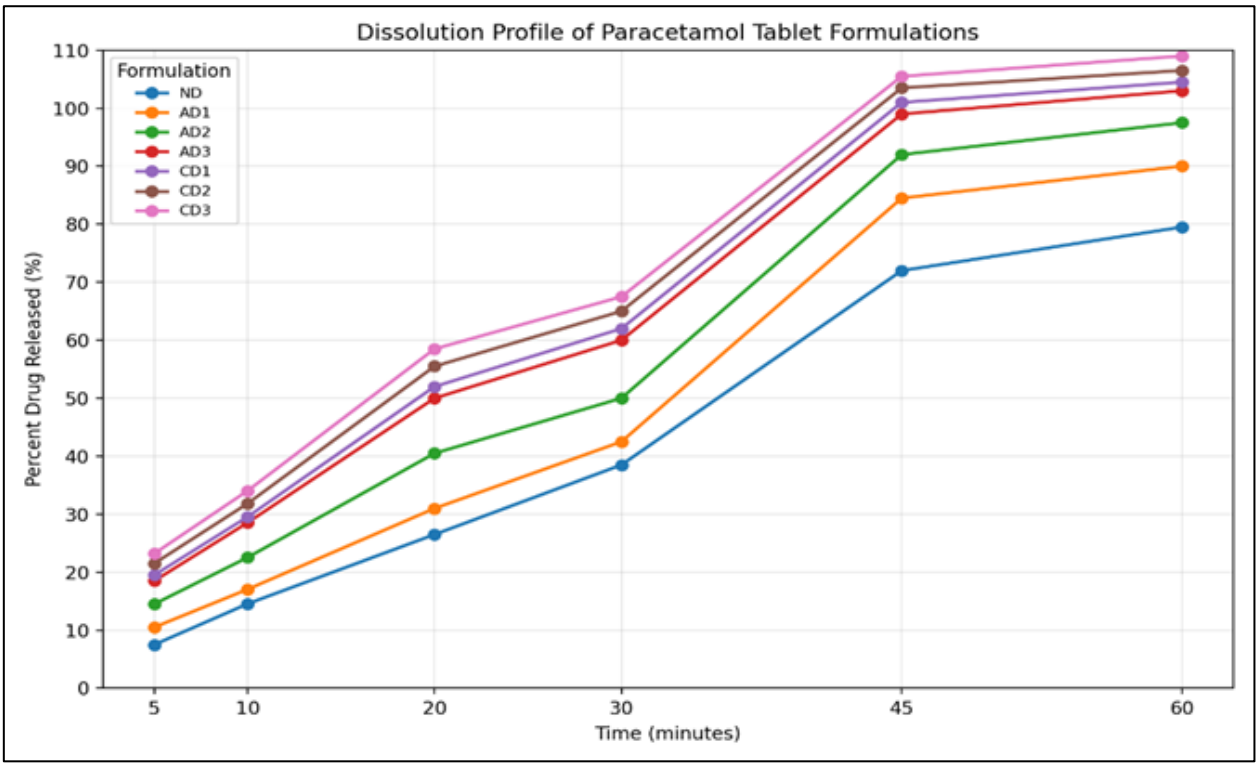

Fig 3 Dissolution Profiles of the Seven Paracetamol Tablet Formulations.

➢ *Drug Content*

Mean drug content ranged from 96.77 ± 4.09% in ND to 106.08 ± 3.76% in CD3, and all formulation means were within the 90%-110% monograph range [19]. ANOVA was significant, $F(6, 14) = 491.23$, $p < .001$. Recalculation from the reported sums of squares gave $\eta^2 = 0.995$, which was rounded to 1.00 in the thesis. Significant differences among means did not imply failure of any formulation because all means remained within the predefined range. AD3 did not differ significantly from CD2 in the reported Tukey analysis ($p = .955$).

➢ *Comparative Interpretation and Study Limitations*

AD3 provided the strongest evidence of disintegrant action among the *Aloe vera* formulations, while AD2 provided a more favorable balance when powder handling was prioritized. AD3 combined rapid disintegration and high drug release with poorer precompression flow, demonstrating the trade-off between functional performance and manufacturability. CMS remained more efficient in powder flow and fastest disintegration. *Aloe vera* mucilage should therefore be considered promising rather than a complete replacement for CMS.

