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Research Article

Design, Characterization and Optimization of Fast Dispersible Herbal Tablet Containing *Ashwagandha, Amla* and *Ginger*

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ABSTRACT

Background: In the ever-changing world of Pharmaceutics, continuous modern inventions are crucial for the improvement in patient compliance, stability and efficacy of formulations.
Aim: Thus, attempt was made to optimize the formulation of a fast-dissolving herbal tablet, containing the extracts of *Ashwagandha, Amla and Ginger*.
Method: Direct compression method was employed for formulation of herbal tablet by mixing suitable excipients and herbal drugs. The independent variables chosen were croscarmellose sodium (CCS) and sodium starch glycolate (SSG). Dependent variables that were tested upon the formulations were hardness and dispersion time.
Results: Average weight of the formulated tablet was 318.43mg and dispersion time was found to be 58.7 seconds. Attenuated total reflectance infrared (ATR-IR) spectroscopy revealed that there were no major interactions between the excipients and the herbal drugs. The average particle size was calculated from XRD data using Scherrer Equation which was found to be 7.956 nm. The microstructure of formulated herbal tablet was observed using field emission scanning electron microscopy (FE-SEM) imaging, which also showed that the herbal constituents were homogeneously distributed throughout the herbal tablet. Antioxidant study showed good radical scavenging activity (% RSA) reaching up to 95.77%.
Conclusion: Qualitative and quantitative HPTLC showed that the herbal components were sufficiently incorporated in the formulations.

Keywords*: Herbal tablet, Nutraceuticals, Ashwagandha, Amla, Ginger, Optimization, HPTLC*

INTRODUCTION

A medicinal tablet provides a means for delivering pharmaceutically active ingredients to patients in a measured fashion. This solid unit dosage form consists of active ingredients and excipients compressed or moulded into a solid substance. Tablet comes in different shapes, sizes, and colours to aid accurate administration, typically through oral ingestion. Their design allows for convenient and controlled delivery of medications. Coatings or scoring are added to some tablets to facilitate swallowing and permit dosage adjustments. The formulation of tablets can vary to meet specific therapeutic needs, making them a versatile drug delivery method widely used in medicine. This solid form allows for tailored and widespread distribution of treatments to address health requirements.[1]

These tablets are designed to supplement the nutritional intake and address specific deficiencies, ensuring the body receives an adequate supply of vital nutrients for overall health and well-being. These kinds of tablets are usually made with a blend of vitamins and minerals, including calcium, iron, zinc, B vitamins (like folic acid and B12), vitamin A, vitamin C, vitamin D, and others.[2] These tablets are designed to disperse or dissolve in water before administration, these tablets are particularly useful for individuals who have difficulty swallowing whole tablets. These tablets are designed to disintegrate rapidly in water, forming a homogeneous suspension or solution.[3] These types of pharmaceutical formulation are designed to rapidly break down in the mouth without the need of water, allowing for smooth

administration. These tablets are particularly useful for people who might find it difficult to swallow regular tablets or capsules.[4]

Herbal tablets are evaluated using *in vitro* tests, physicochemical characterization. The results of this study may further our understanding of herbal formulas and have implications for the broader pharmaceuticals. This might result in the creation of innovative oral treatments with potential applications in the therapeutic fields that are inspired by nature.

MATERIALS AND METHODS

Plant materials

The fresh roots of *Ashwagandha*, *Amla* fruits and *Ginger* rhizomes were collected from the medicinal plant garden, Bengal School of Technology, Hooghly, West Bengal, an eastern region in India. Medicinal plant gardens are primarily focused on the conservation, cultivation, research and educational activities related to authenticated herbal plant species known for medicinal purposes.

The plants specimens were identified from Central National Herbarium (Botanical Survey of India, Kolkata, certificate No. CNH/Tech.II/2023/174 issued on 08-11-2023). The plants identified are as following **Table1.**

TABLE 1: SPECIMEN NUMBER CORRESPONDING TO IDENTIFIED PLANT SPECIMEN

Sl No.	Specimen No.	Scientific Name	Family
1	BST/RDS-04	*Zingiber officinale* Roscoe	Zingiberaceae
2	BST/RDS-05	*Phyllanthus emblica* L.	Phyllanthaceae
3	BST/RDS-06	*Withania somnifera (L.)* Dunal	Solanaceae

Chemicals

Microcrystalline cellulose (MCC) was purchased from Merck Specialities Pvt. Ltd., Mumbai, India Sodium starch glycolate (SSG) was purchased from Loba Chem Pvt Ltd, Mumbai, India and croscarmellose sodium (CCS) was purchased from ResearchLab Pvt. Ltd., Mumbai, India. Magnesium stearate (MgSt.) was purchased from Loba Chem Pvt Ltd, Mumbai, India and saccharin was purchased from Qualikems Fine Chem Pvt. Ltd, Vadodara, India. All the chemicals used, including the solvents, were of analytical grade.

Preparation of herbal powders of *Ashwagandha, Amla and Ginger*

Ashwagandha roots were cleaned and washed with water. It was then air dried and powdered into small particles using a mixer grinder. The powder was sieved using sieve number 22. *Amla* fruits were washed and the pulp was kept for air drying, subsequently in hot air oven at 40^0C. After drying, it was size reduced in a mixer grinder and was sieved through sieve number 22. *Ginger* rhizomes were washed and sliced into small pieces of about 1-3 mm in thickness and left for air drying and subsequently in hot air oven at 40^0C. After that it was size reduced to a powder using mixer grinder and sieved through sieve number 22. All the powders were stored in an air-tight plastic containers.[5]

Determination of moisture content of herbal powders

Herbal powder of 2g was taken and put in the cleaned plate of IR moisture balance. The balance was run for 2 hours at 150^OC till the sample shows constant weight. The change in weight was noted from the scale present in the instrument. The moisture content was noted as percentage.[6]

Determination of ash content of herbal powders

For total ash content, silica furnace crucibles were weighed and 2 g of each herbal powder was weighed and transferred separately. Then the crucibles were put in a muffle furnace. The furnace was run at 550^OC, for 2 hours. After 2 hours, the crucibles were removed from the furnace carefully and cool it in a desiccator to room temperature and weight again.

