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Design and evaluation of *Artocarpus heterophyllus* incorporated herbal effervescent granules

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ABSTRACT

The jackfruit, or *Artocarpus heterophyllus* Lam., is a tropical climacteric fruit that is a member of the Moraceae family. The jackfruit is full of nutrients; some of the phytochemicals are proanthocyanidin, flavonoids, and artemisinin. The jack fruits, leaves, and bark, have been extensively utilized in traditional medicine because of their anticarcinogenic, anti-inflammatory, and hypoglycemic benefits. The present study was undertaken to formulate and evaluate the effervescent granules content of *Artocarpus heterophyllus* extract. Three batches of effervescent granules were prepared from which batch II was found to give good flow properties. The phytochemicals found in jackfruit extract were proanthocyanidin, flavonoids, polyphenols, and the creation of a new solvent system for thin-layer chromatography of methanolic (jackfruit) extract. Methanolic extract of jackfruit shows an Rf value of 0.38 by using a 70:30 ratio of Acetone to n-hexane. FTIR and UV spectroscopy and several post-formulation tests were used to identify the primary ingredient present in both extract and effervescent granules. The results revealed that the extract has the highest concentration of proanthocyanidin, flavonoids, and phenolic components, and the λmax was found to be at 278nm. Moreover, FTIR studies revealed that the extract from Artocarpus heterophyllous has no chemical interactions with the other substances.

Keywords: Artocarpus heterophyllus; Effervescent granules; Citric: tartaric: sodium bicarbonate (1:2:4); Methanolic extract

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INTRODUCTION

The mulberry family (Moraceae) tree species known as *Artocarpus heterophyllus* is also known as Jackfruit. Originally from the western ghats of India and Malaysia, it can also be found in central and eastern Africa, southeastern Asia, the Caribbean, Florida, Brazil, Australia, and a lot of the Pacific islands. Morin, dihydromorin, cyanomacurin, artocarpin, isoartocarpin, cycloartocarpin, artocarpesin, oxydihydroartocarpesin, flavonoid, proanthocyanins norartocarpetin, cycloartenon, and artocarpenon are just a few of the Flavones that make up the *Artocarpus heterophyllus*. It also has fatty acids, glycosides, free sugar (sucrose), and some essential amino acids like arginine, cysteine, and histidine. *Artocarpus heterophyllus* has various medicinal components, including its flowers, leaves, fruit, and seeds [1]. Anti-diabetic, antioxidant, anti-inflammatory, antibacterial, immunomodulatory, and antifungal are among the various pharmacological effects. The exterior rind of jackfruit is composed of hexagonal, bluntly conical carpel apices that cover a thick, rubbery, and whitish to yellowish wall and has a color ranging from green to yellow-brown. Each seed is surrounded by flesh with an acidic and sweet banana flavor. A central fibrous core holds the heavy fruit together. Fruits are 30-40 centimeters in length and have an oblong shape. The seeds are round, light brown, 2-3 cm long, 1-1.5 cm wide, and covered in a thin, whitish membrane. Each fruit can have up to 500 seeds. Seeds can be stored for up to a month in cool, humid conditions because they are resistant. Effervescent jackfruit extract granules have been created and tested in this. Increasing the drug's absorption and lowering hyperglycemia are the primary objectives. In addition, it increases effervescent granule absorption and patient compliance [2] (**Fig. 1.**).

MATERIAL AND METHODS

Fruit authentication: The fruit was authenticated by the Anand pharmacy college after being collected from the local market in the Anand district. Aunthentification no: APC/2023/07.

Extraction of fruits: The fruit was first dried in the sun to make dried powder, and then 40 grams of the powder were treated with petroleum ether to defat it as part of the extraction process. The powder was then extracted for a further 24 hours at room temperature using the Soxhlet method [3] (**Fig. 2,3.**).

Fig. 1. (a) Jackfruit (b) Jackfruit rags (c) Jackfruit seeds (d) Jackfruit powder.

Fig. 2. Jackfruit extracts.

