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Advancements in Traditional Medicine: Preparation and Characterization of Pomegranate Extract Raft Forming Tablets

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ABSTRACT

The present research work aim was to formulate and evaluate Pomegranate extract raft forming tablets by Direct Compression and Wet Granulation methods. Pomegranate extract is a source of powerful polyphenols that offer potent health support for cardiovascular system. They support healthy blood flow and metabolism, help keep blood pressure within the normal range, and contribute to a balanced inflammatory response. Pectin and guar gum are gel-forming agents used at various concentrations to formulate raft-forming tablets. Upon contact with gastric fluids, they create a viscous, cohesive gel in which each portion swells and merge to form a continuous layer, known as a raft. This raft floats on the gastric fluids due to its low bulk density, which results from the generation of carbon dioxide.

Thus it produces retention of dosage form which enhances gastric retention and prolongs drug delivery within the gastrointestinal tract by remaining buoyant on gastric fluids, allowing for a sustained and controlled drug release at the desired rate. The developed pomegranate raft-forming tablets were thoroughly evaluated for both pre-formulation and post-formulation parameters. FTIR and DSC analyses confirmed the compatibility of pomegranate extract with the selected excipients, indicating no significant interactions. Among all formulations tested, F12 demonstrated superior performance, exhibiting optimal raft weight, minimal buoyancy lag time and the most substantial raft formation. Notably, raft weight increased proportionally with higher concentrations of sodium alginate. Overall, formulation F12 provided the best combination of controlled drug release and floating characteristics compared to the other formulations.

1. INTRODUCTION

Recently, the pharmaceutical industry has shown growing interest in oral controlled-release drug delivery systems, recognising their significant therapeutic benefits. These systems offer convenient dosing, improved patient compliance, and greater flexibility in formulation design.[1]

The oral route is widely preferred by patients, primarily due to its ease of administration. Advancements in oral dosage forms have been driven by the introduction of controlled release drug delivery systems, which are designed to dispense medication at a specific rate determined by the drug's pharmacokinetic profile and the required therapeutic levels.[2] The raft-forming system has attracted interest for the delivery of antacids and medications targeting gastrointestinal infections and disorders. Upon contact with gastric fluids, this system forms a viscous, cohesive gel that creates a continuous "raft" layer.[3-6] This raft acts as a protective barrier, preventing the reflux of gastric contents such as hydrochloric acids and digestive enzymes into the oesophagus.[7,8] Typically, this system includes a gel-forming agent along with alkaline bicarbonates or carbonates, which decrease the system's density and enable it to float on gastric fluids.[9] By using the raft-forming approach, the floating drug delivery system improves drug absorption in the stomach and boosts bioavailability.[10] Its buoyancy prolongs the gastric retention time, helping to minimize gastric irritation.[11]

Raft-forming systems have gained considerable attention for delivering antacids and treating gastrointestinal infections and disorders.[12] Their mechanism involves forming a thick, cohesive gel that expands when it comes into contact with gastric fluids, creating a continuous "raft" layer.[13] These gastro-retentive systems enhance drug bioavailability compared to

traditional liquid formulations. Raft formation can be triggered by stimuli such as changes in pH, temperature, or solvent exchange.[14] Typically, the system contains gel-forming agents along with alkaline bicarbonates or carbonates. When exposed to gastric acid, the bicarbonates release CO_2, which becomes trapped within the gel, generating foam and reducing the system's density. This allows the system to float on gastric fluids, extending drug release in the stomach. Both natural and synthetic polymers are used in the development of raft-forming drug delivery systems.[15]

Punica granatum L., widely known as pomegranate and a member of the Punicaceae family, is found across the globe. Different parts of the pomegranate—including its seeds, peels, juice, and leaves—are abundant in bioactive compounds and have long been used in traditional medicine to treat a variety of conditions, such as gastrointestinal, cardiovascular, and endocrine disorders.[16] Pomegranates are rich in beneficial compounds such as flavonoids, anthocyanins, punicic acid, ellagitannins, and have traditionally been used to address gastrointestinal issues. Raft-forming tablets made from pomegranate extract acts as gastro-retentive drug delivery systems by creating a low density layer in the stomach, which aids in controlled drug release, prolongs therapeutic effects, and improves bioavailability. Unlike conventional tablets that use synthetic drugs, these raft-forming tablets are produced from powdered pomegranate juice extract and intended for the treatment of various conditions, including diabetes, hypertension, heart disease and inflammation. They also help reduce macrophages oxidative stress, neutralize free radicals, inhibit lipid peroxidation, supress cell proliferation, and promote apoptosis, thus offering potential anticancer benefits. Furthermore, pomegranate extract enhances anti-inflammatory effects, especially within the stomach. These raft-forming tablets extend the duration of action, reduce dosing frequency, increase gastric residence time, and help maintain steady plasma drug levels while remaining in the stomach.

The Prime objective of this research work is to formulate and develop raft-forming tablets containing pomegranate extract using the compression method. Granules are first prepared through wet granulation, combining pomegranate extract with various concentrations of polymers. These granules are then compressed into the tablets. The resulting pomegranate raft-forming tablets are designed to provide controlled drug release, particularly for the treatment of ulcers and inflammation, while also reducing the frequency of dosing and improving patient compliance.

2. MATERIALS AND METHODS

i. Preparation of Pomegranate juice extract.

