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Research Article

Design and Evaluation of Herbal Based Granular Nutraceuticals

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ABSTRACT

The present study focuses on the formulation and evaluation of polyherbal granules as a nutraceutical, leveraging the therapeutic potential of selected medicinal plants. Petroleum ether and methanolic extracts of Phyllanthus emblica and Aegle marmelos fruits, along with rhizomes of Curcuma longa, were prepared through successive solvent extraction based on increasing polarity. Preliminary phytochemical screening of the petroleum ether (PEPF) and methanolic (MEPF) extracts revealed the presence of sterols, tannins, phenolics, flavonoids, alkaloids, and glycosides. These bioactive constituents, particularly flavonoids, tannins, and alkaloids, are attributed to the observed antioxidant activity, likely through free radical scavenging mechanisms. The polyherbal granules were formulated using the wet granulation method and evaluated for their potential as nutraceuticals. The study supports the growing relevance of phytotherapy, a modern approach utilizing herbal extracts for disease management. Literature review confirms the hepatoprotective and antioxidant potential of the selected plant materials, validating their inclusion in the formulation.

INTRODUCTION

A nutraceutical is defined as a substance that provides physiological benefits or protection against chronic diseases. Nutraceuticals are commonly used to promote health, delay the aging process, prevent chronic diseases, increase life expectancy, and support the structure or function of the body [1]. Typically, nutraceutical products contain appropriate amounts of lipids, proteins, carbohydrates, vitamins, minerals, and other essential nutrients, depending on their specific health focus. Upon ingestion of nutraceutical supplement granules, the body undergoes processes of digestion and nutrient absorption [6]. Medicinal products derived from plant sources are

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referred to as herbal remedies or phytopharmaceuticals [2]. Phytotherapy is a modern therapeutic approach that employs herbal extracts and dried, powdered plant materials in the treatment of various diseases. Approximately 80% of the global population relies on herbal medicines as a primary form of healthcare. In countries such as India, China, and several African nations, herbal medicines are widely prescribed and form a significant component of healthcare systems. Recent scientific investigations into phytopharmaceuticals within the field of ethnomedicine have led to the discovery of numerous phytoconstituents with therapeutic potential [3]. Antioxidants are compounds that prevent or slow down oxidation—a chemical reaction that produces free radicals, which can initiate chain reactions damaging to cells. The liver, being the largest organ in the human body, plays a central role in metabolism, detoxification, and enzyme secretion. A review of the literature highlights the therapeutic potential of various plants in treating conditions such as diarrhea, jaundice, and inflammation. These plants have also demonstrated antidiabetic, hypolipidemic, antibacterial, antioxidant, antiulcerogenic, hepatoprotective, gastroprotective, and chemoprotective properties [4,10].

Table No.1: Plant Profile (Taxonomic status) [5,6,7]

	Phyllanthus emblica	***Aegle marmalos***	***Curcuma longa***
			
Kingdom	Plantae	Plantae	Plantae
Sub-kingdom	Viridiplantae	Tracheobionta	Viridiplantae
Division	Tracheophyta	Magnoliophyta	Magnoliophyta
Class	Magnoliopsida	Spermatophytina	Magnoliopsida
Family	Phyllanthaceae	Rutaceae	Zingiberaceae
Genus	Phyllanthaceae	*Aegle*	Curcuma L.
Species	Phyllanthus emblica L	*marmalos*	Curcuma longa L

MATERIAL AND METHODS:

Collection and Drying

The fruits of *Phyllanthus emblica* and Aegle *marmelos* as well as rhizomes of *Curcuma longa* was collected from Loni a village closed to Shirdi located in Ahmednagar district of Maharashtra. The fruits and rhizomes dried and then pulverized in grinder. The powdered utilized for extraction procedure was passed through 60-120 mesh to obtained fine powder.

Plants Authentication

The authentication of the plant was authenticated by Botanical Survey of India (BSI), Pune. The herbarium of the plant specimens has been deposited at B.S.I. Pune.

Evaluation of Physical Constant

Ash value

Ash value is used to determine quality and purity of crude drug. Ash value contains inorganic radicals like phosphates carbonates and silicates of sodium, potassium, magnesium, calcium etc. sometimes inorganic variables like calcium oxalate, silica, carbonate content of the crude drug affects 'total ash value'. Such variables are then removed by treating with acid and then acid insoluble ash value is determined

Determination of Total ash

Accurately weighed 2 gm of air dried crude drug was taken in a tared silica dish and incinerated at a temperature not exceeding 450°C until free from carbon, cooled and weight was taken. The percentage of ash was calculated with reference to the air-dried drug.

