Analysis of Fine Grinding Performance of Medicinal Herbs used in Pharmaceutical Applications from Laboratory Trails

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ABSTRACT

Herbal medicine is the use of plants to treat disease and enhance general health and wellbeing. Herbs are crucial for medicine as natural sources of therapeutic compounds, offering holistic treatments, fewer side effects, and supporting modern drug discovery, treating conditions from inflammation and heart issues to boosting immunity. These herbs which are barks, stems etc need to pulverize to a powder form for consumption. The grinding of medicinal herbs is a critical preprocessing step that influences the extraction efficiency, bioavailability, and stability of active medical. This laboratory trails and study investigate the performance of size-reduction methods choppers and hammers-based milling on commonly processed herbs such as Ashwagandha, Arjuna, Karakkaya, Athimadhura. Particle-size distributions, time taken for pulverizing, retentions were analysed to evaluate the relationship between grinding mechanisms and product quality.

Results demonstrate that conventional high-speed milling generates significant heat, accelerating volatile compound loss and partial degradation of heat-sensitive constituents. The findings highlight the importance of selecting appropriate pulverization technologies to balance throughput, energy consumption, and compound internal structure. These insights support optimized processing strategies for herbal pharmaceuticals and high-value botanical ingredients.

Key words: Herbs pulverizing, Hammer mills, medical applications.

Preface:

Four medical herbs been constituted for testing with pulverisers to achive the fineness to use in pharma applications. Ashwagandha, Arjuna, Karakkaya, athimadhura. The details of respective herbs are as under.

Athimarudha (Dia.10mm X 20mm long Dia. 40mm X 60mm long. The botanical name of Athimadhuram is Glycyrrhiza glabra. The root has a naturally sweet taste, which actually reflects the meaning of "Athimadhuram" roughly "very sweet."

Athimadhuram's therapeutic effects are attributed to several bioactive constituents. According to descriptions from Ayurvedic/herbal sources:

Glycyrrhizin: responsible for the characteristic sweetness; known to have anti-inflammatory, antiviral, and soothing effects.

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Flavonoids (e.g. glabridin, glabrene), saponins, isoflavones, tannins — contribute antioxidant, antimicrobial, expectorant, and other health-supporting actions.

Thanks to these constituents, Athimadhuram exhibits a broad set of pharmacological properties — anti-inflammatory, demulcent (soothing irritated mucous membranes), expectorant, antioxidant, anti-ulcer, and more.

Many traditional systems (like Ayurvedic, Siddha, Unani) classify Athimadhuram as a "rasayana" (rejuvenating/tonic) — used not just for acute ailments but also supporting general health, vitality, and resilience

Athimadhuram has been used for centuries in traditional Indian medicine. Some of its major uses:

Respiratory problems: Used to manage cough, sore throat, dry cough, bronchitis, asthma, hoarseness of voice — helps soothe mucous membranes and acts as an expectorant.

Digestive & gastrointestinal issues: Beneficial in gastritis, acidity, indigestion, peptic ulcers, stomach upsets — helps soothe and protect the stomach lining.

Anti-inflammatory and pain relief: Used for joint pains, arthritis, general inflammation, due to its anti-inflammatory properties.

Skin and external uses: Sometimes used externally (as paste or in topical preparations) for skin disorders, irritation, ulcers Karakayya (20 X 25mm round shape) The botanical name of Karakkaya is Terminalia chebula

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The medicinal potential of Karakkaya / Haritaki arises from a variety of bioactive compounds present mainly in its fruits. Some of the key phytochemicals and their effects:

Contains phenolic compounds and tannins, including chebulinic acid, chebulagic acid, gallic acid, ellagic acid, and related polyphenolics.

Also contains other chemical constituents like anthraquinones, flavonoids, glycosides, and possibly sennosides — many of these contribute to its therapeutic effects.

These compounds have been studied for antioxidant, antimicrobial (antibacterial/antifungal), anti-inflammatory, anti-ulcer, and laxative/purgative activities.

