



PRINCIPLES OF HARVESTING AND STORAGE OF MEDICINAL PLANT RAW MATERIALS IN THE WORKS OF AVICENNA: A HISTORICAL-PHARMACOGNOSTIC REVIEW

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ABSTRACT

Background. The works of Abu Ali ibn Sina (Avicenna) occupy a special place in the history of medicine and pharmacy. A significant portion of the second volume of The Canon of Medicine is dedicated to medicinal substances, their properties, quality, and methods of harvesting, storage, and application. Many provisions formulated by Avicenna regarding the selection of medicinal raw materials, timing of harvesting specific plant parts, and preservation of their quality show marked similarities to the principles of modern pharmacognosy. Objective. To systematize information on the methods of harvesting medicinal raw materials presented in Avicenna's works and determine their historical and pharmacognostic significance from the standpoint of contemporary concepts of medicinal plant product quality. Materials and Methods. A narrative historical-pharmacognostic review of Avicenna's The Canon of Medicine and modern scientific publications dedicated to his pharmacological heritage was conducted. Information regarding the selection of the medicinal plant, the plant part used, collection timing, raw material maturity, harvesting conditions, drying, storage, and indicators of good quality was analyzed. Results. It was established that Avicenna viewed the harvesting of medicinal raw materials as a comprehensive process encompassing the correct identification of the natural source, selection of the most active plant part, determination of the optimal harvesting period, prevention of adverse environmental impacts, and adherence to storage conditions. Specific recommendations were differentiated depending on whether roots, leaves, branches, flowers, fruits, seeds, or gums were utilized. Conclusion. The system of harvesting

medicinal raw materials presented by Avicenna demonstrates an early formulation of pharmacognostic standardization principles. Its historical significance lies in the transition from the empirical use of plants to a systematized control of origin, harvest time, and quality of medicinal raw materials.

Introduction

The use of natural substances for treating diseases represents one of the most ancient domains of medical practice. For millennia, plants remained a primary source of medicinal agents; however, the evolution of pharmacotherapy was driven not only by expanding the range of utilized species, but also by the emerging understanding of raw material quality. It gradually became apparent that the therapeutic effect of a plant depends on the specific organ used, stage of development, harvest time, preparation methods, and storage conditions. A historical overview of medicinal plant raw materials demonstrates that such knowledge accumulated across various civilizations and was later systematically reflected in medical treatises.

A distinct place in the development of these concepts belongs to Abu Ali al-Husayn ibn Abd Allah ibn Sina (980–1037), known in the European tradition as Avicenna. His foundational work, *Al-Qanun fi al-Tibb (The Canon of Medicine)*, was structured as a systematic medical encyclopedia comprising five books. The second book is dedicated to simple drugs (*materia medica*), while the fifth addresses complex compound remedies. It is precisely in the second book that general principles for evaluating drug properties and rules for handling medicinal raw materials are presented.

The historical and pharmaceutical significance of the *Canon* is determined not merely by the quantity of described medicinal substances, but primarily by the systematic nature of their classification. Contemporary analysis of Ibn Sina's heritage indicates that medicinal agents in his work were differentiated by origin, composition, mechanism of action, route of administration, dosage form, and other characteristics. Furthermore, attention was given to ingredient measurement and the technological instruments used in compounding pharmaceuticals.

Crucial to the history of pharmacognosy is the *Canon's* distinct consideration of the collection and storage of medicinal plants. Investigation by P. Faridi et al. showed that Book II contains specific recommendations regarding the procurement conditions of plant raw materials aimed at preserving their quality. Comparing these rules with modern pharmacognostic approaches, the authors noted substantial similarities across many core principles.

In this context, the term "harvesting of medicinal agents" as applied to Avicenna's era should be viewed broader than the modern concept of pharmaceutical manufacturing. It primarily refers to obtaining raw medicinal material of natural origin, its selection, collection, primary processing, and preservation prior to further compounding into a dosage form.

The objective of this study was to perform a historical-pharmacognostic analysis of the methods for harvesting plant-derived medicinal agents described in Avicenna's practice, systematize the key stages of handling raw materials, and evaluate their significance from the perspective of modern pharmacognosy's evolution.