Acid insoluble ash is determined by dissolving ash in 40% hydrochloric acid. The liquid filtered through an ashless filter paper and thoroughly washed with hot water. The filter paper is then ignited at about 500 °C to constant weight in the original dish, cooled and weighed. Water soluble ash is determined by boiling the ash for 5 minutes with 25 ml of distilled water. Insoluble matter was collected in a crucible or ash less filter paper and washed with hot water, ignited and weighed.[7]

Preparation of herbal tablet

The direct compression method was utilized to prepare the tablets. All the herbal drugs and excipients were mixed in order of *Ashwagandha*, *Amla*, *Ginger*, microcrystalline cellulose (MCC), sodium starch glycolate (SSG) and croscarmellose sodium (CCS). All the ingredients were mixed properly by using a blender. After that, sodium saccharin

and magnesium stearate (MgSt.) were mixed and again blended. Finally, camphor was added and mixed. Then the powder blends were compressed into tablet on rotary tablet punching machine (Rimek, Mini-Press II) using 12 mm oblong punch set. Thickness and weight were adjusted during punching for complete consolidation of powder blends into tablet and ejection of tablets from the die cavity. The tablets were collected and stored in air tight containers and labeled accordingly.[8] **Table 2** provides the composition of all ingredients used for the preparation of the formulations.

Table 2: Formulation ingredients of herbal tablet (weights in mg)

Formulation Code	*Ashwagandha*	*Amla*	*Ginger*	MCC	SSG	CCS	Camphor	Saccharin	MgSt.
F-1	100	100	100	60	8	8	10	6	6
F-2	100	100	100	60	12	8	10	6	6
F-3	100	100	100	60	8	12	10	6	6
F-4	100	100	100	60	12	12	10	6	6
F-5	100	100	100	60	8	10	10	6	6
F-6	100	100	100	60	12	10	10	6	6
F-7	100	100	100	60	10	8	10	6	6
F-8	100	100	100	60	10	12	10	6	6
F-9	100	100	100	60	10	10	10	6	6

Statistical optimization

3^2 full factorial design (2 factors and 3 levels) was used for the formulation design optimization of the herbal tablet (Design Expert Software Trial version13.0.5). The amount of SSG and CCS (disintegrating agent) were selected independent variable (factor), at each of three levels. Dispersion time(sec) and hardness (Kg) were selected as dependent variables (response) for optimization of herbal tablet formulation.[9]

Preformulation studies

Preliminary phytochemical screening

Phytochemical screening was performed by following Mayer's test , Hager's test, Dragendorff test , Foam test, Salkowski test , Molisch's test, Benedict's test ,Modified Brontrager's test ,Keller Kiliani test, Xanthoproteic test , Modified Brontrager's test and Keller Kiliani test.[10]

Carr's compressibility index

The Carr's compressibility index, also known as the Carr's index, is a parameter to characterize the compressibility of a powder. The Carr's index is defined by the following formula:

$$\text{Carr's index} = \frac{\rho(\text{tapped}) - \rho(\text{bulk})}{\rho(\text{tapped})} \text{ x } 100$$

Where, $\rho(tapped)$= tapped density, the density of the powder after tapping, and $\rho(bulk)$ = bulk density of the initial untapped powder sample

Hausner ratio

Hausner ratio, is another parameter used to assess the powder flow properties. It is defined by the ratio of tapped bulk density to untapped bulk density and is calculated using the following formula:

$$\text{Hausner ratio} = \frac{\rho(\text{tapped})}{\rho(\text{bulk})}$$

Angle of Repose

The angle of repose is typically measured by slowly pouring the powder or granular material onto a flat surface until a cone or mound is formed. The angle between the surface and the slope of the cone is then measured to determine the angle of repose.[11]

$$\text{Angle of repose}(\theta) = \tan^{-1}(h/r)$$

Where, h= height of the cone and r= radius of the cone.

Drug excipients interaction study

Attenuated total reflectance infrared (ATR-IR) (Bruker Alpha II) spectroscopy was used as an effective analytical method for evaluation of interactions between drugs and excipients.[12]

EVALUATION OF TABLETS

Physical Evaluation

Hardness: 5 tablets were taken randomly from each batch and hardness was tested using Monsanto hardness tester. The average of five reading was noted. Unit was expressed in Kg.

Thickness: 5 tablets were taken randomly and, their thickness was noted by using a Vernier calipers. The tablets were placed diametrically. The average of the reading was noted. Unit was expressed in mm.

Friability: 20 tablets were taken from a batch and their initial weights were taken. Then they were run in a Roche friabilator for 4 minutes at 25 revolutions per minute (RPM) i.e., 100 cycles. % Friability was calculated as the following formula

$$\% \text{ Friability} = (W_1 - W_2) / W_1 \text{ X } 100$$

Where, W_1 = Initial weight of tablets, W_2 = Final weight of tablets

Weight Variation

According to USP, each of the 20 tablets were weighed separately, and the average weights were determined. Subsequently, the percentage of weight variation was calculated by comparing each weight to the average weight.

Wetting Time:

A piece of double-folded tissue paper was placed in a petri dish (internal diameter 10-cm) containing 6 ml phosphate buffer of pH 6.8. The tablet was placed on the paper and the time for complete wetting of the tablet was measured in seconds.

***In vitro* Dispersion Time**

10 ml of pH 6.8 phosphate buffer was placed in a petri dish (internal diameter 10-cm). The tablet was then carefully placed in the center of the petri dish and the time required for the tablet to completely disintegrate into fine particles was noted. Measurements were carried out in replicates of six tablet (n = 6) and mean SD values were recorded.

Swelling Index:

Tea bag method was used to measure the swelling index. The empty tea bag was measured. The specified amount of powder of different formulations was placed in an empty tea bag and the bag was dipped in an excessive amount of distilled water. Then the tea bag was placed on a dry tissue paper and gently wiped with another dry tissue paper to remove excess water and weakly bound water. Then the tea bag was weighed.

$$\text{Swelling Index} = \frac{W_2 - W_1}{W_1} \times 100$$

Where, W_2= Weight of powder formulation after swelling, W_1= Weight of powder before immersion.

Antioxidant activity study:

The DPPH (1,1 diphenyl-2-picrylhydrazyl) assay is a method for evaluating the antioxidant activity of a substance. Specified weight of herbal tablets was dissolved in 25 ml of 99% methanol which was taken in a conical flask. The flask was sealed using aluminum foil and sonicated in a bath sonicator for 30 minutes. The sample was then centrifuged for 30 minutes at 5000 RPM. The sample was filtered using a whatman filter paper.[13]

The DPPH solution was prepared in methanol and added the reagent to the samples for the evaluation. Absorbance of samples were measured at 517nm by spectrophotometric method using methanol as blank. % radical scavenging activity (%RSA) values were calculated as the following formula.

$$\%RSA = \frac{\text{Absorbance of Control} - \text{Absorbance of Sample}}{\text{Absorbance of Control}} \times 100\%$$

Field emission scanning electron microscopy (FE-SEM):

Field emission scanning electron microscopy (FE-SEM) (Zeiss, Sigma300) was used to study the surface morphology and microstructure of the prepared herbal formulation of tablet.[14]

X-ray diffraction (XRD):

Powder X-ray diffraction (XRD) (Bruker D8 Advance) was used for determination of the crystal structure of the herbal powders and the herbal formulation.

