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Formulation And Evaluation Of Garlic Powder Loaded Capsule

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Abstract

Garlic (*Allium sativum*) has been widely recognized for its therapeutic properties, including antimicrobial, antioxidant, antihypertensive, and lipid-lowering effects. This study investigates the formulation, characterization, and potential health benefits of garlic powder-loaded capsules as a standardized nutraceutical product. The capsules were prepared using a dry powder encapsulation technique, ensuring dose uniformity and preservation of bioactive compounds. Physicochemical evaluations such as disintegration time, moisture content, weight variation, and stability testing were conducted to assess capsule quality. The results support the feasibility of garlic powder-loaded capsules as a convenient and effective delivery system. The results indicated that the garlic capsules met pharmacopeial standards and maintained stability over the test period. This study demonstrates that garlic powder can be effectively delivered in capsule form, offering a convenient and controlled means of administration for therapeutic or nutraceutical purposes.

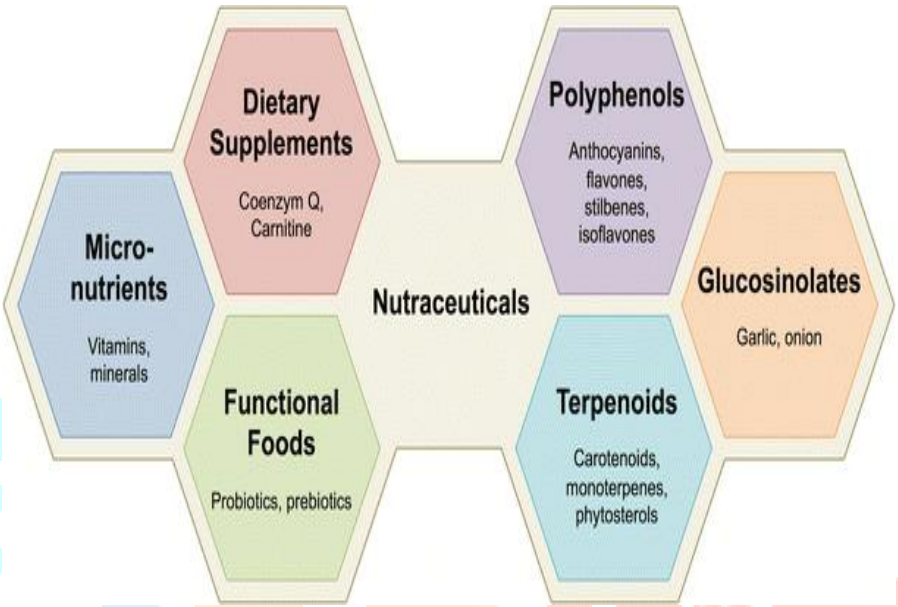
Keywords: Garlic powder, capsule, dissolution, UV, λ max.

1. Introduction

- Nutraceutical is a term coined to describe substance which are not traditionally recognized nutrient but which have positive physiological effects on the human body.[1]
- Nutraceuticals as Vitamins, amino acids, herbs or herbal extracts flavonoids like curcumin, and probiotics have been used for their role in prevention of COVID 19 symptoms such as fever, pain, malaise, and dry cough. Compounds such as lipids, carbohydrates, proteins, minerals and nutrition. Nutraceuticals are oral dietary components naturally found in food.[2]
- A life without food is not possible as it provides nutrient that nourish our body and keep our body working in good condition. The quality of life mainly depends on what we eat, and hence nutrition and its impact on health are very important. The word "nutrition" and "pharmaceutical", was coined in **1989 by Stephen L. Defelice,** founder and chairman of the foundation of Innovation Medicine.[3]
- Human lifestyle has been drastically changing over last five decades due to urbanization, industrialization, hectic schedule and changing cultures.[4]
- Foods has risen leading to many disorders induces because of inappropriate diet, due to which obesity is now a worldwide concern, these factors have changed human habits and force them to fast eating, instant and tasty food, and junk.[5]