Fig. 3. Soxhlet apparatus.

PRELIMINARY PHYTOCHEMICAL ANALYSIS

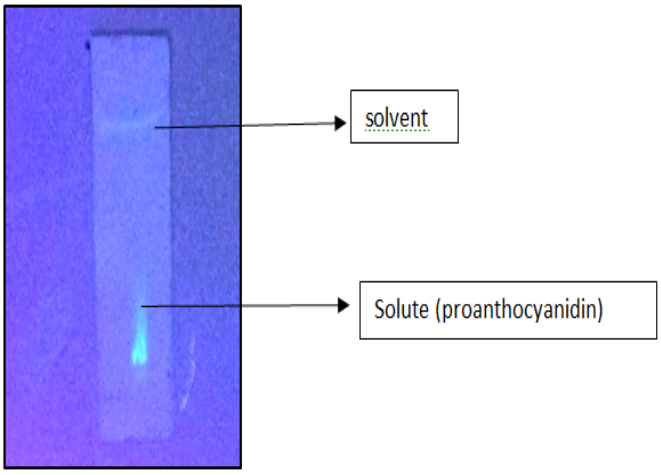
Chemical Test: Identification of flavonoids, alkaloids, and tannins: Flavonoids, alkaloids, and tannins were identified using the tube test technique and the proper reagents for each type of component being tested.

Utilizing ammonia vapor reagents, flavonoids are examined Alkaloid compounds are found using the Mayer reagent, which is then used to determine whether or not precipitation occurred [4].

By examining the color of the reaction product, the Fecl3 reactor is used to test for polyphenols (tannins)

TLC: TLC plates that had been previously coated with 0.25mm layers of silica gel 60 F254 were used for TLC. After extract application, the plates were developed to a thickness of 19 cm in paper-lined chambers, which had all been given at least 30 minutes to acclimatize. Acetone-n-hexane was employed in two mobile stages for this experiment. By using a UV chamber, flavonoids, and polyphenols may be seen. And 0.38 was discovered to be the Rf value [5] (**Fig. 4.**).

Fig. 4. TLC of proanthocyanidin.



STANDARD CALLIBRATION CURVE (UV-ANALYSIS)

The spectroscopy of photons in the UV-visible range is connected to ultraviolet-visible spectrophotometry, or UV-Vis. The visible spectrum or its nearby wavelengths are used in UV-visible spectroscopy. The absorption in the visible ranges is directly influenced by the color of the substances involved. In various portions of the electromagnetic spectrum, molecules go through electronic transitions. The spectrometer automatically scans each of the component wavelengths during a brief period. The visible section is often between 400 and 800 nm, whereas the ultraviolet (UV) region is typically between 200 and 400 nm. A 100 ml volumetric flask containing 100 ml of methanol was used to provide 100 µg of the Artocarpus heterophyllus' methanolic extract. The solution's concentration was then 1000 µg/ml [6]. Further dilution was performed at volumes of 1 ml, 2 ml, 3 ml, 4 ml, and 5 ml, giving concentrations of 100 µg/ml, 200 µg/ml, 300 µg/ml, 400 µg/ml, and 500 µg/ml, respectively. The extract was then scanned in the UV-Visible spectrophotometer between 200 nm and 400 nm. The wavelength of the Lambda UV spectrometer (Shimadzu, Japan) was adjusted in order to determine the value of max, and the maximum absorbance was calibrated using different blanks for each extract. After inserting each sample solution, a wavelength between 400 and 200 nm was passed. It was noted what wavelength the absorption was at its highest. The maximum wavelength was found to be 278nm. The scanning graph and associated absorbance values were recorded. The regression factor for jackfruit in HCL pH. 1.2 was found to be 0.984 [7] (**Fig. 5.**).