The herb is also credited with immune-supportive and rejuvenating (rasayana) properties in traditional medicinal texts

Karakkaya has been used for centuries in traditional Indian (Ayurveda) and related herbal systems. Some of its major reported uses:

Digestive health & bowel regulation: It is widely used as a laxative / mild purgative, helping relieve constipation, indigestion, gas, bloating, and irregular bowel movements.

Detoxification / cleansing (body purification): It helps cleanse the digestive system, clear accumulated toxins, and support liver and colon health.

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Respiratory health: Used in ailments like cough, asthma, respiratory congestion — helps soothe throat and may support lung health

Arjuna (Dia. 10mm X 20mm long Dia.40mm X 60mm long) Botanical name: Terminalia arjuna. The bark is smooth, grey to pinkish, and peels in thin flakes — this is the medicinally valuable part. These compounds give Arjuna its antioxidant, heart-supporting, and anti-inflammatory properties. Traditional and Medicinal Uses

Cardiovascular Health (Primary Use) Arjuna is one of the most revered cardiotonic herbs in Ayurveda. Traditionally used for supporting cardiac function and strength

Ashwagandha (Dia. 10mm X 20mm long Dia. 60mm X 80mm long) Botanical name: Withania somnifera. A small, woody shrub growing 50–150 cm tall. Ashwagandha's medicinal properties come from its unique compounds. These compounds give Ashwagandha its adaptogenic, anti-stress, anti-inflammatory, and rejuvenating effects.

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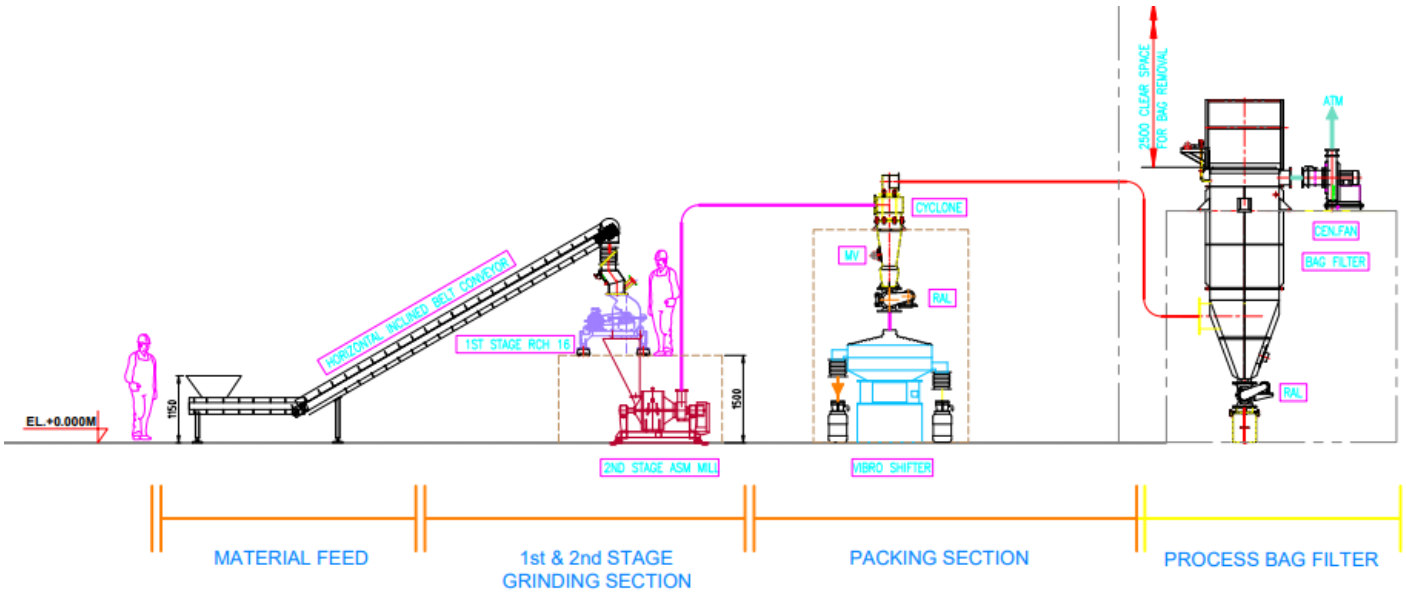
Traditional & Medicinal Uses