Materials and Methods

This work was conducted as a narrative literature review incorporating elements of comparative historical-pharmaceutical analysis. The primary conceptual source examined was information pertaining to Book II of *The Canon of Medicine*, which is dedicated to simple drugs.

Additionally, scientific publications addressing Avicenna's pharmacological and pharmaceutical heritage were analyzed, including the specialized study by Faridi P. et al., "Collection and storage of medicinal plants in the Canon of Medicine," published in *Pharmacognosy Journal*. That study directly investigates the provisions of the *Canon* concerning the collection and preservation of medicinal plant material.

The review also included research characterizing Avicenna's general principles of pharmacy, drug classification, approaches to medicinal plants, dosage forms, and drug efficacy assessment. Modern historical and pharmaceutical analyses confirm that the *Canon* contains systematized information regarding drug classification, metrics, preparation, and tools of apothecary practice.

Information was categorized into the following thematic areas: drug source; plant part used; selection criteria; optimal harvest timeframe; material maturity; primary processing; environmental impact; storage conditions; shelf-life retention; and the significance of harvesting techniques for drug efficacy.

A methodological feature of this study was the differentiation between Avicenna's historical terminology and modern pharmacognostic concepts. The *Canon's* recommendations were interpreted not as direct equivalents of modern regulatory requirements, but as historical precursors to the principles of medicinal plant raw material standardization.

Results

Avicenna's General Approach to Raw Material Quality

Source analysis demonstrates that Avicenna viewed the quality of a medicinal substance as a direct determinant of its therapeutic efficacy. Book II of the *Canon* discusses the nature and quality of drugs, their intrinsic properties, and alterations resulting from interaction with external factors.

Fundamentally important is the premise that a medicinal substance must not acquire extraneous properties due to environmental influences. When outlining rules for studying drug actions, Ibn Sina highlighted changes caused by heating, cooling, spoilage, or proximity to other substances. This approach underscores an understanding that the state of medicinal material at the moment of use may diverge from its original properties.

From a pharmacognostic standpoint, this concept is of foundational significance: the therapeutic profile of a medicinal plant is inseparable from the quality of the specific raw material sample. The plant species per se does not guarantee the retention of expected activity if the material was improperly harvested, dried, or stored.

Differentiation of Raw Materials by Plant Part

Avicenna did not treat the plant as a homogenous medicinal entity. Various morphological organs served as medicinal raw materials. According to analysis of the *Canon*, these included leaves, roots, branches or shoots, seeds, fruits, flowers, and plant gums.

This differentiation carries substantial weight. In modern terms, different organs of the same plant species can vary significantly in chemical composition and active constituent

concentration. Thus, specifying a precise plant part acted as an early form of identifying medicinal plant raw material.

In Avicenna's work, the choice of plant part was linked not only to species taxonomy, but also to its state and developmental stage. Consequently, the object of procurement was not merely "the plant," but a specific organ present in the condition most suitable for medicinal use.

Significance of Harvest Timing

One of the most notable findings of this analysis is Avicenna's differentiated approach to collection timeframes. Scholars of his legacy emphasize that his guidelines for collecting medicinal plants aimed to secure raw materials of the highest attainable quality.

In essence, this reflects an early realization that raw material properties are dynamic across a plant's life cycle. Young tissue, a mature organ, a flowering plant, and a fully developed fruit were not regarded as pharmacologically equivalent states.

For leaves, reaching an adequate degree of development was critical. Leaf material was not to be harvested too young, as immaturity was viewed as an indicator of underdeveloped drug qualities. Conversely, advanced senescence was equally undesirable due to the loss of optimal properties. This maturity principle extended to other plant parts; thus, harvest time was determined not solely by the calendar season, but by the biological state of the medicinal object.

Harvesting Roots

Roots held a prominent place among medicinal plant organs. In historical pharmacognosy, root harvesting posed particular challenges, as extracting the root system terminates the plant's further growth.

Analysis of Avicenna's recommendations reveals that root selection accounted for plant age, overall development, and degree of maturity. Preference was granted to well-formed raw materials rather than overly young subterranean organs. This aligns with the overall logic of his pharmaceutical paradigm: medicinal material should be collected when the corresponding plant organ reaches optimal functional properties.