High-Performance Thin-Layer Chromatography:

High-Performance Thin-Layer Chromatography (HPTLC) is a chromatographic method for separating, identifying, and quantifying constituents in mixtures.

HPTLC (Camag, Linomat 5) was performed for qualification and quantification of the active constituents present in the herbal formulations (ISF Analytical Laboratory, ISF College of Pharmacy, Moga, Punjab, India). For the analysis, CAMAG Linomat 5 linked with winCATS software was used as sample application device. Silica gel 60, F254, 10 x 10 cm HPTLC plates were used for this experiment. Benzene: ethyl acetate (9:1) was used as mobile phase for the detection of *Ashwagandha.* Ethyl Acetate: formic acid: methanol (3:3:0.8:0.2) was used as mobile phase for the detection of *Amla* and hexane: ethyl acetate (6:4) was used as mobile phase for the detection of *Ginger.*[15]

Results and discussion

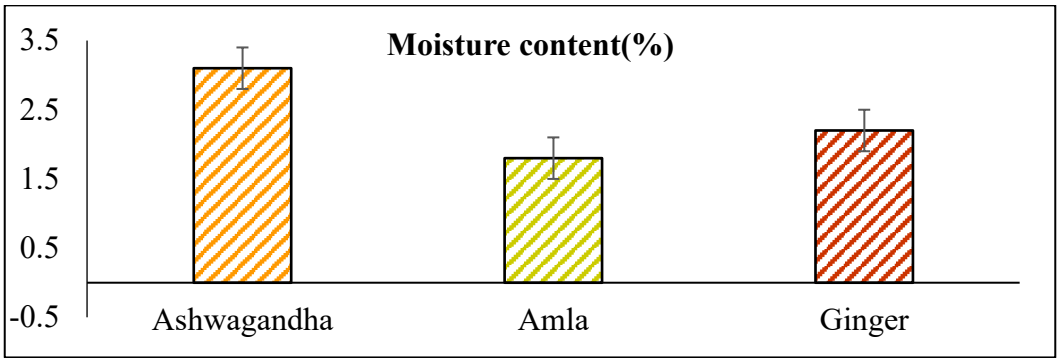


Figure 1: Moisture content of herbal powders

Phytochemical screening was employed which was found to contain alkaloids, saponins, flavonoids, phenols, phytosterols, carbohydrates, glycosides, amino acids, and tannins. Notably, the analysis also revealed that the mixture did not contain any steroidal compounds.[16]

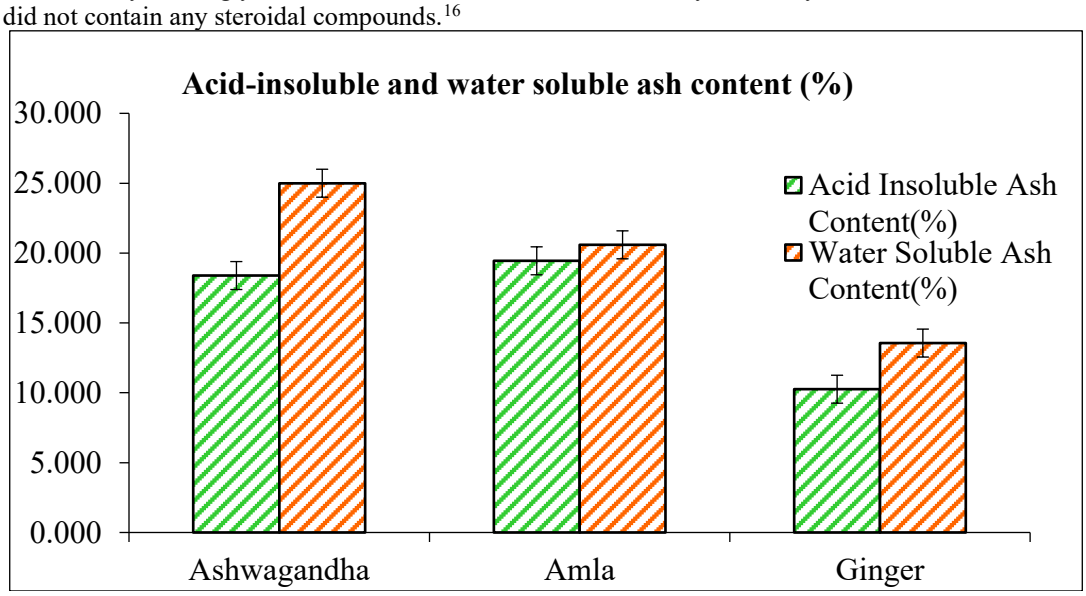


Figure 2 Acid-insoluble and water-soluble ash content of herbal powders

Ash value helps to determine the quality and purity of crude drug, and these values are important qualitative standards. The values for total ash content were 8%, 7% and 4%, acid-insoluble ash content were 18.391%, 19.444% and 10.256%, and water-soluble ash content were 25%, 20.588% and 13.599% for *Ashwagandha, Amla* and *Ginger* respectively. The crude drugs had a moisture content of less than 3.1%, 1.8% and 2.2% respectively.[17,18] **Figure1-2.**

Table 3: Compressibility index and Hausner ratio of powder blends

Sl NO.	Weight of empty cylinder (g)	Weight of cylinder+powder (g)	Bulk volume (ml)	Tapped volume (ml)	Bulk density (g/ml)	Tapped density (g/ml)	Carr's index	Hausner ratio	Inference
F-1	40.54	56.1	50	40.5	0.3112	0.3842	19	1.23	**Fair**
F-2	40.54	58.8	50	43.5	0.3652	0.4198	13	1.14	**Good**
F-3	40.54	58.4	50	43	0.3572	0.4153	14	1.16	**Good**
F-4	40.54	55.2	50	42	0.2932	0.3490	16	1.19	**Fair**
F-5	40.54	54.4	50	41	0.2772	0.3380	18	1.21	**Fair**
F-6	40.54	61.4	50	45	0.4172	0.4636	10	1.11	**Excellent**
F-7	40.54	61.2	50	45	0.4132	0.4591	10	1.11	**Excellent**
F-8	40.54	59.3	50	43	0.3752	0.4363	14	1.16	**Good**
F-9	**40.54**	**58.2**	**50**	**42.5**	**0.3532**	**0.4155**	**15**	**1.17**	**Good**