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The findings are limited to the tested paracetamol composition, 100 mg target tablet weight, extraction process, and laboratory conditions. Other limitations include three trial-level observations per formulation, a laboratory-scale single-punch press, limited control of die filling and compression force, natural-material variability, residual moisture, absence of quantitative acemannan or glucomannan analysis, absence of direct drug-mucilage compatibility testing, and no microbial-limit, long-term stability, toxicity, scale-up, or in vivo bioavailability evaluation. Analytical review is also required for dissolution values above 100%.

Table 8 Summary of Inferential Statistical Findings

Parameter	Test	Statistic	p-value	Effect Size	Principal Interpretation
Angle of repose	One-way ANOVA	$F(6,14)=1.71$	$p=.192$	$\eta^2=.423$	Not significant
Bulk density	One-way ANOVA	$F(6,14)=20.48$	$p<.001$	$\eta^2=.898$	Significant
Tapped density	One-way ANOVA	$F(6,14)=16.08$	$p<.001$	$\eta^2=.873$	Significant
Carr's index	One-way ANOVA	$F(6,14)=12.53$	$p<.001$	$\eta^2=.843$	Significant
Hausner ratio	One-way ANOVA	$F(6,14)=15.75$	$p<.001$	$\eta^2=.871$	Significant
Weight variation	Kruskal-Wallis	$H(6)=1.45$	$p=.963$	$\varepsilon^2=.07$	Not significant
Thickness	One-way ANOVA	$F(6,14)=2.87$	$p=.049$	$\eta^2=.55$	Omnibus significant; no adjusted pair significant
Breaking force	One-way ANOVA	$F(6,14)=44.86$	$p<.001$	$\eta^2=.95$	Significant
Tensile strength	One-way ANOVA	$F(6,14)=3.44$	$p=.027$	$\eta^2=.60$	Omnibus significant; no adjusted pair significant
Friability	Welch ANOVA	$F(6,6.08)=1.72$	$p=.262$	-	Not significant
Disintegration	Welch ANOVA	$F(6,5.64)=17829.43$	$p<.001$	-	Significant; AD3 vs CD1 $p=.609$
Dissolution	Kruskal-Wallis	$H\approx19.58$-19.64	$p=.003$	$\varepsilon^2=.98$	Only CD3 vs ND remained significant after correction
Drug content	One-way ANOVA	$F(6,14)=491.23$	$p<.001$	$\eta^2=.995$	Significant; all means within 90%-110%

IV. CONCLUSION

Aloe vera mucilage demonstrated promising concentration-dependent disintegrant activity in the evaluated direct-compression paracetamol tablets. The extracted material showed water uptake and swelling behavior, while FTIR supported the presence of functional groups consistent with polysaccharide-rich mucilage. Tablets containing *Aloe vera* mucilage maintained usable mechanical quality, friability below 1.00%, and mean drug content within the 90%-110% range used in the study.

AD3, containing 10% w/w *Aloe vera* mucilage, showed the strongest natural-disintegrant performance, with a mean disintegration time of 40.83 ± 4.54 s and 99.00 ± 0.67% release at 45 min. AD2 provided a more favorable precompression processing balance, whereas AD3 showed better immediate-release performance but poorer powder flow. CMS remained superior in overall powder flow and fastest disintegration. Therefore, *Aloe vera* mucilage cannot yet be considered a complete CMS replacement, but it merits further optimization as a natural immediate-release tablet excipient.

RECOMMENDATIONS

Future work should evaluate intermediate mucilage concentrations of 6%-9% w/w and improve control of die filling, compression force, drying, particle-size distribution, residual moisture, and storage. Larger independently prepared batches should be tested to confirm reproducibility. Microbial-limit and stability studies are necessary, particularly because the extracted mucilage retained appreciable moisture. Validated quantitative methods should be used to determine acemannan and glucomannan content. Drug-excipient compatibility should be assessed using the actual paracetamol-mucilage mixture, and dissolution calculations should be audited against raw absorbance data. Comparisons with established superdisintegrants, additional immediate-release active ingredients, and, when justified, in vivo performance studies would clarify the broader pharmaceutical applicability of *Aloe vera* mucilage.

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