Ashwagandha is one of Ayurveda's most powerful Rasayana herbs — promoting longevity, vitality, and resilience. Stress Reduction & Nervine Support (Primary Use) Used for anxiety, fatigue, irritability, burnout, and chronic stress. Sleep & Nervous System Health

Laboratory Pulverizing Test setup:

The entire test set was setup in two stages. First stage the crushing or primary grinding takes place. Here the crushing of feed material to reduce the size upto 3-6mm. The material fed constantly to the feeding hopper of the chopper mill. The speed of crusher rotor shear the material and collects into a bin. In second stage the collected 2-6mm material been fed continuously constantly into an air swept mill. Where this crushed material will undergo fine grinding by a high-speed rotor for arriving a fine particle. The chamber has liners inside so that the shearing and revering back the material to rotor will act simultaneously to break in finer particles. This screenless pulverizer that uses high-speed hammers and an airflow to finely grind the fed material into required fineness. The grounded material passes to a high efficiency cyclone and there the cut sizes are separated. Th very fines were collected into a bag filter by a vacuum method. The entire process been controlled by PLC control panel from where the readings of current consumed, RPM of the rotor been monitored. At end of each trails the material undergo sieving to arrive the fineness achieved and check on moisture content as well.



Pic: Setup on Pulverizing system

Pic: Material Feeding to

Pic: Fibrous material

Pic: In Chopper retained

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Pic: Milled material

Pic: Dust from mill

Pic: Moisture check

Pic: Moisture check

Pic: Moisture check

Pic: Moisture check

Data readings from trails:

Atimadhura

Chopper Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
7.5/11.5	1000	8mm	125 sec	15	2-6mm P.d222/T.d500

ASM Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
11/13	3200	1mm	45 sec	3	105-125 microns P.d416/T.d526

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Arjuna

Chopper Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
7.5/11.5	1000	8mm	104 sec	15	2-6mm P.d222/T.d500

ASM Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
11/13	3200	1mm	39 sec	3	105-125 microns P.d416/T.d526

Karakkaya

Chopper Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
7.5/13	1000	8mm	70 sec	15	2-6mm P.d222/T.d500

ASM Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
Not performed	Not performed	Not performed	Not performed	Not performed	Not performed

Ashwagandha

Chopper Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
7.5/11.5	1000	8mm	155 sec	15	2-6mm P.d222/T.d500

ASM Kw/amp	RPM	Screen Size	Time required for griding	Chicken feed Mass kg	Product fineness
11/13	3500	1mm	36	3	105-125 microns P.d370/T.d500

The stems of the Atimadhura and Ashwagandha had been a challenge to perform the second stage grinding due to the fibrous content. Much dust evolved from the filtration and discharge section. The fibrous content caused clumsy of the material in the housing areas. Though there is no electrostatic force across but there is suspect at large actual pulverizing may have this impact to take care. The sides of the rotors are stuck with the fibrous thread like layers observed during internals inspection and every trail been underwent cleaning these items. Whereas the Arjuna and Karakkaya being as a bulblike structure relatively easier to primary crushing and only Arjuna herb taken to second stage for achieving fineness. Aswagandh taken much time for primary crushing out

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of these four herbs due to the moisture content and high fibrous nature, but second stage it was pulverize less time than others. Karakkaya had taken lesser time in primary crushing due to the bulb shaped structure and brittle nature.

CONCLUSION

Pulverizing herbs has various challenges due to their respective physical and inherent composition. The fibrous, brittleness, volatile content, moisture content, while shearing only the gases vaporizers (in case of kernels) etc. While pulverizing a detailed study on the material is essential so as the choking and blockage of machines can be avoided. The art of pulverizing is so physics-based technology unless materials been tested cannot be able to perform to reduce the size. Many features and parameters to be taken into consideration like Feeding Material enters the grinding chamber. High-speed hammers (beaters) strike the material, breaking it down against deflector liners or plates, maintaining proper airflow & classification, fineness control and end material collection.

There are many herbs that can only be in fine powder form and essentially undergo pulverizing. More study and understanding are required to achieve the desired fineness in economic and optimized way.

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