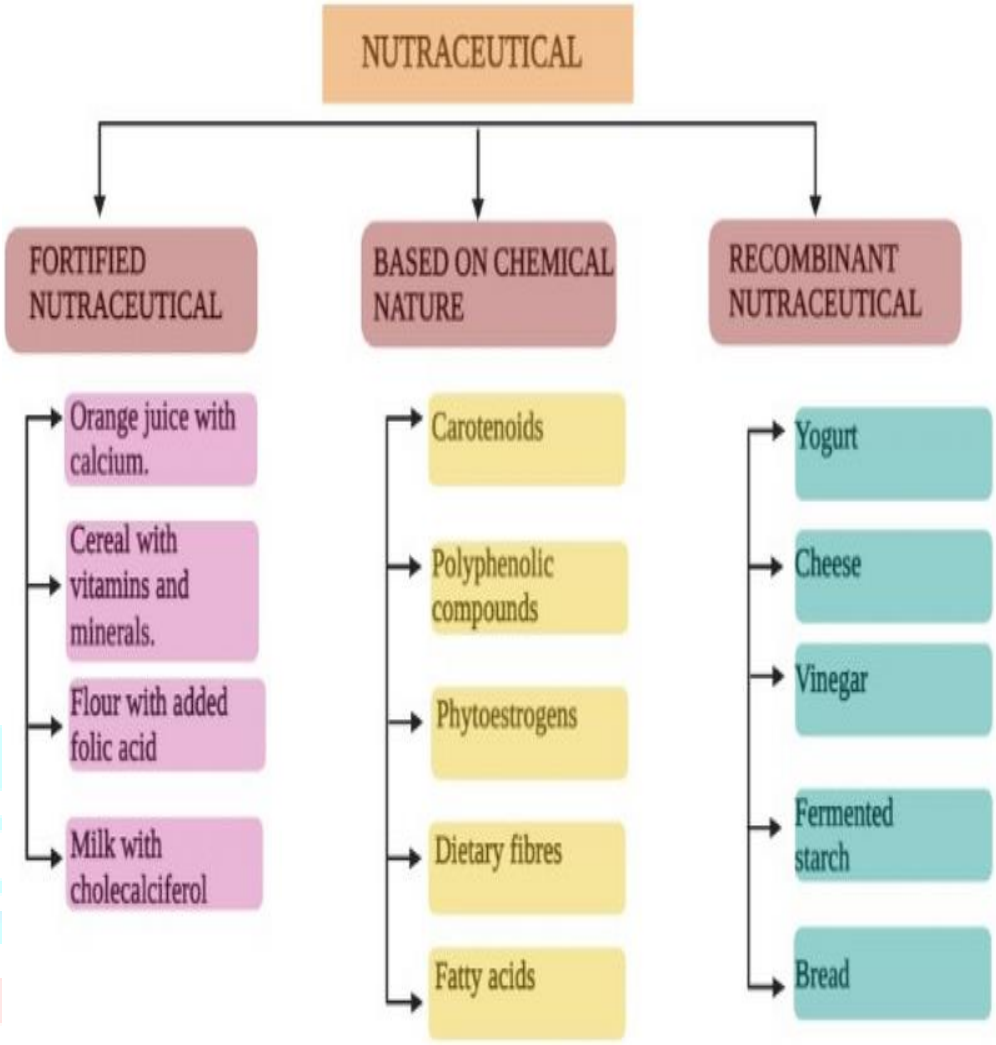
- In few years ago COVID -19 diseases enter in country and more people died due to deficiency of Nutraceuticals. Most importantly, regular consumption of Nutraceuticals has been to boost the immune system and prevent viral infection. There are many over 470 Nutraceuticals and functional food product is available with proven health advantages.[6]

Figure 1: Nutraceuticals Health Supplements.