Table 4: Angle of repose of powder blends

Sl NO.	Diameter (cm) (1)	Diameter (cm) (2)	Diameter (cm) (3)	Average diameter(cm)	Radius (cm)	Height(cm)	Angle of repose	Inference
F-1	5.5	5.2	5.7	5.47	2.73	2.0	36.19	Fair
F-2	5.6	5.7	5.5	5.60	2.80	1.8	32.74	Good
F-3	5.4	5.5	5.4	5.43	2.72	1.9	34.25	Good
F-4	5.4	5.77	5.2	5.47	2.73	2.2	38.83	Fair
F-5	5.4	5.9	5.1	5.45	2.73	2.2	39.30	Fair
F-6	5.3	6.1	4.9	5.43	2.72	1.6	29.71	Excellent
F-7	5.3	6.2	4.8	5.42	2.71	1.5	28.65	Excellent
F-8	5.2	6.4	4.6	5.40	2.70	1.8	33.40	Good
F-9	5.2	6.5	4.5	5.38	2.69	1.8	33.77	Good

Angle of repose for selected formulations (F6, F7) were found to be less than 30° which indicate free flowing powder. Carr's index was found to be less than 25% indicating good flowability. The Hausner ratio was found to be less than 1.34 indicating good flowability. The angle of repose, Carr's index and Hausner ratio of selected formulations were found to be 28.65°, 10% and 1.11 respectively. This indicates good flow property of the powders. **Table 3-4**

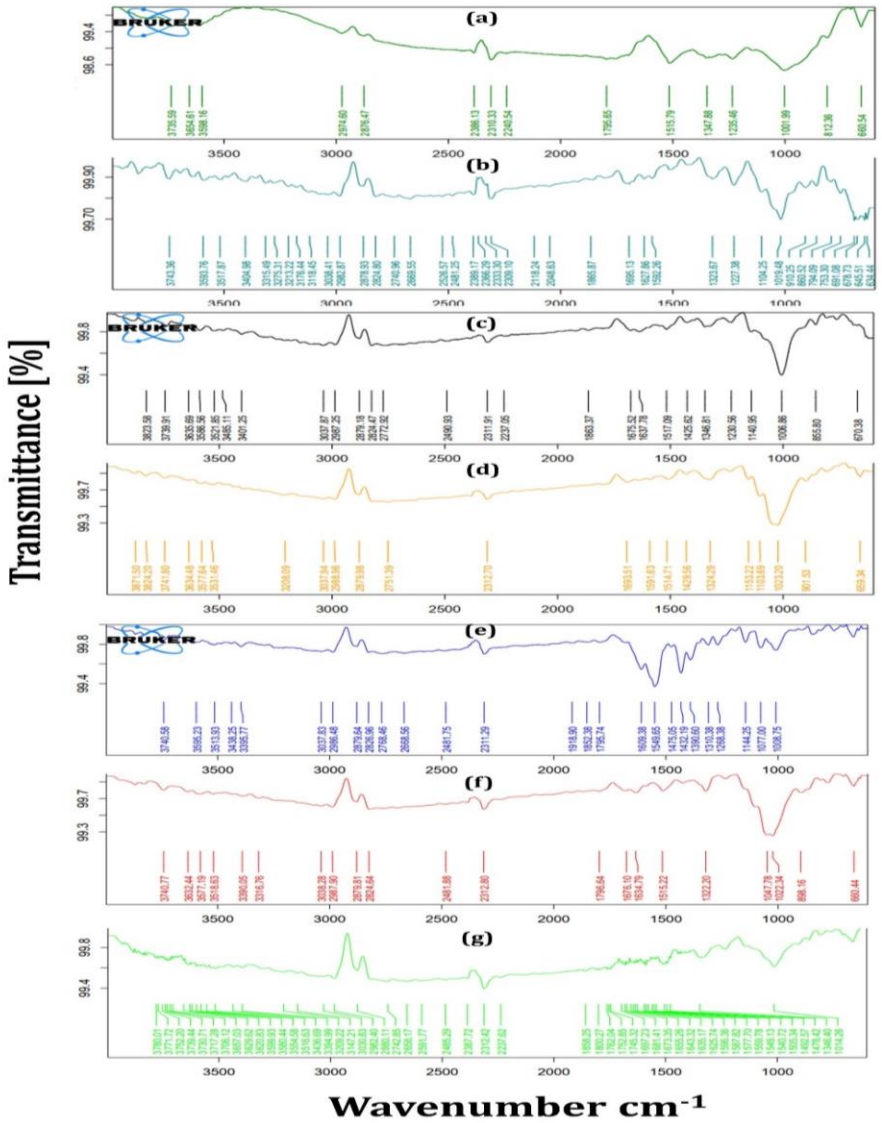


Figure 3: ATR-IR Spectra of (a) *Ashwagandha*, (b) *Ginger*, (c) *Amla*, (d)Microcrystalline cellulose, (e) Sodium starch glycolate, (f) Croscarmellose sodium and (g) Formulation.

In the ATR-IR analysis of the powders, the characteristic functional groups were shown. In the spectra for *Ashwagandha*, various stretching and bending like C-O carboxylic Acid stretching, C=O unsaturated ketonic bending, C-O alkoxy stretching were observed. This correspond to the presence of withanolides which are steroidal lactones, hentriacontane which is a acyclic alkane, dulcitol, etc. In the spectra of *Amla* powder, C=O ketonic bending, C=C cyclic alkene stretching, O-H alcoholic stretching, C-O and N-O stretching corresponds to the presence of amino acids like alanine, aspartic acid, lysine which had C=O, O-H groups in them. Gallic acid and vitamin-C can also be confirmed from the spectra. In the spectra for *Ginger*, N-H stretching, C=C stretching, C=O stretching along with various others are present. Those type of functional groups are present in α-curcumene, 6-gingerol, zingiberene. The spectra were also recorded for microcrystalline cellulose, sodium starch glycolate, croscarmellose sodium and the formulation. Thus, the study report revealed that there were no major changes in the stretching or bending of major functional groups of the herbal drugs with all excipients. So, incompatibility between herbal drugs and excipients was not observed. **Figure 3**

The post-compression parameters like thickness, hardness, friability, wetting time, dispersion time of tablets were described. The thickness varied from 4.94 ± 0.05-5.18 ± 0.05 mm for various formulations and did not show much variations amongst each other of the formulations. **Table 5**

The hardness varied from 3.22 ± 0.33-3.68 ± 0.51 kg. The values of standard deviation indicate that the hardness of all the formulation was almost uniform and the tablets possessed good mechanical strength to withstand packaging, handling, and transportation without breaking. **Figure 4**

The friability was found to be range of 0.79-0.89% . All the values were below 1% indicating that the tablets possessed good mechanical strength , showing ability to withstand handling, packaging, and transportation without breaking or crumbling. **Table 5**

The weight variation of all formulations were given in **Table5**. The formulations passed weight variation test since the results obtained were within the pharmacopoeia limit.