Pomegranates were purchased from the fruits market, healthy fruits were washed, manually peeled the fruits, separating the seeds, and extracting the juice by a Phillips Electric juicer, which is then be processed further to concentrate.

ii. Pre-formulation Studies

a. Standard Graph of Pomegranate Extract Procedure

Accurately weigh 0.1g (100mg) of pomegranate extract and dissolve in 100ml of water to get 1mg/ml of stock solution. From the stock solution pipette out 5ml and dilute it with 50ml water to get a sub stock solution from the sub stock solution pipette out 0.5, 1, 1.5, 2, 2.5, 3ml and dilute to 10ml with water to get 5, 10, 15, 20, 25, 30µg/ml of concentration respectively. Measure the absorbance @276nm wavelength.

b. Drug Excipients Physical Compatibility Study (FTIR)

The active drug nature and drug-excipients compatibility study was done prior to the formulation by Fourier transform infra-red (FTIR) by comparing spectral peaks in the spectra of PNZ drug and excipients with standard reference spectra. [17, 22]

c. Differential Scanning Calorimetry (DSC)

DSC is one of the most used calorimetric techniques, employed to characterize the solubility and physical state of drug in the complex. Thermo grams of PNZ and one formulation of PNZ loaded formulation was recorded using a DSC and were compared. The samples (5 mg) were hermetically sealed in flat bottomed aluminum pans and heated at a temperature of 100-300 °C using alumina as a reference standard.[23]

d. Angle of repose: Angle of repose is defined as the maximum angle between the surface of pile of the powder and the horizontal plane 10. Fixed funnel method was used. The angle of repose (ɵ) was then calculated.

$$\Theta = \tan^{-1} (h/r)$$

Where ɵ = Angle of repose,

h =Height of pile,

r = Radius of the base of pile.

e. Bulk density: Bulk density was determined by using bulk density apparatus, during measurement accurately weighed quantity of the powder were taken in a measuring cylinder and recording the volume and weight of the total powder. Bulk density is expressed in gm/ml and is given by the following equation.

BD=W/Vo

Where, BD = Bulk density (gm/ml)

W = weight of powder (gm)

Vo = Initial volume of the powder

f. **Tapped density:** Tapped density was determined by using Tapped density apparatus during measurement accurately weighed quantity of the powder were taken in a measuring cylinder and recording the volume of powder after 30 tapping and weight of the total powder.[25]

TD =W/VF

Where, TD= Tapped density (gm/ml)

W = weight of powder (gm)

VF = Final volume of powder (ml)

g. **Compressibility index (or) Carr's index**: Compressibility index is an important measure that can be obtained from the bulk and tap densities. The percentage compressibility of the bulk drug was determined by using the following formula. [26]

Compressibility index = [(TB)/B]× 100

Where, T = Tapped density of the powder,

B = Bulk density of the powder.

h. **Hausner's ratio:** It indicates the flow properties of the powder. The ratio of tapped density to bulk density of the powder is called Hausner's ratio.

Hausner's Ratio=TD/BD

Where, TD = Tapped density of the powder.

BD = Bulk density of the powder.

C. Preparation of Tablets

Tablets are pressed/compressed by two methods

1. **Direct compression method**
2. **Wet granulation**

1) Direct compression method:

This is the easier method of tablet formulation Firstly weigh the Ingredients such as Pomegranate extract, Guar gum, Pectin, Mannitol, Sodium bicarbonate Talc according to the table no. 1 and then mix it thoroughly in a mortar and pestle by adding all the ingredients and then it is weighed according to the need and subjected for tablet press.

Table no.1 Formulations prepared by Direct Compression Method

Ingredients	F1	F2	F3	F4	F5	F6	F7	F8	F9
Extract	150	150	150	150	150	150	150	150	150
Guar gum	60	70	80	90	100	110	120	130	140
Pectin	100	100	100	100	100	100	100	100	100
Mannitol	130	120	110	100	90	80	70	60	50
NaHCO3	50	50	50	50	50	50	50	50	50
Talc	10	10	10	10	10	10	10	10	10

2) Wet granulation method:

In this method the ingredients are weighed according to the table no.2

Preparation of Granulating medium (starch solution): Starch of 10g is weighed and added into a beaker (250ml) containing one third of water and stirred to get a slurry. Slurry is added to boiling water (remaining quantity) and stirred. Heating is continued until starch paste is obtained and cooled.

After the preparation of the starch solution the drugs are mixed along with excipients (only half of the talc is added here) to form a wet mass. The formed wet mass is sieved using the sieve (sieve no.10#) then the moist granules are dried using hot air oven then again, the dried granules are screened using the sieve (sieve no. 22 and 44) to separate course and fine granules. Then it is mixed with remaining talc and then it is weighed according to the need and subjected for tablet press.

Table no.2 Formulations prepared by Wet Granulation Method

Ingredients	F10	F11	F12	F13	F14	F15	F16	F17	F18
Extract	150	150	150	150	150	150	150	150	150
Guar gum	60	70	80	90	100	110	120	130	140
Pectin	100	100	100	100	100	100	100	100	100
Mannitol	130	120	110	100	90	80	70	60	50
NaHCO3	50	50	50	50	50	50	50	50	50
Talc	10	10	10	10	10	10	10	10	10

Post compression evaluation

a. Hardness: The resistance of a tablet to breakage during transportation, storage, and handling is determined by its hardness.[27] Tablet hardness was assessed using a Monsanto tester and expressed in Kg/cm2. Five tablets were randomly selected and tested for hardness, and the average value was calculated and recorded.

b. Thickness: The thickness of the tablets was measured using a calibrated vernier caliper to ensure uniformity. Five tablets from each formulation were randomly selected, and theier thickness was measured individually. [28]

c. Friability: The friability of the prepared tablets was evaluated using a roche friability apparatus and expressed as a percentage (%). Initially, 20 tablets were weighed and placed in the friabilator, which was operated at 25 rpm for four minutes. After the operation, the tablets were reweighed, and the percentage friability was calculated using the appropriate formula.[29]