2. Classification of Nutraceuticals

Figure 2: Nutraceutical Classification

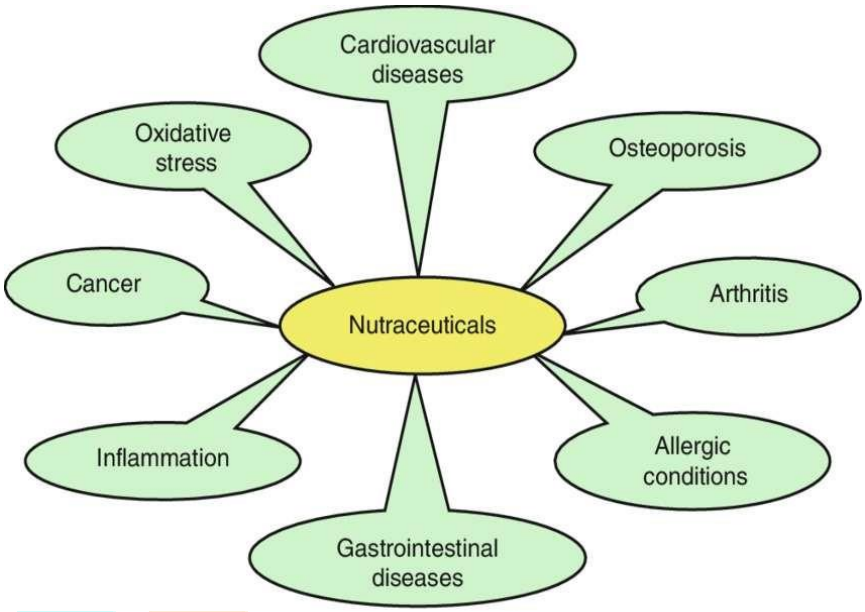


Advantages

- Nutraceuticals like food and note on sided as drugs so have less or fewer side effects.
- They enhance overall health and wellbeing.
- They are available without prescription means accessible and affordable.

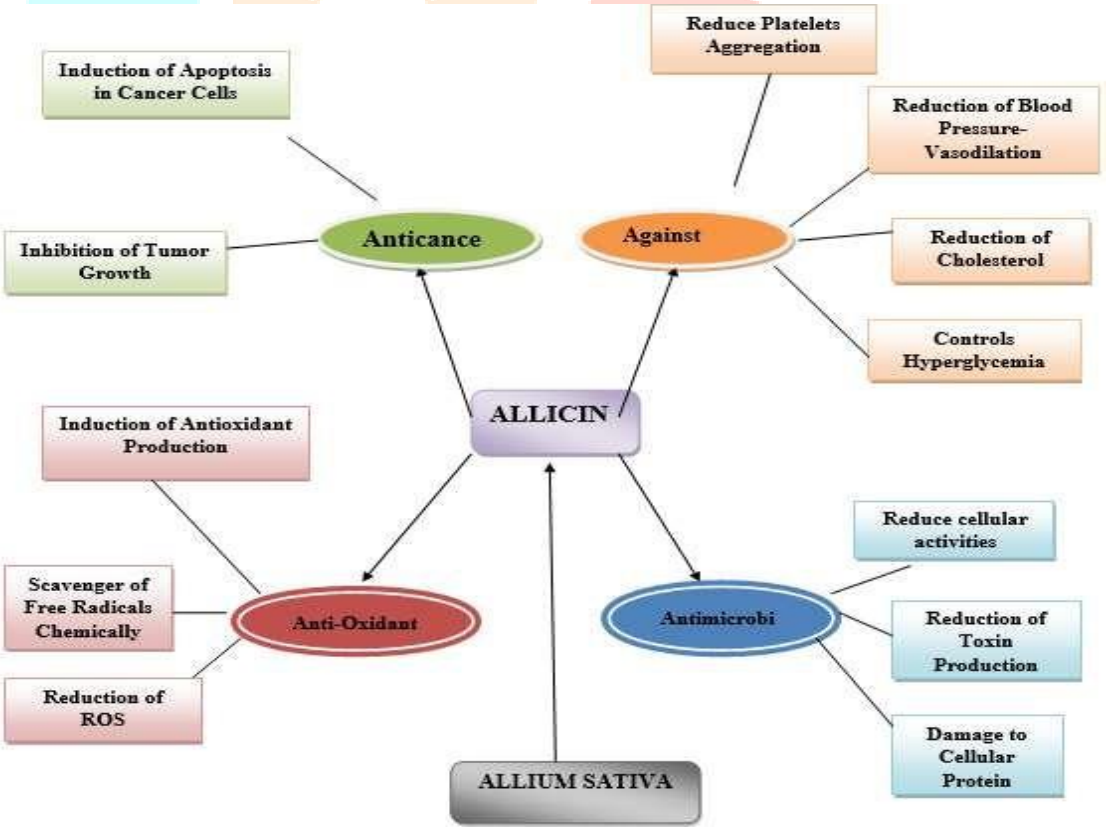
3. Role of Nutraceutical in Prevention of Illness

Figure 3: Role of Nutraceutical in Prevention of Illness



4. Mode of Action of *Allium sativum*

Figure 4: Mode of Action of Garlic (*Allium Sativum)*



5. Drug Profile

GARLIC

Synonyms: Lasuna, lashan, lahsun.