FORMULATION OF HERBAL EFFERVESCENT GRANULES

The wet granulation technique was used to create effervescent grains. All the components were weighed in accordance with the recipe after being sieved with a mesh size 10 sieves and dried in the oven for 30 minutes beforehand. The combination was made from a semi-solid extract of Artocarpus heterophyllus, tartaric acid, citric acid, sodium bicarbonate, stevia, lactose, and PVP [8]. It was also sieved with a mesh size 10 and dried in a 50 °C oven for 30 minutes. Dry granules are rescreened through a sieve with a mesh size of 10. An airtight container was used to pack the mixture. The resulting granules were assessed. Colour, flavour, and taste are all examined as part of the organoleptic assessment. Mainly three batches were prepared from which batch II was found to give good post formulation results. The formulation of granules can be seen from below table [9] (**Tab.1. and Fig.6.**).

EVALUATION OF FORMULATED HERBAL EFFERVESCENT GRANULES

Angle of repose: The angle of repose was measured using the fixed funnel method. The angle of repose was measured with a funnel. A funnel was secured above a graph paper that was laid out horizontally on a flat surface at a predetermined height (h). The mixture was carefully poured through the funnel until the conical pile's apex just touched the funnel's tip. The conical pile's base's radius was measured. The following formula was used to determine the angle of repose (θ):

Tan θ =h/r,

Where, θ = angle of repose, h is the height of the cone, and r is the base's radius. If the angle of repose is ≤ 30o, the material is usually free-flowing, while angles of ≥40o indicate poor flowing, 25-30 show excellent flow properties, 31-35 show good flow properties, 36-40 show fair flow properties, and 41-45 showing passable flow properties [10].

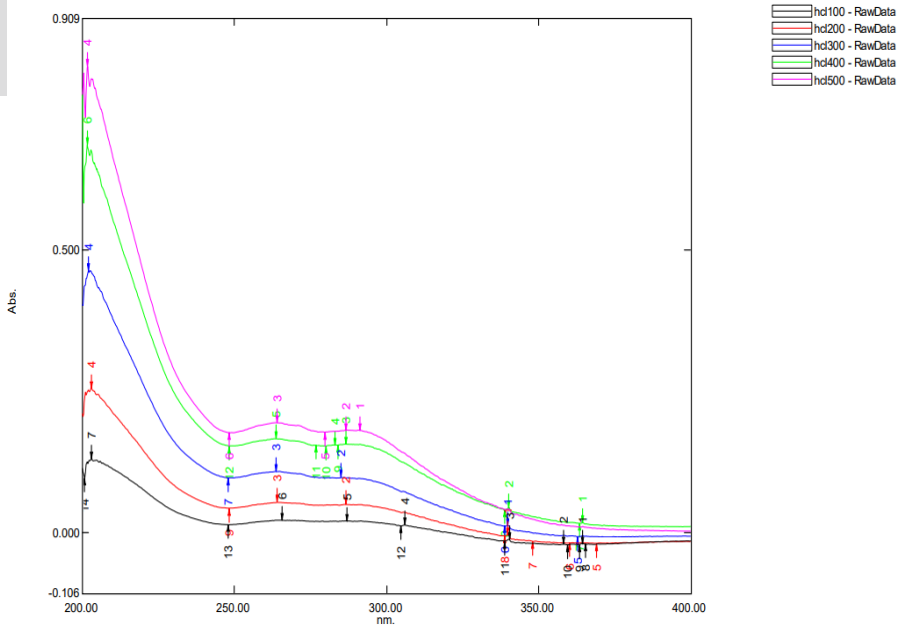
Bulk density: 15 grams of powder mix are introduced without compacting into a dry 100-milliliter cylinder. Vo was read as the powder was levelled with care to avoid compacting and the unsettled apparent volume. The following formula was used to determine the bulk density:

ρb=M/Vo,

Where ρb is the apparent bulk density, M is the sample's weight, and V is the powder's apparent volume [12].

Tapped density: The cylindrical container holding the sample was struck 100 times after performing the steps outlined in the determination of bulk density. The gap between the subsequent measurement and the tapped volume (Vf), which was measured to the closest graduated unit, is less than 2%. The following method was used to

Fig. 5. Callibration curve for Jackfruit in HCL at pH 1.2 and its regression factor.