- % Friability =W1-W2/W1 ×100
  - W1= Initial weight of tablets.
  - W2= Final weight of tablets.

d. Weight variation: The weight of the tablets was measured to ensure each tablet contained the correct amount of drug. Twenty tablets were randomly selected from each formulation and weighed using an electronic balance. The average weight was calculated and the individual tablet weights were compared to this average to assess weight variation. [30]

e. Drug content uniformity: The drug content of the prepared tablets was determined by accurately weighing and finely powdering the tablets using a mortar and pestle. A quantity of powder equivalent to 100mg of PNZ was transferred to a volumetric flask and dissolved in 60mL of 0.1N HCl. The contents were sonicated for 15 minutes, and then the volume was adjusted to 100ml with 0.1N HCl. The resulting solution was analysed using UV-Visible spectrophotometer, and the drug concentration in the sample was calculated.[31]

f. *In-Vitro* Buoyancy Studies: The invitro buoyance of the tablets was assessed by measuring the floating lag time. This is defined as the time interval between introducing the dosage form into simulated gastric fluid and its emergence on the surface, as well as the duration for which the dosage form remains buoyant. To determine this, each tablet was placed in a 100ml

beaker containing 0.1N HCl. The time taken for the tablet to rise to the surface and begin floating was recorded as the floating lag time. [32]

g. *In-vitro* dissolution studies: The dissolution of the tablets was performed using a USP type II (Paddle) dissolution apparatus. Each tablet was attached to the paddle via a hydration mechanism. A dissolution vessel was filled with 900 ml of 0.1N HCl as the dissolution medium, maintained at 37 ± 0.5˚C. The paddle was rotated at 100rpm. At predetermined time intervals (15minutes, 30 minutes, 1 hour, 2 hours, 4hours, 6 hours, 10 hours and 12 hours), 5 mL samples were withdrawn and replaced with an equal volume of fresh medium to maintain sink conditions. The collected samples were diluted to 10 mL with 0.1N HCl, filtered, and analysed using a UV-Visible spectrophotometer at 281nm, with 0.1N HCl as the blank. The percentage cumulative drug release was then calculated. [33]

h. Raft strength measurement by in house method: A quantity of tablet powder equivalent to a unit dose was transferred to 150ml of 0.1N HCl and maintained at 37˚C in a 250ml glass beaker. An I- shaped wire probe (1.2 mm diameter) was positioned upright in a beaker, allowing the raft to form around it over a 30 minute period. Raft strength was then measured using a modified balance method: water was added drop wise to the balance pan, and the amount of water required to break the raft was recorded as the raft strength. [34]

i. *In vitro* acid neutralization Study

A quantity of tablet powder equivalent to a unit dose was placed in a 250mL beaker, to which 50 mL of water was added. The mixture was stirred on a magnetic stirrer for 1 minute. Subsequently, 30 mL of 0.1N HCl was added while stirring continued for an additional 10 minutes. After acid addition, stirring was stopped and the gum base was promptly removed using a long needle. The needle was then rinsed with 20mL of water. And the rinsing was collected in the beaker. Stirring was resumed for another 5 minutes. Titration was initiated immediately thereafter. The excess HCl was titrated with 0.5 N sodium hydroxide until a stable pH of 3.5 was reached. The number of milliequivalents (mEq) of acid consumed by the tablet was calculated using the appropriate formula.[35]

Total mEq = (30 * N HCl) - (V NaOH * N NaOH)

Where, N HCI=Normality of HCl;

V NaOH =Volume of NaOH

N NaOH =Normality of NaOH.

3. RESULTS

i. Standard Graph of Pomegranate Extract

Table no. 3 Uv Absorbance of Pomegranate Extract

SL No.	Concentration (µg/ml)	Absorbance @ 276 nm
1	5	0.1308
2	10	0.2988
3	15	0.4627
4	20	0.7139
5	25	0.8699
6	30	1.0069

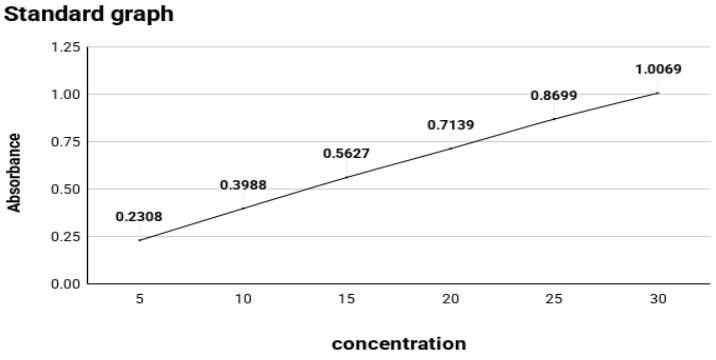

Fig no. 1 Standard graph of Pomegranate Extract

The calibration curve for famotidine was prepared using water as the solvent. Statistical data related to the calibration curve are presented in Table 3, and the corresponding graph is shown in figure 1. The regression coefficient (R^2) was found to be 0.996, indicating a strong linear relationship between the variables. The calibration curve yielded the equation Y = 0.0443 ± 0.0014.

ii. Drug Excipients Physical Compatibility Study (FTIR)