Source: It consists of dried and fresh bulb of ***Allium Sativum*** belonging to the family ***Liliaceae.***

Chemical Constituents: Proteins (5-6%), Carbohydrate (31%), fats (0.2%), with high amount of Allicin ($C_6H_{10}OS_2$).

Uses

- In cardiovascular disease: It is used in the treatment of high blood pressure, used in the treatment of high cholesterol, it's used in Angina pectoris, it prevents and treats Heart attack and atherosclerosis, it can improve blood circulation acts as blood thinner.
- It is anticancer agent and used to prevent cancers like colon cancer, rectal cancer and stomach cancer.
- Fighting respiratory infections its antibiotic properties render it useful for respiratory tract infections especially in throat e.g.; Tonsillitis.
- It is antibacterial, antifungal, antiparasitic, antiprotozoa and antiviral agent.
- It acts as immune modulator by fighting infection, improving resistance to infection.
- It has diuretic effect which is beneficial in treatment of rheumatoid arthritis gout and edemas.
- It has good wound healing activity by correcting angiogenesis.[7]

Figure 5: Garlic Bulb

6. Materials

- Maize starch was obtained from local market of Mohanlal Ganj, Lucknow.
- Acacia was taken from Thermo fisher ScientificIndiaPvt.Ltd. Mumbai, 400076.
- Starch was taken from Thermo fisher Scientific India Pvt. Ltd. Mumbai, 400076.
- Magnesium stearate was taken from Thermo fisher Scientific India Pvt. Ltd. Mumbai, 400076.
- Lactose was taken from Thermo fisher Scientific India Pvt. Ltd. Mumbai, 400076.
- Garlic powder was obtained from the dried bulb of *Allium sativum* processed in laboratory and solvents were analytical grade and were used as supplied.

7. Instruments and equipment's

i. **Instruments:** Spectrophotometer, pH meter, thermometer, weighing balance.

ii. **Equipment's:** Muffle furnace, hot air oven, disintegration apparatus, dissolution apparatus, mortar and pestle, beaker, funnel, Petri dishes, crucible, China dish, stirring rod.

8. Method of Preparation

i. Preparation of Garlic Powder

Allium sativum bulbs were collected from local market of Mohanlal Ganj in the month of September 2024. The bulb and cloves were peeled, cut into chips and Maize starch was added to the garlic chips at a ratio of 1:1 to absorb the garlic oil, dried at room temperature overnight and aid in the particle size reduction and again dried it in oven for 3 minutes and after 3 min. change or shake the chips to avoid burning and repeat it until dried properly. The garlic chips were then milled using a mixer grinder and screened through size no 10 (1.7 mm) to obtain uniform size particles which were further dried and also screened through sieve number 16 (size 1.0 mm) to further obtain uniform size particles.

ii. Preparation of Garlic Powder Loaded Capsules

Maize starch was sprinkled with garlic chips to absorb garlic oil and dried it in oven for 3minutes and after 3 min.

↓

The chips were flipped to avoid burning and repeat it until dried properly

↓

The chips were powdered in mixer grinder

↓

0.75gm of garlic powder was weighed for 25 capsules

↓

0.075 gm of acacia was added as binder

↓

0.735gm was added, magnesium stearate 0.075gm was added as lubricant

↓

Lastly 7.5 gm of lactose was added and mixed properly with the above material

↓

The Powder was filled individually in capsule shell

9. Evaluation Parameter

- **Pre-formulation Studies**

i. Angle of Repose

- The angle of repose, or critical angle of repose, of a granular material is the steps in angle of descent or dip relative to the horizontal plane on which the material can be piled without slumping. At this angle the material on the slope face is on the average of sliding. The angle of repose can range from 0°to90°. The morphology of the material affects the angle of repose; smooth, rounded and grains cannot be piled as steeply as can rough, interlocking sands. The angle of repose can also be affected by additions of solvents.
- If a small amount of water is able to bridge the gaps between particles, electrostatic attraction of the water to mineral surfaces increases the angle of repose, and related quantities such as the powder strength. When bulk granular materials are poured onto a horizontal surface, a conical pile forms. The internal angle between the surface of the pile and the horizontal surface is known as the angle of repose and is related to the density, surface area and shapes of the particles, and the coefficient of friction of the

material. Material with a low angle of repose forms flatter piles than material with a high angle of repose.