Determination of Water- soluble ash

The ash was obtained as per method described above and boiled for 5 minutes with 25 ml of water, filtered and collected the insoluble matter on an ash less filter paper, washed with hot water and ignited for 5 minutes at a temperature not exceeding 450°C and weight was taken. Subtracted the weight of the insoluble matter from the weight of the ash; the difference in weight represents the water-soluble ash. The percentage of water –soluble ash was calculated with reference to the air-dried drug.

Determination of Acid -insoluble ash

The ash was obtained as per method described above and boiled for 5 minutes with 25 ml of 2M hydrochloric acid, filtered and collected the insoluble matter on an ash less filter paper, washed with hot water and ignited cooled in a desiccator and weighed. The percentage of acid –

Extractive values

Different extractive values like alcohol soluble extractive, water soluble extractive values were performed by standard method**.**

Determination of water-soluble extractive value

5 gm of air dried coarsely powdered drug was macerated with 100 ml of Water in a closed flask for 24 hours, and it was shaken frequently during first 6 hours and allowed to stand for 18 hours. Then it was filtered, 25 ml of the filtrate was evaporated in a flat shallow dish, and dried at 105^0c and weighed. Percentage of water-soluble extractive value was calculated with reference to air-dried drugs.

Determination of Alcohol-soluble extractive value:

5 gm of air-dried coarsely powdered drug was macerated with 100 ml of ethanol of specified strength in a closed flask for 24 hours, and it was shaken frequently during first 6 hours and allows standing for 18 hours. Then it was filtered, during filtration precaution was taken against loss of ethanol, 25 ml of the filtrate was evaporated in a flat shallow dish, and dried at 105^0c and weighed. Percentage of ethanol soluble extractive value was calculated with reference to air-dried drugs.

Loss on Drying

Accurately weighed glass-stopper, shallow weighing bottle, was dried. 2gm of sample was transferred to the bottle and covered, the weight was taken, and sample was distributed evenly and poured to a depth not exceeding 10 mm. Then loaded bottle was kept in an oven and was removed. The sample was dried to constant weight. After drying it was collected to room

temperature in a desiccator. Weighed and the loss on drying was calculated in terms of percent w/w.

Extraction (Soxhlet Extraction Method)

200 gm powder of the fruits *Phyllanthus emblica* and Aegle *marmelos* as well as rhizomes of *Curcuma longa* were taken for extraction. The extraction was started with non polar solvents like petroleum ether and polar solvents like Methanol as shown in fig no. 1. [8]

Fig No. 1: Extraction of crude drugs

Preliminary Phytochemical Screening

The different phytochemical tests were performed for establishing the profile of plant extract for its phytochemical constituents. The test for carbohydrates, Aminoacids, Proteins, Steroids, Glycosides, Flavonoids, Alkaloids and Tannins was carried out [5].

Preparation of polyherbal granules

The wet granulation technique was selected due to its convenience for small scale preparations. The granules were prepared by using iso-propyl alcohol with different compositions of extracts of each drug, starch as disintegrator, talc as lubricant, magnesium stearate as glidant, acacia gum as a binder and lactose was used as filler as shown in Table No. 2.[9]

Table No. 2: Formula for Preparation of polyherbal granules

Ingredients	Amount in mg
Extract of *Phyllanthus emblica*	50
Extract of *Aegle marmelos*	50
Extract of *curcuma longa*	50
Starch	20
Talc	5
Magnesium Stearate	5
Acaciagum	5
Lactose	315

Evaluation of polyherbal granules [11,12]

Angle of repose:

Determined by using the funnel method. Accurately weighed granules were taken in a funnel and the height of the funnel was adjusted in such a way that the tip of the funnel just touches

the apex of the heap. The granules were allowed to flow through the funnel freely onto the surface.

Loose bulk density (LBD):

Determined by pouring a weighed quantity of granules into a graduated cylinder and measuring the volume and weight.

LBD = Weight of the powder / volume of the packing

Tapped bulk density (TBD):

Determined by placing a graduated cylinder, containing a known mass of granules. The cylinder was allowed to fall under its own weight onto a hard surface from the height of 10 cm at two second intervals. The tapping was continued until no further change in volume was noted.

TBD = Weight of the powder / volume of the tapped packing

Hausner ratio:

It is the measurement of frictional resistance to the drug. The ideal range should be 1.2- 1.5. It is determined by using the following formula:

Hausner ratio= TBD / LBD

Compressibility index:

The Compressibility index of the blends was determined by the Carr's compressibility index.