Table 5: Thickness, Average weight and % Friability of herbal tablet formulations

Formulation Code	Thickness (mm) (Mean ± SD , n=10)	Average weight (mg) (Mean ± SD , n=20)	Friability (%)
F1	4.95 ± 0.05	264.1 ± 0.80	0.88
F2	4.94 ± 0.05	257.05 ± 0.82	0.89
F3	5.01 ± 0.05	252.95 ± 0.91	0.85
F4	5.03 ± 0.05	253.55 ± 0.87	0.85
F5	5.06 ± 0.05	316.8 ± 0.96	0.88
F6	5.15 ± 0.05	305.65 ± 0.88	0.79
F7	5.18 ± 0.05	308.2 ± 0.85	0.80
F8	5.08 ± 0.05	309.45 ± 0.90	0.82
F9	5.07 ± 0.05	307.75 ± 0.86	0.86

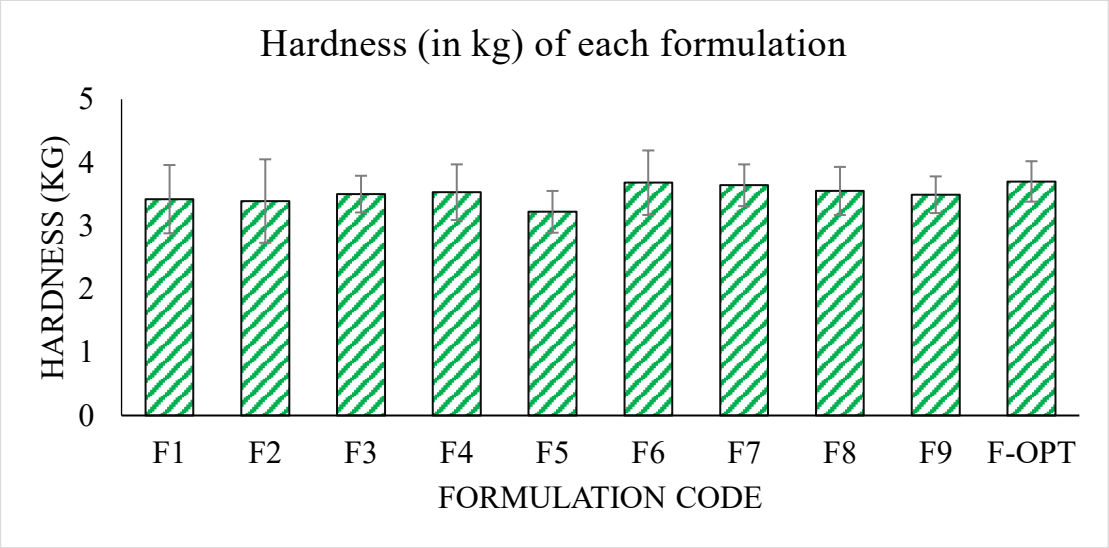


Figure 4: Hardness of each formulation (Data given in Mean ± SD, n=3)

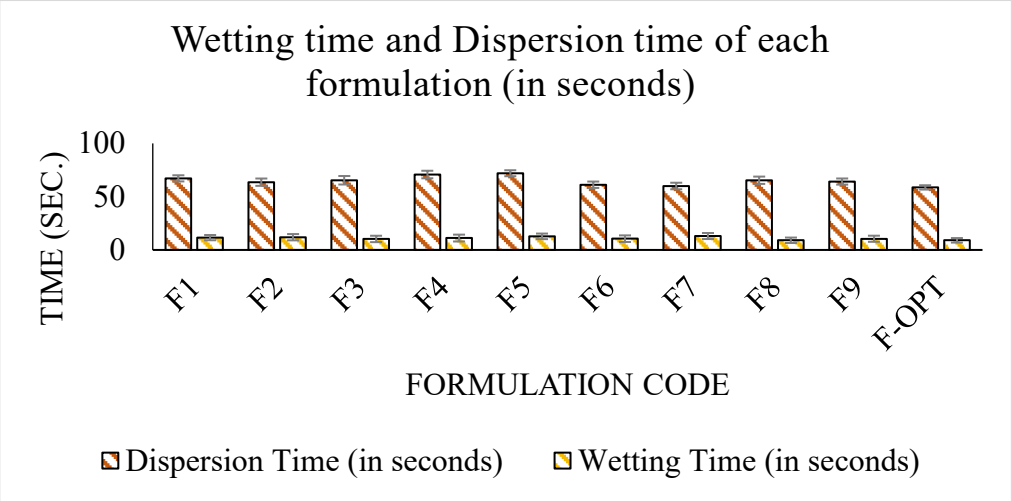


Figure 5: Wetting time and Dispersion time of herbal formulations (Data given in Mean ± SD, n=3)

Study showed shortest dispersion time, clocking in at 58.7 seconds, indicating rapid dispersibility. **Figure 5** The swelling index results were depicted in **Figure 6.** The results showed good swelling property which reached upto 57.41%.

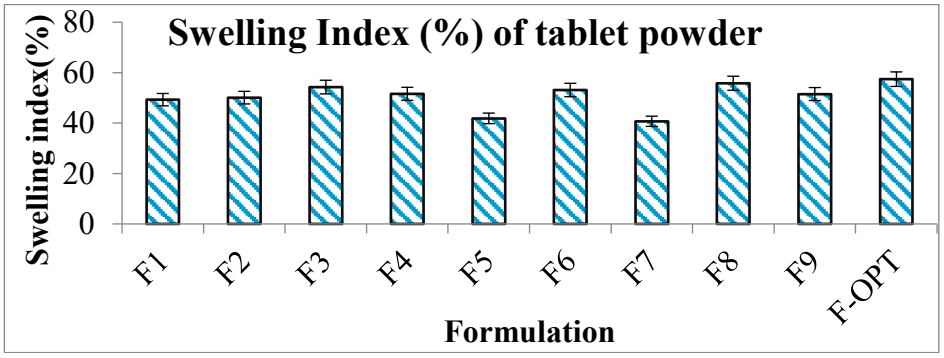


Figure 6: Swelling index of herbal formulations (Data given in Mean ± SD, n=3)