- The term has a related usage in mechanics, where it refers to the maximum angle at which an object can rest on an inclined plane without sliding down. This angle is equal to the arctangent of the coefficient of static friction μ_s between the surfaces. The formula used to determine the angle of repose is:

$$\theta = \tan^{-1}\frac{h}{r}$$

Where,
θ =angle of repose.
h= height o f the pile of powder or granules.
r= radius of the base of the pile (distance from the center to the edge of the pile).[8]

ii. Tapped Density

- Use a tapped density tester (also known as a tapping machine) that conforms to standard. Ensure that the equipment includes a graduated cylinder or a container with a fixed volume (usually 50 ml, 100 ml, or 250 ml), depending on the sample size. Weigh a known quantity of the powder sample. A typical sample weight may range from 20 to50 grams, but the weight will depend on the powder density and the container size. Ensure that the powder sample is homogeneous, and avoid any moisture or contamination.
- Fill the graduated cylinder with the weighed powder sample. Make sure the powder is level with the top of the cylinder, avoiding any air pockets or overfilling. Record the initial volume occupied by the powder. In the cylinder before tapping (this is the initial volume). Place the cylinder in the tapped density tester. Set the machine to perform a specific number of taps (usually 1000 or 1250 taps, depending on the standard procedure). The machine will mechanically tap or vibrate the cylinder, causing the powder to settle and compress. Tapping is typically done at a fixed rate (e.g., 300 taps per minute).
- After each tapping, the volume of the powder decreases as the particles pack more tightly together. Measuring Final Volume: After the set number of taps, stop the machine and measure the final volume of the powder in the graduated cylinder. The volume after tapping is referred to as the tapped volume.

$$\textbf{Tapped density} = \frac{\textbf{Mass of the sample}}{\textbf{Tapped volume}}$$

Where,
Tapped Density is typically expressed in g/cm³.
Mass of Sample is the weight of the powder (in grams).
Tapped Volume is the final volume of the powder after tapping (in cm³).[9]

iii. Bulk Density

- A representative sample of the material is obtained. If the sample is in solid form, it should be broken up to pass through a sieve of appropriate size. The empty container (typically a graduated cylinder or a specific volume container) is first weighed. Then, a known quantity of the sample is carefully poured into the container, avoiding excessive air gaps or compaction.
- The filled container is weighed again to determine the total weight of the sample and the container. The volume of the sample is measured, either by the volume of the container or using a displacement method if necessary. Ensure that the container is calibrated and that the sample is free of air pockets or voids.[10]

$$\textbf{Bulk density} = \frac{\textit{Massof the sample}}{\textit{Total volume of sample}}$$

iv. Ash Value

- A known quantity of the sample (usually 1–2 grams) is weighed accurately and placed in a clean, dry

$$\text{Ash Value} = \frac{\text{Weight of ash}}{\text{weight of sample}} X\ 100$$

crucible. The sample should be free from moisture before starting the test. The crucible containing the sample is heated gradually in a muffle furnace at a temperature of about 600°C until the sample is completely ashed. The process involves burning off the organic matter, leaving only the inorganic residue (ash). This is done until the sample turns into a white or grayish-white ash, indicating complete combustion. After the incineration, the crucible is removed from the furnace and allowed to cool in a desiccator to prevent moisture absorption. Once cooled, the crucible with the remaining ash is weighed to determine the weight of the inorganic residue.[11]

v. Acid Insoluble Ash

The ash obtained is then transferred into a beaker and treated with a specified volume of dilute hydro chloric acid(usually25mLof0.1NHCl). The mixture is heated gently for a few minutes to dissolve the soluble portion of the ash. The solution is filtered using a fine filter paper to separate the insoluble portion of the ash. The residue is washed thoroughly with hot water to ensure that all acid-soluble materials are removed. The insoluble residue is then dried in the crucible and incinerated again at about 600°C to remove any remaining organic material, ensuring that only the acid-insoluble inorganic portion remains. The crucible containing the acid-insoluble ash is allowed to cool and is weighed again. The weight of the acid-insoluble ash is determined by subtracting the initial weight of the crucible from the final weight.[12]

$$\text{Acid insoluble ash \%} = \frac{\textit{weight of insoluble residude}}{\textit{weight of the sample}} X100$$