Tab.1. Formulation of effervescent granules.

Ingredients	Batch I	Batch II	Batch III
Drug extract + lactose	12 gm	12 gm	12 gm
Citric acid	0.6 gm	0.8 gm	1 gm
Tartaric acid	1.2 gm	1.6 gm	2 gm
Sodium bicarbonate	2.4 gm	3.2 gm	4 gm
PVP K30	1.2 gm	1.2 gm	1.2 gm
Stevia	0.8 gm	2 gm	2 gm
Lactose	1.8 gm	1 gm	0 gm
Total	20 gm	21.8 gm	22.2 gm

Fig. 6. Effervescent granules.

determine the measured density in grams per millilitre.
ρt=M/Vf
Where ρt is the tapped density, M is the sample weight, and Vf is the tapped volume of powder [13].

Carr's index (%): A measurement of a powder's tendency to be compacted is the compressibility index, also known as Carr's index. From the mass and tapped weights, it is calculated. Theoretically, a substance is more flowable if it is less deformable. It serves as a gauge for the relative significance of particle interactions. Such interactions are typically less important in a free-flowing powder, and the values of the bulk and tapped densities will be closer. There are commonly more particle contacts in poorly moving materials, which results in a larger discrepancy between the bulk and tapped densities. The Carr's Index, which is determined using the following methods, reflects these variations [14].
Carr's index= [(ρt-ρb)/ ρt]/100
Where, ρb=bulk density, ρt=tapped density.

Hausner's ratio: Hausner's ratio is a proximate indicator of particle movement simplicity. The method used to determine it is as follows.
Tapped density (t) / Bulk density (b) is known as Hausner's Ratio.
Where b is the bulk density and t is the tapped density. Hausner's ratios between 1.25 and 1.5 show middling flow properties, while those over 1.5 show bad flow. Lower Hausner's ratios (1.25) suggest better flow properties than larger ones [15].

Determination of drug release: To determine the percentage of drug content of *Artocarpus heterophyllus* extract in the prepared granules, 600 mg of effervescent granules were weighed, added to 250 ml of water, and thoroughly mixed. The solution was then filtered and analysed using a UV-visible spectrophotometer (UV 1800 shimadzo, Japan) at 278 nm. Each sample's drug content

was calculated using the standard curve they had previously created.

Fourier transforms infrared spectroscopy (FTIR) study: The compatibility of the *Artocarpus heterophyllus* extract with different excipients was examined using FTIR spectroscopy. Using a disc of potassium bromate with a wavelength of 4000-400 cm-1, the ftir spectra of the extract, each component in the formula, and the chosen formula were recorded [16].

RESULTS AND DISCUSSIONS

PHYTOCHEMICAL SCREENING

The phytochemicals present in the *Artocarpus heterophyllus* are shown below in the (**Tab. 2. and Fig. 7.**).

Post formulation studies and physical characteristics of granules: After separation, the Methanolic extract of *Artocarpus heterophyllus* yielded 21.6%w/w. Initial chemistry analysis revealed the existence of flavonoids, glycosides, and tannins. All the three batches post formulation studies were conducted. The particles had a distinctive odour and were dark green in appearance. Batch II bulk density (b) and tapped density (tap) of the grains were 0.466 and 0.539, respectively, while the angle of repose was 25.83. Compressibility index (Carr's index) reading of 15 and Hausner's ratio of 1.15 demonstrate the material's flow good characteristics. Hence from three batches mentioned below batch II was found to produce good flow property [17] **(Tab. 3.)**.

Determination of % cumulative drug relase: Microsoft Excel 2019 was used to further gauge the drug content results. The equation for the *Artocarpus heterophyllus* standard calibration graph was taken into consideration. The highest drug content was 95%, after which asymptotic equilibrium was reached**(Tab. 4. and Fig. 8.).**

FTIR spectroscopy: Fig. 9 displays the findings of the FTIR investigation. The peaks of the Artocarpus heterophyllous extract are shown in Fig. 10, where strong bands for C-H, C=C, O-H, and C-O are seen at 2919.36 cm^{-1}, 1607.72 cm^{-1}, 1336.71 cm^{-1}, and 1140.93 cm^{-1}, respectively. The FTIR

Tab. 2. Preliminary phytochemical test.