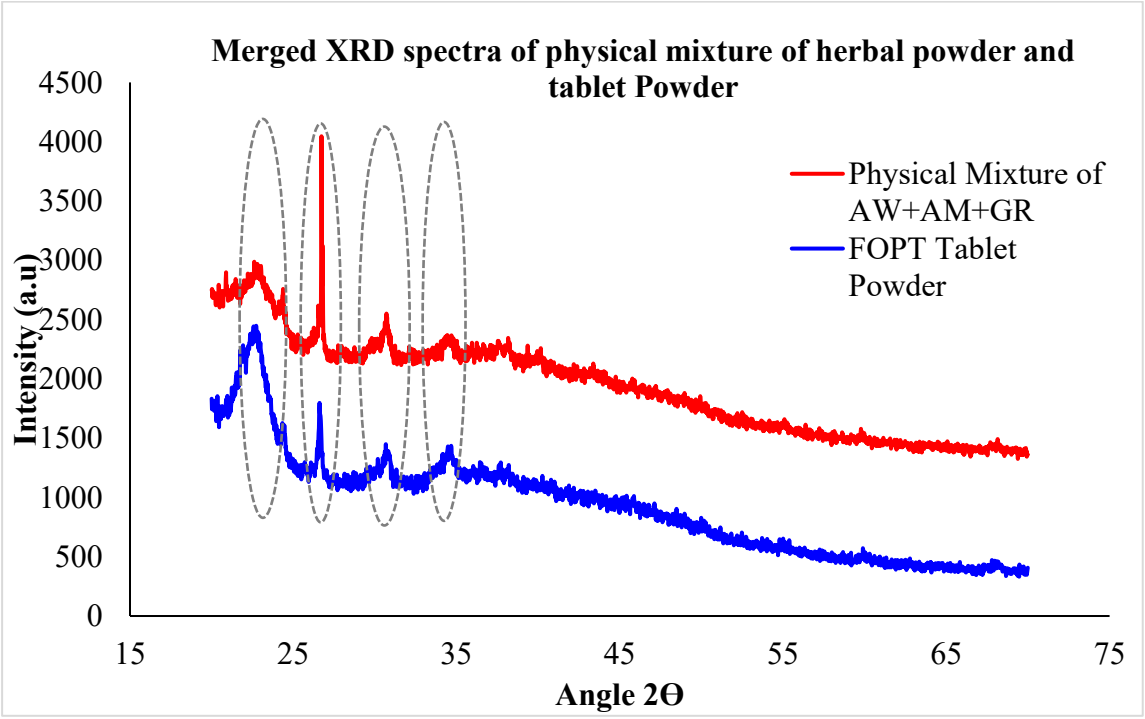


Figure 7 : XRD Spectra of the physical mixture of herbal powder and herbal tablet

Table 6: Average particle size from XRD Spectra of herbal formulations (using Scherrer Equation)

2Θ	Θ(in radians)	CosΘ	β(FWHM in Radian)	βcosΘ/λ	kλ	D=kλ/βcosΘ	Average D
22.737	0.198417756	0.98038	0.019174187	0.122017	0.138654	7.376003823	7.9561
26.599	0.232120064	0.973181	0.014819765	0.093615	0.138654	9.613853765	
30.665	0.267602608	0.964408	0.01669931	0.104537	0.138654	8.609407233	
34.568	0.301662708	0.954844	0.023325627	0.144569	0.138654	6.225392465	

The absence of distinct sharp peak of herbal powders suggest that the powders are amorphous in nature. The absence of distinct sharp peak revealed no perfect crystalline structure in the powder grind of the formulation while presence of MCC in the powder grind sample denoted a broad amorphous hump in the 16-22° 2Θ range and a crystalline peak at 26°. **Figure 7** For the calculation of average particle size, Scherrer Equation was employed and particle size was found to be 7.956 nm. **Table 6**

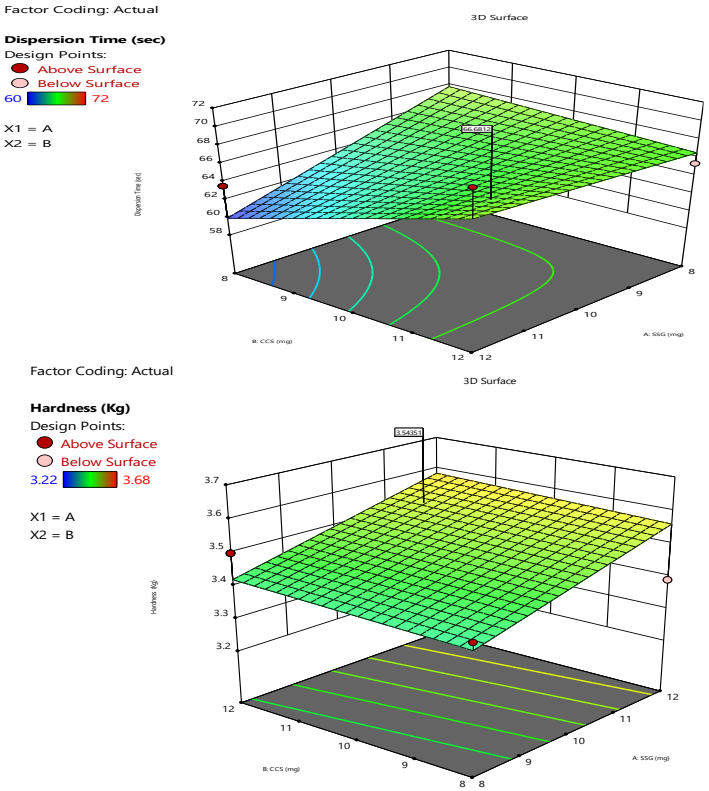


FIGURE 8 : 3D RESPONSE SURFACE PLOT FOR (A) DISPERSION TIME AND (B) HARDNESS

3D response curves were plotted against the SSG and CCS (independent variables). This response curve denoted that the amount of the SSG and the amount of the CCS might have effect on dispersion time. **Figure 8**. Response surface methodology has been reported to be an effective tool for the optimization of a process when the independent variables have a combined effect on the desired response.