vi. Loss on Drying

A representative sample of the material (usually 1–2 grams, depending on the substance being tested) is accurately weighed and transferred in to a clean, dry weighing container, such as a shallow, flat-bottomed dish or a suitable crucible. The sample is placed in an oven, which is preheated to a specified temperature, typically 105°C±2°C. The sample is then dried for a prescribed period, usually2–4hours, until it reaches a constant weight. During this time, the moisture in the sample evaporates. After the drying period, the sample is removed from the oven and allowed to cool in desiccators to prevent moisture absorption from the air. Once cooled, the sample is weighed again and determines its final weight. The loss of drying is calculated by subtracting the final weight (after drying) from the initial weight (before drying) and then dividing by the initial weight.[13]

$$\text{Loss on drying \%} = \frac{\textit{initial weight} - \textit{final weight}}{\textit{Initial weight}} X100$$

vii. Determination of UV Absorption (λ max) of Crude Drug

- A known amount of the crude drug is extracted using a suitable solvent, typically alcohol, methanol, or water, depending on the solubility of the active constituents. The extract is filtered to remove any solid particles, and a clear solution is obtained. A standard solution of the crude drug or a reference substance with known UV absorption characteristics is prepared in the same solvent, ensuring similar concentration and conditions for accurate comparison. A blank solution, containing only the solvent used for the extraction (without the drug), is prepared to account for any absorbance by the solvent itself. This is used to zero the spectrophotometer. The UV spectrophotometer is calibrated and set to scan the sample over a specified range of wavelengths, typically between 200 nm and 400 nm. The instrument should be set to record the absorbance of the sample solution as a function of wavelength. The sample solution is placed in a UV-transparent cuvette, and the absorption spectrum is recorded. The UV spectrophotometer scans across the predetermined wavelength range, and the maximum absorbance (λ max) is observed.
- The λ max is the wavelength at which the highest absorbance occurs. This is considered the characteristic

peak for the crude drug or its active constituents. The λ max is then noted and compared to known values to confirm the identity of the crude drug or extract. The λ max is reported in nanometers (nm). The UV absorption characteristics of the crude drug, including λ max, are used for the identification and st[illegible] [14]