Test	Petroleum ether extract	Methanolic extract
Steroids (fats and oil)	+	-
Saponin	+	+
Alkaloid	-	+
Flavonoid	-	+
Tannins	-	+
Glycosides	-	+
Amino acids	-	+
Reducing sugar	-	+
polyphenols	-	+

Fig. 7. (a) Saponin (b) Flavonoid (c) Fehling test.

Tab. 3. Physical evaluation of granules.

Sr.no	Parameter	Batch I	Batch II	Batch III
1	Angle of Repose	30.22+0.5	25.89+1.88	24.69+0.65
2	Bulk density	0.472+0.0005	0.464+0.0015	0.479+0.0005
3	Tapped density	0.561+0.005	0.539+0.0015	0.55+0.005
4	Carr, s index	19	15	19
5	Hausner's ratio	1.18	1.15	1.19
6	Effervescent cessation time	1-2 min	1-2 min	1-2 min
7	Colour	Olive green colour	Olive green colour	Olive green colour
8	Odour	Characteristic odour	Characteristic odour	Characteristic odour
9	Appearance	Amorphous granules	Amorphous granules	Amorphous granules

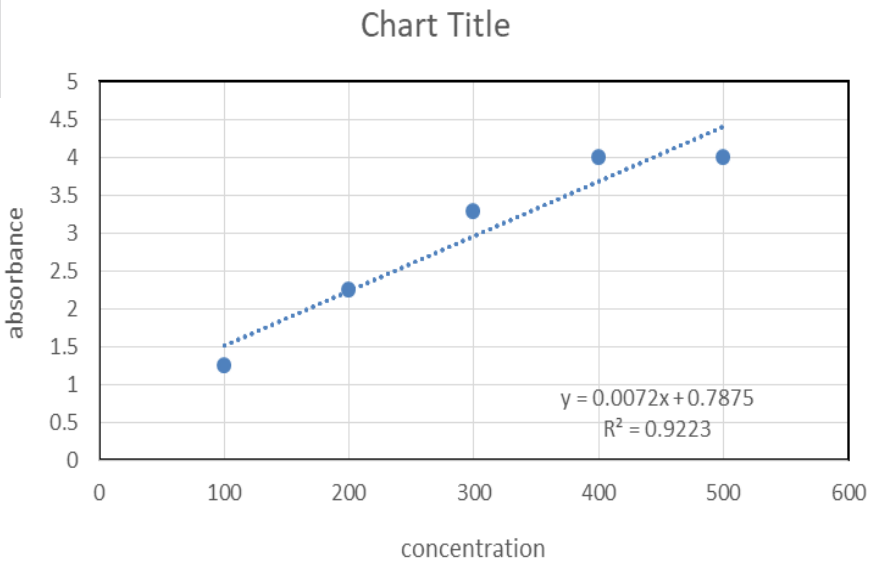
spectra of the granules from *Artocarpus heterophyllus* are shown in Fig. 10. The outcome shows that the extract from Artocarpus heterophyllous has no chemical interactions with the other substances [18] (**Tab. 5. and Fig. 9,10.**).

Stability studies: After storage, no observable changes in the granule's appearance were identified in stability tests on the enhanced granule formulation (B2). The drug's content was found to be 94% after storage as opposed to 95% before storage. The quantity of extract released from the B2 before and after storage was 100% within 2 minutes during dissolving tests. There was no noticeable difference in the average amount of extract released or the drug content from B2 granules after being stored for three months at 40oc/75% RH [19].

Tab. 4. Drug content.

concentration	absorbancee	µg/ml
100	1.253	30.2122
200	2.255	53.8444
300	3.288	78.2075
400	4	95
500	4	95

Fig. 8. Concentration vs absorbance graph of drug content.