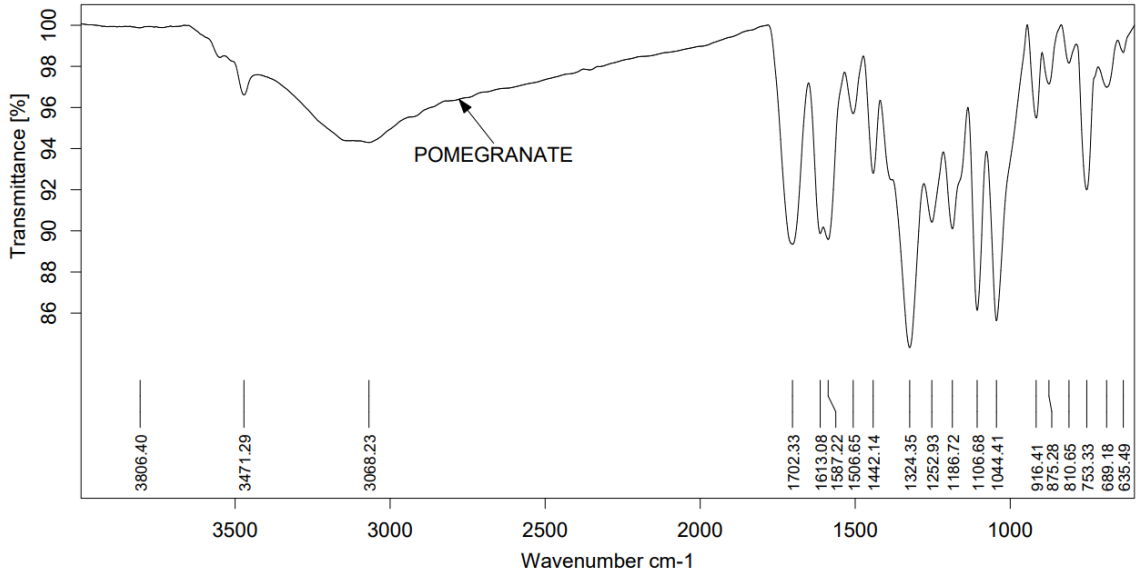

Fig no. 2 FTIR graph of Pomegranate Extract

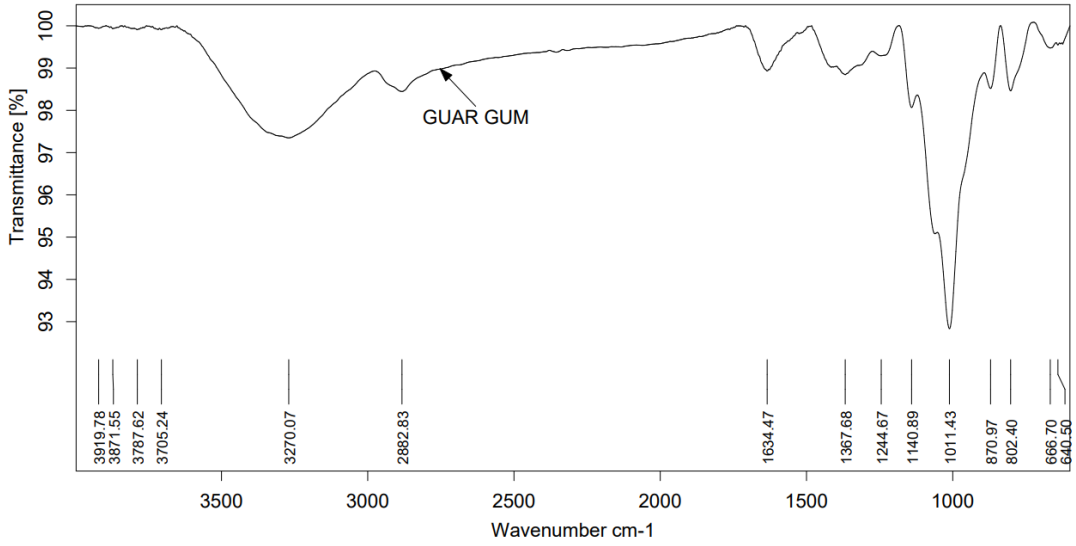

Fig no. 3 FTIR graph of Guargum

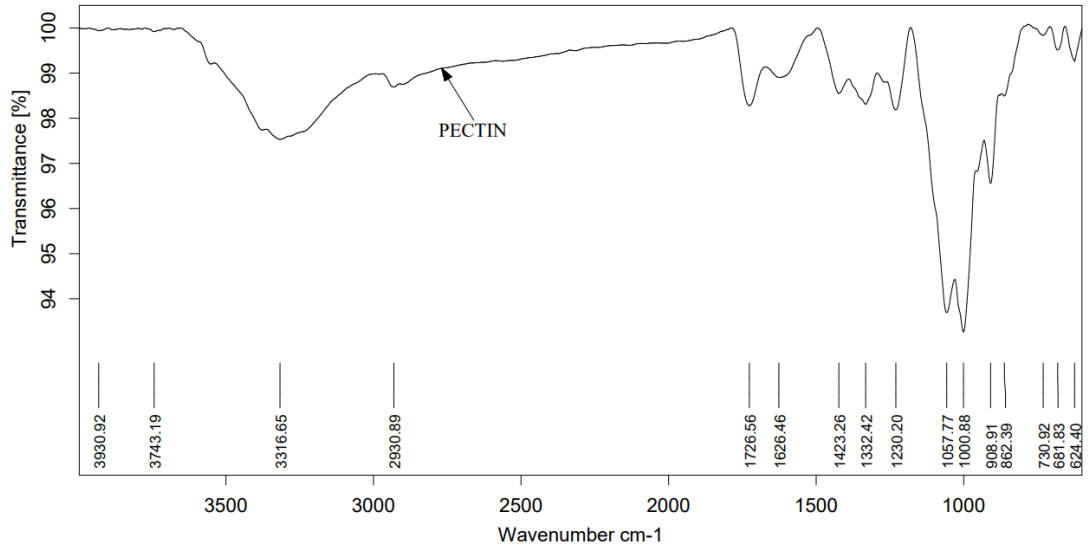

Fig no. 4 FTIR graph of Pectin

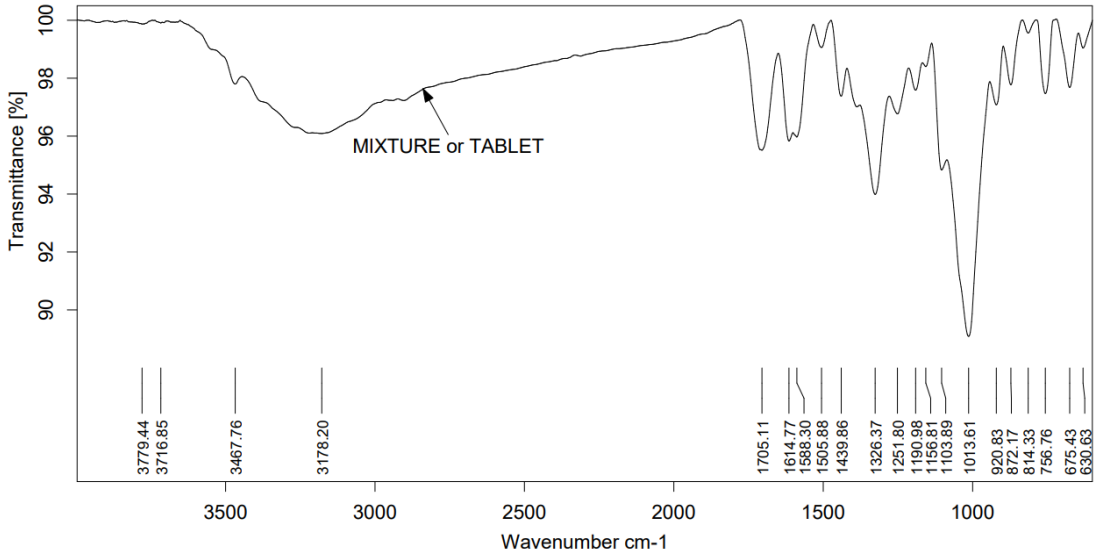

Fig no. 5 FT-IR graph of Pomegranate Tablet Mixture

FTIR spectral analysis was conducted to assess the compatibility between pectin, guar gum and pomegranate extract in the formulation. The FTIR spectrum of the pomegranate extract displayed characteristic bands at 1106 cm^{-1} (C-H stretching, ester function), 1613 cm^{-1} (C=O stretching , aldehyde function), and a narrow band around 2900 cm^{-1} (CH stretching, alkene function). Additionally, the presence of O-H groups was observed at 3471.29 cm^{-1}, and C=C stretching at 1613.52 cm^{-1}, as shown in Figure 2.

For pectin, major hydroxyl group peaks appeared at 3316.65 cm^{-1}. The aliphatic C–H and carbonyl (C=O) groups were observed at 2930 cm^{-1} and 1726.56 cm^{-1}, respectively, with additional peaks at 2930.89 cm^{-1} and 1626.49 cm^{-1}, as depicted in Figure 3.

Guar gum exhibited a strong and broad absorption band at 3270 cm^{-1}, indicating O–H stretching, and a sharp band at 2882 cm^{-1} corresponding to C–H stretching. The spectrum also showed a peak at 1634 cm^{-1}, representing O–H bond scissoring for absorbed water, CH_2 bending at 1367 cm^{-1}, and CH_2–O–CH_2 bending at 1011 cm^{-1}, as illustrated in Figure 4.

Importantly, the principal peaks corresponding to pomegranate extract, pectin, and guar gum were retained in the FTIR spectrum of the pomegranate raft tablet mixture (Figure 5). These results clearly indicate that there is no significant chemical interaction between the pomegranate extract and the excipients (pectin and guar gum), confirming their compatibility in the

formulation.