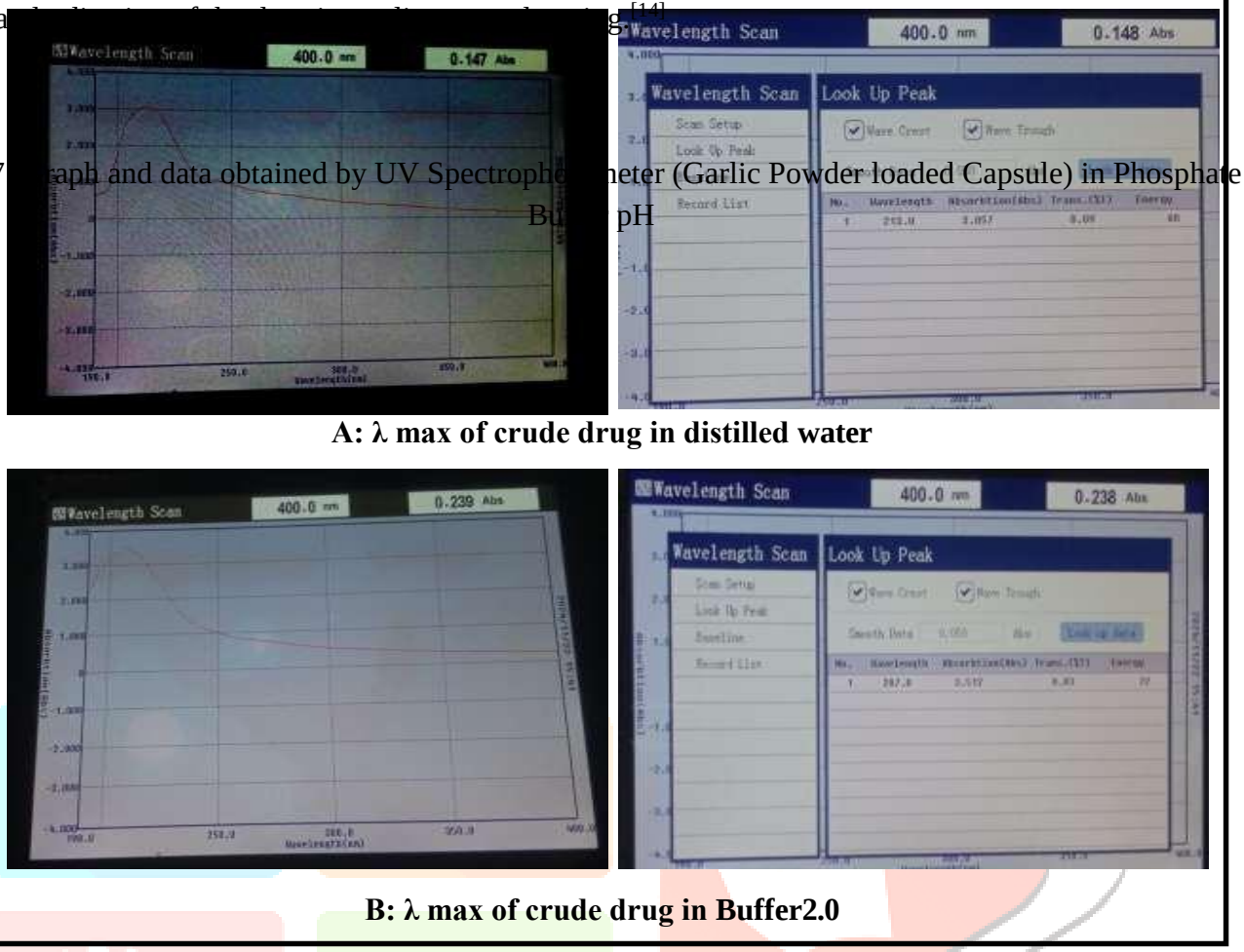


Fig.7 [illegible]raph and data obtained by UV Spectroph[illegible]meter (Garlic Powder loaded Capsule) in Phosphate Bu[illegible] pH

A: λ max of crude drug in distilled water

B: λ max of crude drug in Buffer2.0

- **Post Formulation Studies**

i. Disintegration Test

- The disintegration test apparatus consists of a basket-rack assembly with six tubes, each capable of holding one table to capsule. The apparatus is designed to operate in a water bath, where the temperature is maintained at37°C±2°C. The basket-rack assembly is submerged in a specified liquid medium, usually water or a buffer solution, which simulates the conditions in the gastrointestinal tract. A specified number of tablets or capsules (usually six) are selected from the batch to be tested. They should be free from any visible damage or defects. The tablets or capsules are placed individually into the mesh baskets. The baskets are then lowered into the medium, ensuring the tablets or capsules are fully submerged. The assembly is operated to move up and down in the medium at a constant rate (typically 30 cycles per minute).
- This motion mimics the peristaltic action of the stomach. The disintegration of the tablets or capsules is observed at regular intervals (e.g., after 15, 30, and 45 minutes). The test continues until all tablets have either disintegrated or the prescribed time limit (usually 30 minutes for immediate-release tablets) is reached. The criteria for disintegration are that the tablet or capsule must break into smaller particles, and no residue should remain on the mesh. The test is considered complete when all the tablets or capsules have disintegrated into particles that pass through the mesh, or they have dissolved completely in the medium, as specified by the pharmacopeial monograph. If the sample does not meet the criteria within the prescribed time, it may be considered non-compliant with the disintegration requirements.
- The disintegration time is reported as the time it takes for all units to disintegrate. In some cases, the test may require that a certain percentage of tablets or capsules disintegrate within a specified time frame

(e.g., 90% disintegration within 30 minutes).[15]

Figure 7: Disintegration Apparatus

ii. Dissolution Test

- The dissolution test is typically performed using a dissolution apparatus, such as a rotating basket or paddle. The apparatus consists of a vessel containing a specified volume of dissolution medium, usually a buffer or water at a prescribed pH, maintained at a constant temperature of 37°C±0.5°C. The apparatus is capable of agitating the medium, either by rotating a basket or a paddle, to simulate the conditions in the gastrointestinal tract. A specified number of tablets or capsules (usually six) are selected for the test. The dosage form should be free from defects or visible damage.
- The tablets or capsules are placed in to the dissolution apparatus. If using the paddle method, the paddle is positioned to rotate at a prescribed speed (typically50–75rpm), while in the basket method, the basket is rotated at a prescribed speed (typically 50 rpm). The dissolution medium is maintained at the prescribed temperature (37°C ± 0.5°C), and the dissolution process begins. At regular intervals (e.g., 5, 10, 15, 30, and 60 minutes), samples of the dissolution medium are withdrawn. The samples are filtered to remove any un dissolved particles, and the concentration of the dissolved drug is determined, usually by **spectrophotometer** or other suitable methods.
- The amount of drug dissolved at each time point is calculated, and a dissolution profile is generated by plotting the percentage of drug dissolved versus time. The test is conducted until a specified percentage of the drug (usually 80–90%) has dissolved, or until the prescribed time limit is reached, as specified in the pharmacopeial monograph for the specific drug.[16]