Tab. 5. FTIR spectroscopy.

Functional group	Std wave number	Extract (cm-1)	Granules (cm-1)
C-H Stretching	3350-3310	3323.46	3342.75
C=C Stretching	1670-1600	1607.72	1664.62
O-H bending	1390-1310	1336.71	1339.61
C-O Stretching	1205-1124	1140.93	1140.93

Fig. 9. FTIR spectroscopy for Jackfruit effervescent granules.

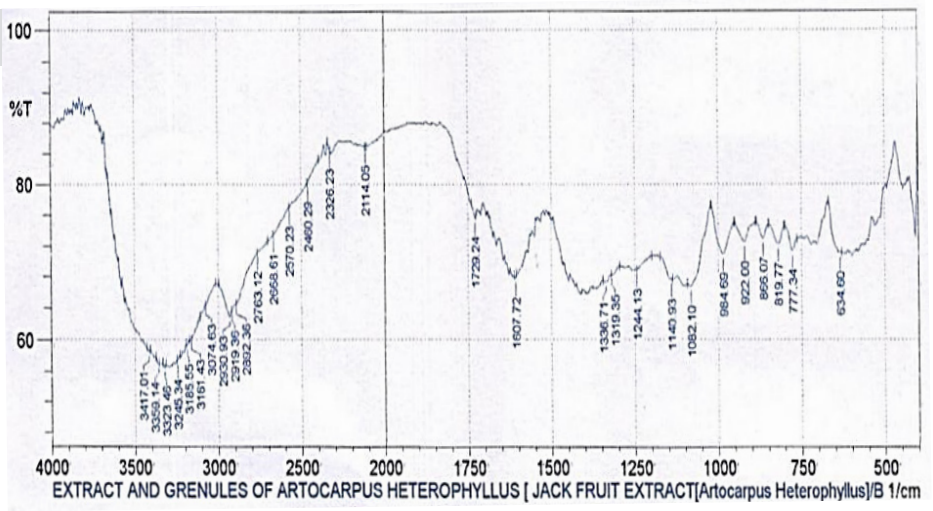
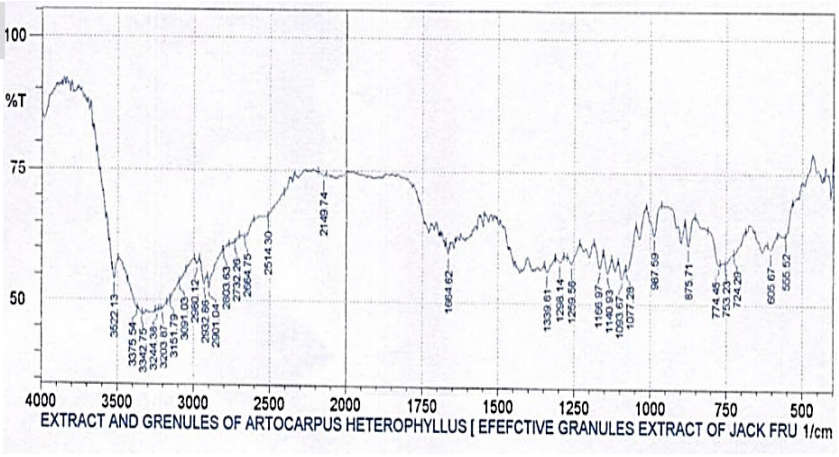


Fig. 10. FTIR spectroscopy for Jackfruit extract.



CONCLUSION

The present research focus on the formation and evaluation of herbal effervescent granules, Different chemical tests have been carried out to identify the component. Additionally, TLC and UV analysis were used to confirm the phytochemicals. A total of 3 batches of effervescent granules have been made, with batch II showing good flow characteristics. For its flow ability check, several post-formulation investigations have been conducted. Additionally, FTIR spectroscopy was used to identify the functional group, and it was shown that there was no interaction between the extract and the effervescent granules. The stability investigations for the three months were completed last, and they revealed 94% drug content, no color changes, and an effervescence period of two minutes.

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