iii. **Differential Scanning Calorimetry (DSC)**

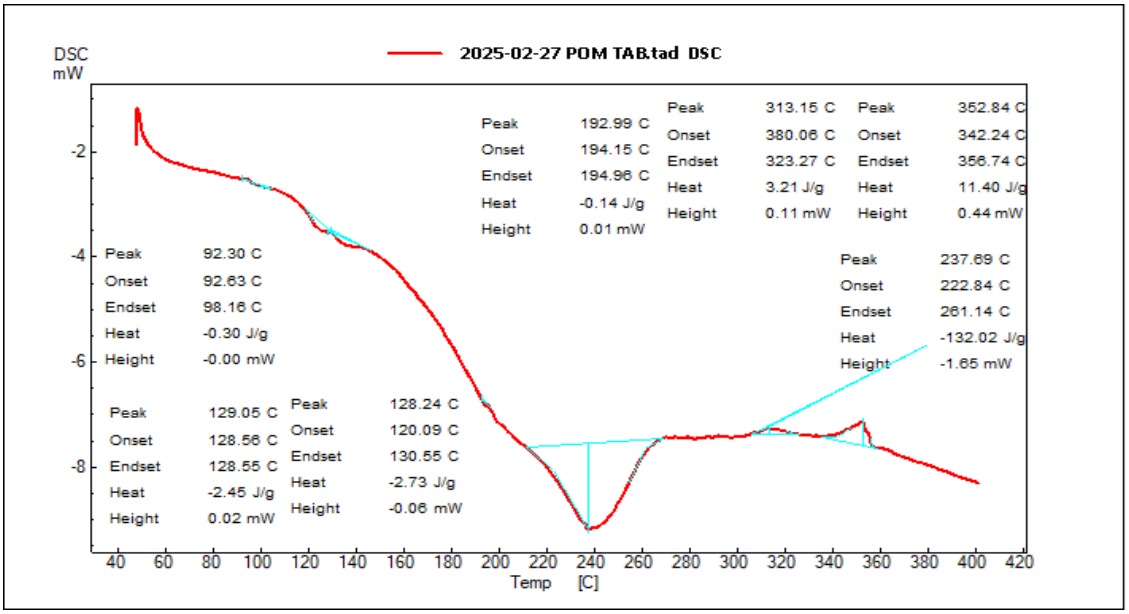

Fig no. 6 DSC graph of Pomegranate Tablet Mixture

Differential scanning calorimetry (DSC) is a valuable technique used to evaluate the compatibility between pomegranate extract, pectin, and guar gum. The DSC thermograms of pomegranate extract, pectin, and guar gum are presented in Figure 5. An endothermic peak was observed at 245.82°C, corresponding to the characteristic peak of pomegranate extract. These results indicate that the integrity of the pomegranate extract was maintained after combining it with the raft excipients. This confirms the compatibility of pomegranate extract with formulation excipients such as pectin and guar gum.

iv. Pre-formulation Studies

Table no.4 Pre formulation studies of F1- F9 Formulations prepared by Direct Compression Method

Formulations	Untapped density (g/cm^3)	Tapped density (g/cm^3)	Carr's index(%)	Angle of repose (θ)	Hausner's ratio
F1	0.55	0.62	11.2	21.87	1.127
F2	0.572	0.794	11.95	21.908	1.138
F3	0.56	0.77	11.27	20.700	1.137
F4	0.51	0.59	11.55	13.36	0.38
F5	0.56	0.63	11.11	17.87	1.12
F6	0.54	0.611	11.620	19.78	1.13
F7	0.537	0.604	11.09	19.95	1.12
F8	0.52	0.59	8.86	18.77	1.13

F9	0.565	0.69	9.11	21.80	1.221

The preformulation studies for the dry granulation formulations F1 to F9 included evaluations of untapped density, tapped density, Carr's Index, angle of repose, and Hausner's ratio, as shown in Table 4. The loose (untapped) bulk density ranged from 0.51 g/cm³ to 0.57 g/cm³, while the tapped density varied from 0.59 g/cm³ to 0.79 g/cm³. These values fall within the acceptable range, with minimal differences between loose and tapped densities, supporting accurate calculation of the powder's percent compressibility.

The angle of repose for all formulations was found to be between 13°36' and 21.90', with all values below 30°, indicating good flow properties. The percentage compressibility, determined using Carr's Consolidation Index, ranged from 8.86% to 11.95%, further confirming that the powder mixtures exhibit good to excellent flow characteristics.

Hausner's ratio, calculated from the loose and tapped bulk densities, ranged from 0.98 to 1.38 for all formulations, which also indicates excellent powder flow. Overall, these preformulation results demonstrate that the tablet mixtures possess suitable flow and compressibility properties for successful tablet manufacturing.

Table no. 5 Pre formulation studies of F10- F18 Formulations prepared by Wet Formulations Method

Formulations	Untapped density ($g/cm^{3)}$	Tapped density ($g/cm^{3)}$	Carr's index(%)	Angle of repose (θ)	Hausner's ratio
F10	0.460	0.507	9.27	11.50	1.102
F11	0.45	0.52	13.46	6.39	1.05
F12	0.466	0.60	11.33	9.365	1.31
F13	0.59	0.72	9.05	10.597	1.22
F14	0.369	0.398	7.2	12.40	1.07
F15	0.47	0.54	12.96	16.15	1.14
F16	0.421	0.485	13.19	10.04	1.15
F17	0.418	0.47	12.76	16.31	1.14
F18	0.477	0.59	10.15	16.69	1.23

The preformulation studies for the wet granulation formulations F10 to F18 included evaluations of untapped density, tapped density, Carr's Index, angle of repose, and Hausner's ratio, as detailed in Table 5. The loose bulk density ranged from 0.36 g/cm³ to 0.59 g/cm³, while the tapped bulk density varied from 0.47 g/cm³ to 0.72 g/cm³.

These values are within the acceptable range, with minimal differences between loose and tapped densities, facilitating accurate calculation of percent compressibility. The angle of repose for all formulations was found to be between 6°39' and 16.69', with all values well below 30°, indicating excellent flow properties.

The percentage compressibility, calculated using Carr's Consolidation Index, ranged from 8.86% to 11.95%, confirming that the powder mixtures exhibit good to excellent flow characteristics. Hausner's ratio, derived from the loose and tapped bulk densities, ranged from 1.05 to 1.31 for all formulations, further indicating excellent powder flow. Overall, these preformulation results demonstrate that the tablet mixtures possess suitable flow and compressibility properties for effective tablet manufacturing.

v. Post formulation studies

Table no.6 Post formulation studies of F1- F9 Formulations prepared by Direct Compression Method