iii. Weight variation

- A specified number of capsules (typically 20 capsules) are randomly selected from a batch to be tested. The capsules should be free from any defects such as damage or leakage. Each individual capsule is weighed on an analytical balance to determine its weight. The weight of each capsule is recorded carefully. The total weight of all 20 capsules is calculated by adding the individual weights. The average weight of the capsules is then determined by dividing the total weight by the number of capsules (usually 20). The weight of each individual capsule is compared with the average weight. The IP specifies that for capsules with an average weight of 300mg or less, not more than two capsules may differ from the average weight by more than 10% of the average weight. For capsules with an average weight greater than 300 mg, no more than two capsules may differ by more than 7.5% of the average weight.
- If more than two capsules deviate from the average weight by more than the allowed percentage, the batch fails the weight variation test. If the deviations are within the specified limits, the batch passes the test.

$$\textbf{Weight variation} = \frac{Initial\ weight - Average\ weight}{Average\ weight} X100$$

Where,
Iw=Initialweight.
Aw =Average weight.[17]

10. Result and Discussion

- Angle of repose of crude garlic powder was found to be **33.6º**.
- Tapped density of crude garlic powder was found to be **0.95gm/cm^3.**
- Bulk density of crude garlic powder was found tobe**0.74gm/cm^3.**
- Ash value of crude garlic powder was found to be **43.68%.**
- Acid insoluble ash of crude garlic powder was found to be**55.57%.**
- Loss on drying of crude garlic powder was found to be **23.91%.**
- Wavelength (λ max) of Crude garlic powder was found to be **213nm.**
- Disintegration time of Garlic powder loaded capsule was found to be**27 min**.
- Weight variation of Garlic powder loaded capsule was foundtobe**1.463%.**

Table 1: Table of Dissolution Test Readings obtained in buffer 2.0 pH

S. No.	Wavelength (λmax)	Time(min)	Absorbtion (Abs)
1.	213.0	10	2.097
2.	213.0	20	2.099
3.	213.0	30	1.531
4.	213.0	40	1.068
5.	213.0	50	1.178

11. Discussion

In this research work use of garlic powder (*Allium sativam*), a member of the Liliaceae family, in our work. Garlic is also used to treat a variety of illnesses, including cancer, repeated colds in the throat, mouth ulcers, respiratory, digestive, and dermatological infections, and hyperlipidaemia.
To treat hypertension, Garlic Powder, Acacia, Starch, Magnesium Stearate, and Lactose were combined to create Garlic Powder Loaded Capsules. Pre-formulation metrics such as bulk density, taped density, and angle of repose were used to evaluate the resulting capsules. Other parameters such as the dissolution and disintegration tests, the measurement of the λ max of the crude drug, in this we observe that the dissolution at pH 7.5 the drug does not show any wavelength or spectroscopy results and the weight variation of the capsules were also used. For this formulation, hard gelatin capsule shells were utilized.

12. Conclusion

Hypertension is also known as high blood pressure, is a chronic condition in which the pressure in blood vessels is consistently too high due to excessive accumulation of fats or cholesterol in blood vessels. In the present work we have selected Garlic Powder (*Allium sativa*) belonging to the family Liliaceae. Garlic also used in different disease like Hyperlipidaemia, respiratory, digestive and dermatological infections, mouth ulcer, cancer, throat recurrent colds etc. A Garlic Powder loaded Capsules were prepared by using Garlic Powder, Acacia, Starch, Magnesium Stearate, and Lactose for treatment of hypertension. The obtained capsules were evaluated with pre-formulation parameters like Bulk density, Tapped Density, and Angle of repose and on the based on other parameter like Dissolution test, Disintegration test and determination of λ max of crude drug and weight variation of capsules. Hard gelatin capsule shells were used for this formulation.

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