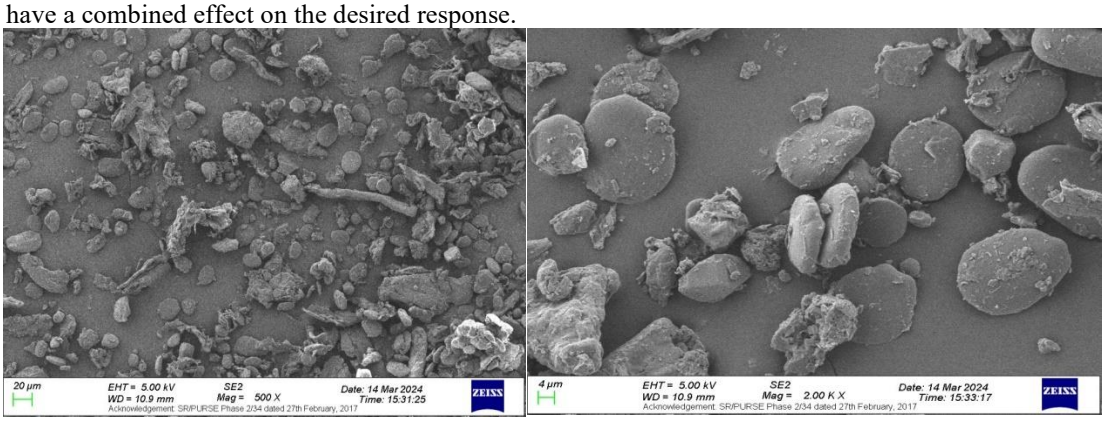


FIGURE 9: FIELD EMISSION-SCANNING ELECTRON MICROSCOPY(FE-SEM) IMAGE OF HERBAL FORMULATIONS

In the image of scanning electron microscopy, the surface morphology of the herbal ingredients, namely *Amla, Ashwagandha,* and *Ginger*, were precisely identified and observed, with cylindrical structures indicative of *Ashwagandha*, larger rocky particles likely representing *Amla*, and sharp, rough structures characteristic of *Ginger*. **Figure 9**

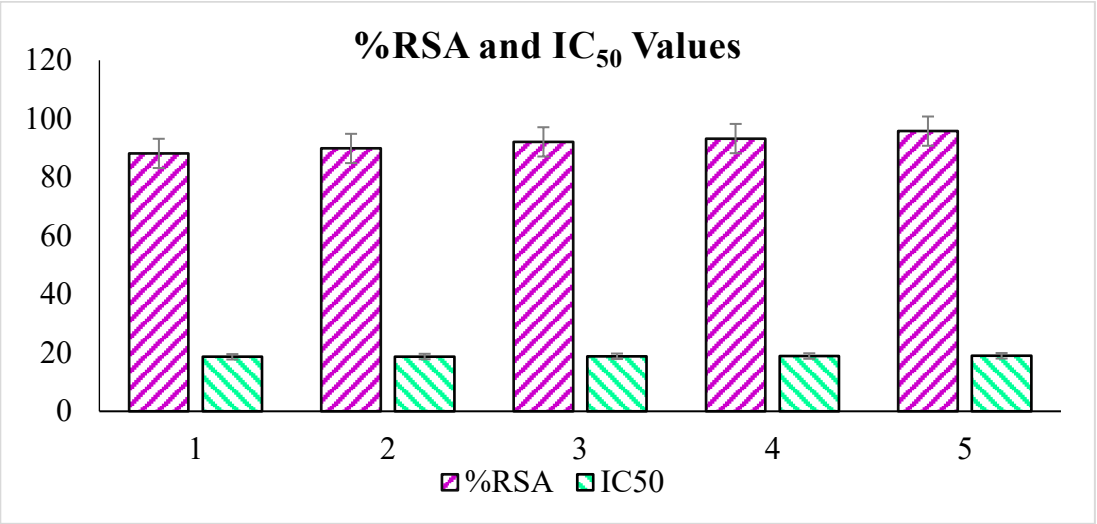
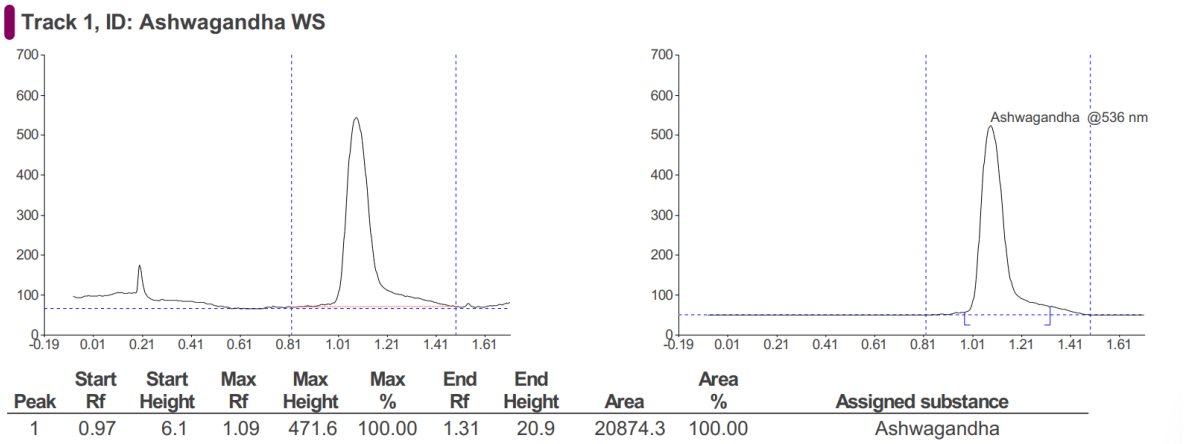


FIGURE 10: %RADICAL SCAVENGING ACTIVITY OF HERBAL FORMULATIONS (DATA GIVEN IN MEAN ±SD, N=3)

The *in vitro* antioxidant study utilizing DPPH radical scavenging activity revealed a notably high efficacy in neutralizing free radicals. The phytoconstituents that exhibit antioxidant activity, include; *Ashwagandha* contains withanolides, *Amla* contains ascorbic acid, and *Ginger* contains gingerols, shogaols. **Figure 10**



Peak	Start Rf	Start Height	Max Rf	Max Height	Max %	End Rf	End Height	Area	Area %	Assigned substance
1	0.97	6.1	1.09	471.6	100.00	1.31	20.9	20874.3	100.00	Ashwagandha

Figure 11: PEAK FOR RETENTION FACTOR AND AREA UNDER CURVE OF ASHWAGANDHA

Table 7: RETENTION FACTOR AND AREA UNDER CURVE FOR EACH PEAK OF *ASHWAGANDHA*

Track	Vial	Rf	Height	Area	Sample ID/Remark
1	1	1.09	471.56	20874.31	Ashwagandha WS
2	1	1.08	468.23	20794.36	Ashwagandha WS
3	1	1.10	470.69	20856.24	Ashwagandha WS
4	1	1.09	472.16	20847.74	Ashwagandha WS
5	1	1.09	471.74	20826.38	Ashwagandha WS
6	2	1.11	480.33	21693.81	Powdered Tablet
7	2	1.12	481.57	21536.72	Powdered Tablet