Compressibility index (%) = (TBD-LBD) X 100 / TBD

Loss on drying:

One gram of granules was transferred into a dried, glass stoppered shallow weighing bottle. The contents were distributed evenly and placed in the drying chamber. The stopper was removed from the bottle and the contents were dried for a specified time to achieve a constant weight.

Loss on drying (%) = [(Initial weight – Final weight) / (Initial weight)] X 100

Accelerated Stability Studies

The stability parameters of a drug dosage form can be influenced by environmental conditions of storage, i.e. temperature, light, air and humidity, as well as the package components. All the formulations were subjected for accelerated stability for the period of 3 months at accelerated temperature conditions, i.e. room temperature (25±2°C)/60% RH, 5°C/Ambient and 40°C/75% RH. The different parameters such as color, odor and the texture of the granules.

RESULTS AND DISCUSSION:

The Soxehlet extraction was done using two different solvents Petroleum ether (a non-polar solvent) and Methanol (a polar solvent) on three medicinal plants *Phyllanthus emblica* (Amla), *Aegle marmelos* (Bael), *Curcuma longa* (Turmeric) as per indicated in Table No. 3. The percentage yield refers to the amount of extract obtained from the raw plant material, expressed as a percentage of the total weight of the plant material used. Methanol, being a polar solvent, extracted a higher yield from all three plants compared to petroleum ether. This is likely because many bioactive compounds in these plants (like phenolics, flavonoids, alkaloids, etc.) are polar and dissolve better in methanol.Petroleum ether, being non-polar, is more effective for extracting non-polar compounds like lipids, but generally results in lower yields for medicinal plants rich in polar constituents. Methanol is a more effective solvent than petroleum ether for extracting polar bioactive compounds from these

medicinal plants. Among the plants tested, *Curcuma longa* showed the highest extractive value, making it potentially more potent or rich in extractable constituents under the given conditions.

Table No.3: Percentage Yield of Extract

Sr. No.	Extracts		Color	Nature	Percentage Yield
1	Petroleum ether	Phyllanthus Emblica	Brown	Semi –solid	4.10%
1		Aegle marmelos	Brown	Semi –solid	2.96%
		Curcuma longa	Yellowish brown	Semi –solid	6.88%
2	Methanol	Phyllanthus emblica	Brown	Semi –solid	8.04%
2		Aegle marmelos	Brown	Semi –solid	5.88%
		Curcuma longa	Yellowish brown	Semi –solid	9.88%

Evaluation of preliminary Phytochemicals in extract

The Phytochemical screening was done by the standard procedure shown in Table No 4. The fruits of *Phyllanthus Emblica* in petroleum ether extract showed the presence of steroids, alkaloids and tannins while carbohydrates, proteins, glycosides, flavonoids in the methanolic extract *and* the fruits of *Aegle marmelos* in petroleum ether extract showed the presence of steroids and tannins while carbohydrates, proteins, glycosides, flavonoids in the methanolic extract as well as rhizomes of *Curcuma longa* which showed the presence of carbohydrates, glycosides, flavonoids, tannins in the petroleum ether extract while carbohydrates, proteins, glycosides ,alkaloids, flavonoids and tannins in Methanolic extract.

Table No. 4: Preliminary Phytochemical Screening Result

Chemical Constituent	Chemical test	*Phyllanthus emblica*		*Aegle marmalos*		*Curcuma longa*	
		PE	ME	PE	ME	PE	ME
Carbohydrate	Molish test	-	+	-	+	-	+
	Fehling's test	-	+	-	+	+	+
	Benedict test	-	+	-	+	+	-
Protein	Biuret test	-	+	-	+	-	-
Amino acid	Ninhydrin test	-	-	-		-	+
Steroids	Salkowski test	+	-	+	-	-	+
	Libermann Burchard test	+	-	+	-	-	-
Glycoside	Cardiac glycoside	-	+	-	+	+	-
	Anthraquinone glycoside	-	+	-	+	+	+
	Saponin glycoside	-	+	-	-	-	+
Flavonoid	Shinoda test	-	+	-	+	+	+
	Sodium hydroxide test	-	+	-	+	+	+
Alkaloid	Mayer's test	+		-	+	-	+
	Hager's test	-		-	+	-	+
	Wagner's test	+		-	+	+	+
Tannins	Nitric acid test	+	+	+	-	+	+

Physical Constant:

Total ash Represents total inorganic material (natural or adulterant). Higher values may indicate more contamination or naturally higher mineral content. *Curcuma longa* has the highest total ash could be due to inherent minerals or soil contamination. Acid insoluble ash Reflects silica content (e.g., sand or soil) High values suggest contamination. *Phyllanthus emblica* has the highest acid-insoluble ash, indicating more sand or earthy material. Water soluble ash Indicates the amount of water-soluble inorganic salts *Curcuma longa* has the highest water-soluble ash, showing higher levels of soluble minerals. Alcohol soluble extractives often indicate the presence of polar constituents like alkaloids, glycosides, and flavonoids. *Phyllanthus emblica* shows highest alcohol-soluble extractive value likely rich in bioactive phytochemicals. Water-soluble extractives include sugars, tannins, mucilage, and some glycosides. Again, *Phyllanthus emblica* has the highest, which aligns with its known richness in polyphenols and ascorbic acid. LOD measures moisture content in the sample. Excess moisture can lead to microbial growth and degradation. Lower LOD values indicating better shelf life. *Curcuma longa* has the lowest moisture content, suggesting better stability and lower chance of spoilage. *Aegle marmelos* has the highest moisture, which may require more careful storage as shown in Table No.5.

Table No. 5: Physical Constant

No.	Parameters	*Phyllanthus emblica (%W/W)*	*Aegle marmelos (%W/W)*	*Curcuma longa (%W/W)*
1.	Ash values: Total ash	3.31	5.35	6.99
	Acid insoluble ash	1.35	0.25	0.53
	Water soluble ash	4.01	4.56	8.55
2.	Extractive values: Alcohol soluble extractive	41.02	20.13	19.45
	Water soluble extractive	47.31	35.76	23.00
3.	Loss on drying	4.70	6.45	4.43

Evaluation of Granules

The evaluation parameters of granules are essential to assess their suitability for tablet formulation. The angle of repose (23.2°) indicates excellent flowability, important for uniform die filling. Loose and tapped bulk densities help determine the packing ability of granules, and the difference between them is used to calculate Hausner ratio (1.03) and Compressibility Index (24.23%)**.** These values suggest good flow but moderate compressibility, which may slightly affect tablet formation. Loss on drying (0.67%) shows **l**ow moisture content, ensuring good stability and reduced risk of microbial growth. Overall, the granules are suitable for compression with minor optimization as shown in Table No.6.

Table No. 6: Evaluation of Granules

Parameters	Result	Evaluation
Angle of repose	23.2±1.02°	Excellent flow

3 Loose bulk density (g/cm)	0.351±0.012	Acceptable
3 Tapped bulk density (g/cm)	0.490±0.023	Acceptable
Hausner ratio	1.03±0.03	Good flow
Compressibility index (%)	24.23±1.02	Fair to Good compressibility
Loss on drying (%)	0.67±0.007	Excellent moisture control

Accelerated stability study of granules

The Table No.7 presents stability observations of a formulation over 90 days under different storage conditions: room temperature with 60% relative humidity (RH), refrigeration (5°C), and accelerated conditions (40°C, 75% RH). Throughout the study, odor and texture remained unchanged (NC)**,** indicating good stability in these parameters. Color stayed consistent for up to 60 days, but by 90 days under accelerated conditions, a slight change to faint green was observed, indicates minor degradation but the overall formulation shows excellent physical stability under normal and refrigerated conditions, with only a slight color change under stress.

Table No. 7: Accelerated Stability Study of Granules

Parameters	**Observations**									
	Initial	**30 days**			**60 days**			**90 days**		
		RT/ 60%RH	5°C/ Ambient	40°C/ 75%RH	RT/ 60%RH	5°C/ Ambient	40°C/ 75%RH	RT/ 60%RH	5°C/ Ambient	40°C/ 75%RH
Color	Yellowish green	NC	NC	NC	NC	NC	NC	NC	NC	Faint green
Odor	Characteristic	NC	NC	NC	NC	NC	NC	NC	NC	NC
Texture	Smooth	NC	NC	NC	NC	NC	NC	NC	NC	NC

NC= No Change, RT= Room Temperature (25±2°C)

CONCLUSION:

In the present study the leaves of plant material-Polyherbal formulation were subjected for continuous extraction by using solvents with increasing polarity. On preliminary phytochemical analysis the extracts were found to contain sterols, tannins, phenolics, flavonoids, alkaloids and glycosides. The study indicates the therapeutic potential of Polyherbal formulation provides scientific evidence for traditional uses. The plant may prove to be promising in management of hepatic toxicity. Furthermore Polyherbal formulation may be used in alleviation of liver diseases, an antioxidant and used as an neutraceuticals.

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