Sl.No	Run	Hardness (kg/cm2)	Friability (%)	Weight variation (g)	Thickness (mm)	Drug Content (%)
1	F1	5.34±0.2	0.4±0.02	490±0.14	4.19±0.15	98.81±0.48
2	F2	5.12±0.5	0.8±0.01	497±0.56	3.98±0.2	96.78±0.34
3	F3	5.52±0.4	0.98±0.01	498±0.74	4.15±0.12	97.34±0.12
4	F4	5.58±0.2	0.2±0.05	495±0.92	4.15±0.13	96.43±0.45
5	F5	5.30±0.3	0.6±0.07	499±0.34	4.18±0.15	96.76±0.56
6	F6	5.44±0.3	0.8±0.02	498±0.39	4.19±0.18	97.89±0.54
7	F7	5.42±0.5	0.7±0.03	499±0.12	4.15±0.16	97.98±0.51
8	F8	5.42±0.1	0.3±0.08	499±0.24	3.99±0.11	95.67±0.45
9	F9	5.44±0.2	1±0.05	499±0.16	3.95±0.17	94.34±0.34

The post-formulation evaluation of dry granulation formulations F1 to F9 included assessments of hardness, friability, weight variation, thickness, and drug content, as summarized in Table 6. The hardness of the floating tablets, measured using a Monsanto tester, ranged from 5.12 to 5.58 kg/cm². Friability, determined with a Roche Friabilator, was well within acceptable limits, ranging from 0.1 ± 0.05% to 0.2 ± 0.05%, which is below the standard threshold of 1%.

All formulations passed the weight variation test, with percent weight variation remaining within the pharmacopeial limit of 5% of the average tablet weight. Tablet thickness, measured by vernier caliper, ranged from 3.95 ± 0.11 mm to 4.19 ± 0.18 mm. The pomegranate extract content in the formulations was found to be between 94.34 ± 0.34% and 98.81 ± 0.48%, which falls within the acceptable range for drug content uniformity (100 ± 10%). Additional parameters such as drug release, floating time, buoyancy lag time, and raft strength for F1 to F9 are presented in Table 8. The drug release profile ranged from 81.99% to 94.98%, with formulation F4 demonstrating superior release compared to the others. Buoyancy lag time was between 10 and 12 seconds, and total floating time ranged from 10.23 to 15.24 hours or more. Among the tested formulations, F10 exhibited the highest raft strength at 5.42 ± 0.40 g. The percentage release of pomegranate extract is illustrated in Figure 8.

Table no. 7 Post formulation studies of F10- F18 Formulations prepared by Wet Formulations Method

Sl.No	Run	Hardness (kg/cm2)	Friability (%)	Weight variation (g)	Thickness (mm)	Drug Content (%)
1	F10	3.9±0.5	0.3±0.08	499±0.74	4.11±0.18	94.97±0.21
2	F11	4.1±0.3	0.4±0.05	499±0.15	3.99±0.19	98.56±0.67
3	F12	3.4±0.2	0.7±0.04	498±0.48	3.86±0.15	94.78±0.98
4	F13	4.4±0.4	0.3±0.09	499±0.22	3.94±0.11	95.93±0.34
5	F14	4.1±0.4	0.8±0.02	500±0.34	3.84±0.13	95.98±0.45
6	F15	4.4±0.5	0.6±0.04	499±0.49	4.15±0.1	95.76±0.43
7	F16	4.08±0.3	1±0.01	498±0.48	4.16±0.19	98.76±0.67
8	F17	4.46±0.2	0.4±0.03	498±0.34	4.19±0.17	98.13±0.43
9	F18	3.9±0.4	0.5±0.02	499±0.51	4.18±0.16	97.65±0.93

The post-formulation evaluation of wet granulation formulations F10 to F18 included assessments of hardness, friability, weight variation, thickness, and drug content, as presented in Table 7. The hardness of the floating tablets, measured using a Monsanto tester, ranged from 3.9 to 4.4 kg/cm². Friability values were maintained between 0.0 ± 0.08% and 0.1 ± 0.01%, well below the standard limit of 1%. All formulations (F10 to F18) passed the weight variation test, with percent weight variation remaining within the pharmacopeial limit of 5% of the average tablet weight. The thickness of the tablets ranged from 3.86 ± 0.15 mm to 4.19 ± 0.17 mm.

Table no.8 Post formulation studies of F1- F9 Formulations prepared by Direct Compression Method

Sl.No	Drug release (%)	Floating time (secs)	Buoyancy Time (Secs)	Raft Strength (g)
F1	92.23	12.3	12	5.13±0.12
F2	89.55	15.01	10	4.56 ±0.76
F3	84.12	14.05	11	4.91 ±0.65
F4	94.98	10.23	11	5.87 ±0.54
F5	86.85	11.2	10	5.65 ±0.76
F6	94.93	10.5	11	4.76 ±0.54
F7	89.50	14.62	10	4.18 ±0.99
F8	86.85	13.24	11	5.23 ±0.65
F9	81.99	15.24	10	4.65 ±0.71

Table no. 9 Post formulation studies of F10- F18 Formulations prepared by Wet Formulations Method

Sl.No	Drug release (%)	Floating time (Secs)	Buoyancy Time (secs)	Raft Strength (g)
F10	86.83	14.78	10	4.93±0.11
F11	94.41	25.30	10	5.18 ±0.69
F12	96.21	28.36	12	5.76 ±0.92
F13	86.83	12.25	10	4.78 ±0.13
F14	84.10	14.35	10	5.43 ±0.13
F15	81.42	10.98	11	3.98 ±0.12
F16	84.14	16.30	11	4.54 ±0.49
F17	86.85	14.78	11	5.19 ±0.13
F18	81.40	15.24	11	4.79 ±0.61