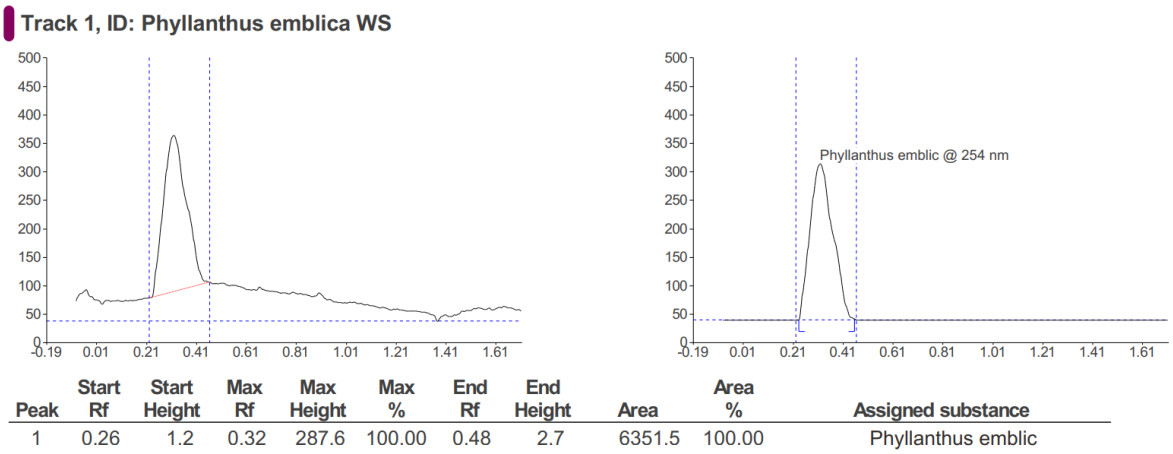


Figure 12: PEAK FOR RETENTION FACTOR AND AREA UNDER CURVE OF *AMLA*

Table 8: RETENTION FACTOR AND AREA UNDER CURVE FOR EACH PEAK OF *AMLA*

Track	Vial	Rf	Height	Area	Sample ID/Remark
1	1	0.32	287.64	6351.51	Phyllanthus emblica WS
2	1	0.31	285.71	6327.74	Phyllanthus emblica WS
3	1	0.32	286.07	6339.82	Phyllanthus emblica WS
4	1	0.32	286.89	6345.66	Phyllanthus emblica WS
5	1	0.32	285.13	6308.29	Phyllanthus emblica WS
6	2	0.33	282.56	6284.34	Powdered Tablet
7	2	0.31	281.89	6219.76	Powdered Tablet

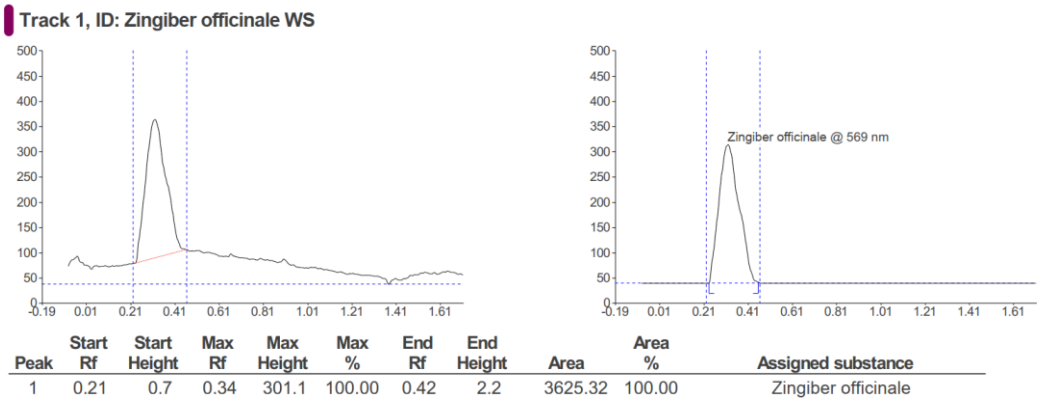


Figure 13: PEAK FOR RETENTION FACTOR AND AREA UNDER CURVE OF *GINGER*

Table 9: RETENTION FACTOR AND AREA UNDER CURVE FOR EACH PEAK OF *GINGER*

Track	Vial	Rf	Height	Area	Sample ID/Remark
1	1	0.34	301.10	3625.32	Zingiber officinale WS
2	1	0.33	304.06	3621.48	Zingiber officinale WS
3	1	0.36	307.14	3694.35	Zingiber officinale WS
4	1	0.32	301.11	3656.29	Zingiber officinale WS
5	1	0.33	303.07	3635.15	Zingiber officinale WS
6	2	0.35	305.38	2679.35	Powdered Tablet
7	2	0.35	308.93	2604.72	Powdered Tablet

In the chromatogram for the high-performance thin-layer chromatography (HPTLC) of herbal drug of Ashwagandha, the range of retention factor (Rf) spanned between start Rf 0.97 to end Rf 1.38 for the two extremes. This indicates the diversity of compounds present within the sample. Similarly, for the powdered tablet, the start Rf and end Rf were recorded as 0.98 and 1.36 respectively, showcasing a comparable range of compounds. The starting Rf, approximately 0.97, suggests the presence of alkaloids. Table 7 & Figure 11 Similarly, in the chromatogram for Amla, the range of retention factor extended from start Rf 0.22 to end Rf 0.59. Gallic acid and ascorbic acid exhibited standard Rf values of

approximately 0.33 and 0.5-0.6 respectively, affirming the presence of these vital medicinal compounds within both the Amla powder and the herbal tablet formulation. Table 8 & Figure 12 Moving to the chromatogram of HPTLC of Ginger powder, the start Rf was noted at about 0.21 and end Rf at 0.55, denoting a broad spectrum of compounds present. Standard Rf values for specific compounds within Ginger, such as eugenol (0.21), 6-gingerol (0.4), and shogaol (0.5), further confirm the presence of these compounds within both the crude Ginger powder and the herbal tablet formulation. Table 9 & Figure 13 Thus, the chromatogram analysis strongly suggests that the herbal compounds are present in herbal tablet formulations.

In the quantitative analysis, drug content for Amla, Ashwagandha, Ginger was calculated to be 104.760 mg, 110.093 mg, and 76.905 mg respectively. The result of this assay concludes that drug was incorporated in the herbal tablet formulations.

Conclusion

Through a comprehensive examination of various studies and analyses, a holistic understanding emerges regarding the formulation and characterization of herbal tablet formulation containing *Ashwagandha, Amla, and Ginger.* With its diverse array of bioactive compounds, favourable physical properties, and potent antioxidant activity, the formulation holds promise as a therapeutic agent with potential applications in various health conditions. Continued research and refinement will undoubtedly further enhance our understanding and utilization of this herbal formulation in clinical practice.

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CONFLICT OF INTERESTS

The authors report no conflicts of interest in this research work.

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