Fig no 7 Raft formation of F12 formulation

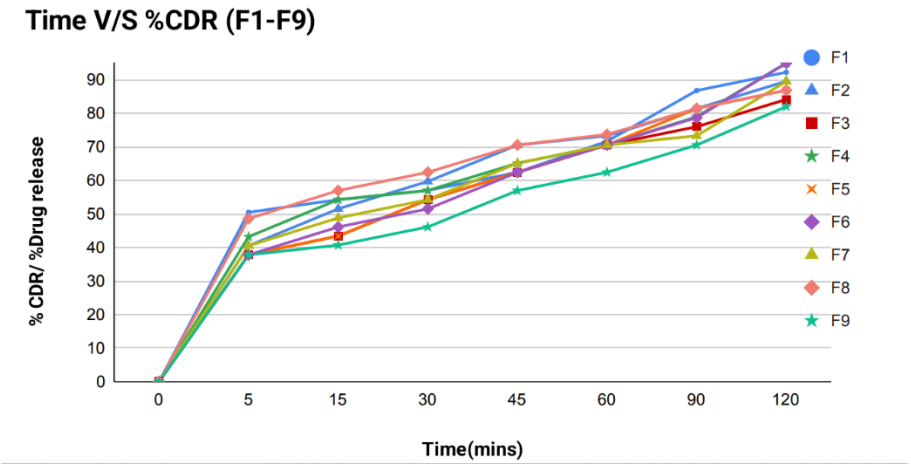

Fig no 8 % CDR of Pomegranate release from dry granulation raft forming tablets

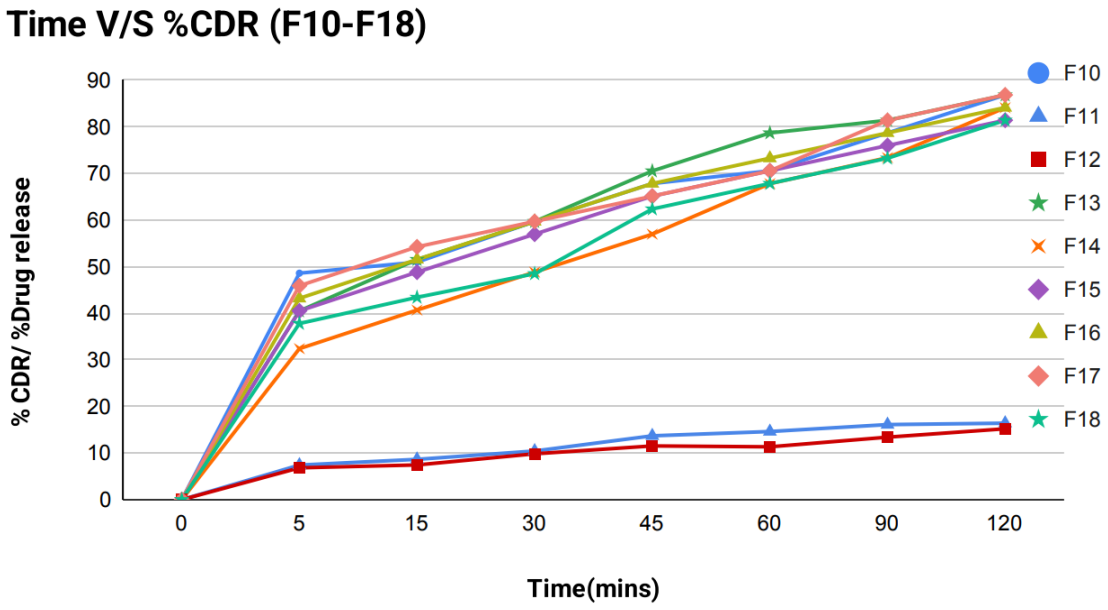

Fig no 9 % CDR of Pomegranate release from wet granulation raft forming tablets

The pomegranate extract content in formulations F10 to F18 ranged from 94.78 ± 0.51% to 98.76 ± 0.67%, which is within the acceptable limit for drug content uniformity (100 ± 10%). Data on drug release, floating time, buoyancy lag time, and raft strength for these formulations are presented in Table 9. The drug release profile varied from 81.40% to 96.21%, with formulation F12 demonstrating superior release compared to the others. The percentage of pomegranate release is illustrated in Figure 9. Buoyancy lag time for the tablets was between 10 and 11 seconds, while the total floating time ranged from 10.98 to 28.36 hours or more. Among all formulations, F11 exhibited the highest raft strength at 5.76 ± 0.92 g.

4. CONCLUSION

The primary objective of this investigation was to develop and evaluate raft-forming tablet systems containing pomegranate extract. Pomegranate has a long history of use in Ayurvedic medicine, primarily due to its potent antioxidant properties. Oxidative stress is a key factor in the development of various chronic diseases, including diabetes and cardiovascular disorders. Research suggests that pomegranate juice may offer significant benefits for heart health, such as lowering blood pressure and improving conditions like coronary artery disease and atherosclerosis.

In this study, raft-forming tablets were formulated using pomegranate extract along with gelling agents such as guar gum and pectin, and an effervescent agent, sodium bicarbonate. Comprehensive pre-formulation studies were carried out for both dry and wet granulation methods, assessing parameters such as angle of repose, bulk density, tapped density, Hausner's ratio, and Carr's index. The results indicated excellent powder flow and compressibility, with all values falling within acceptable limits.

Evaluation of the finished tablets demonstrated compliance with pharmacopeial standards for weight variation, thickness, diameter, friability, and hardness. All prepared tablets exhibited rapid floating and buoyancy times, remaining within 30 seconds and 12 seconds, respectively. Both drug release profiles and raft weight measurements were also within acceptable ranges.

Looking ahead, there is a growing need to integrate herbal and natural products into mainstream therapy to reduce toxicity and enhance therapeutic outcomes. The future of healthcare should embrace a complementary, ethical, and inclusive approach, combining the strengths of both synthetic and herbal medicines to provide the public with the most effective, safe, and affordable treatment options.

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