From a modern standpoint, this principle can be interpreted as an early intuitive grasp of the relationship between an organ's chemical composition and its stage of ontogeny, although Avicenna framed this phenomenon within the natural philosophy and medical concepts of his era.

Harvesting Leaves and Aerial Parts

Leaves were among the most widely utilized medicinal plant components. Their quality was evaluated based on freshness, maturity, and the absence of damage.

A key feature of Avicenna's methodology was the drive to utilize plant tissue during the window when it had fully formed but had not yet lost its characteristic properties through senescence or adverse environmental exposure. A similar principle persists in modern harvesting practice, though specific optimal phases today are determined individually per species based on active constituent accumulation dynamics.

Flower Collection

Flowers represent an exceptionally sensitive category of raw material. Their morphological structures exhibit a relatively brief period of optimal condition, and delicate tissues deteriorate rapidly post-harvest.

In the tradition systematized by Avicenna, the developmental stage of the flower was crucial to raw material quality. This conforms to his overarching pattern: harvesting must not occur arbitrarily, but during a defined developmental phase of the target organ. The historical value of this position lies in recognizing that an unopened bud, a flower in full anthesis, and a senescing flower represent raw materials of distinctly different quality.

Seeds and Fruits

During the procurement of seeds and fruits, maturity emerged as the paramount criterion. This logically correlates both with their biological function and the physiological transformation of internal constituents during ripening.

Avicenna effectively linked the medicinal value of raw materials to the completion of their natural development. In this regard, his recommendations display an empirical understanding of the phenological dependence of plant material quality. In modern pharmacognosy, this idea is fundamental: the content of secondary metabolites, fixed oils, glycosides, organic acids, and other compounds changes substantially during fruit and seed formation. Nevertheless, direct extrapolation of modern biochemical explanations onto medieval texts must be avoided.

Plant Gums and Exudates

Beyond structural organs, medical practice utilized gums and other natural exudates. Obtaining these required a procurement strategy distinct from harvesting leaves or fruits.

The inclusion of gums in the *materia medica* demonstrates Avicenna's broad conceptualization of plant-derived medicinal resources. Furthermore, the value of exudates was contingent upon purity, physical state, and absence of spoilage—reaffirming that origin was merely one criterion for Avicenna; actual quality at the time of use was of equal importance.

Primary Processing of Raw Materials

Following collection, the goal shifted to maximum preservation of properties. Essentially, this stage encompassed cleaning, sorting, and preparation for storage or downstream processing.

Modern historical-pharmaceutical research indicates that apothecary technology in Avicenna's time involved diverse operations, notably size reduction and component blending. The *Canon* describes the application of dedicated implements, including mortars for triturating medicinal materials.

This allows harvesting to be viewed not as an isolated act of collection, but as the initial link in a pharmaceutical process chain: a natural specimen was transformed into processed medicinal raw material, and subsequently into a formulated drug.

Drying Medicinal Materials

Drying constitutes a central operation in preserving plant material. Although medieval concepts regarding causes of decay differed from contemporary microbiology and biochemistry, the practical importance of moisture reduction and decay prevention was well understood.

The recommendations articulated in the *Canon* aimed to preserve original plant properties and prevent transformations that could diminish therapeutic value. Faridi et al. highlight that these specific aspects allow drawing direct parallels between Avicenna's methodology and later pharmacognostic principles.

However, asserting that Avicenna possessed modern insights into thermolabile compounds, oxidative degradation, or microbiological contamination would be historically

inaccurate. His recommendations were empirical and theoretically contextualized within 11th-century medical science.

Storage of Raw Materials

In Avicenna's view, gathering high-quality raw material did not automatically guarantee long-term therapeutic preservation. Subsequent storage conditions played a decisive role.

Particularly significant is his premise concerning drug alteration under external influences. His guidelines for evaluating medicines specify that natural characteristics can be altered by temperature fluctuations, spoilage, or contact with other substances. Consequently, storage was required to safeguard individual raw material characteristics and prevent unwanted chemical or physical changes.

Faridi et al., in their specialized analysis of the plant collection and storage sections, concluded that Ibn Sina's principles correspond in many respects to the logical structure of contemporary quality assurance standards for starting plant materials.

Shelf Life as a Historical Pharmaceutical Category

Of special historical interest is the concept that medicinal plant raw materials do not retain their efficacy indefinitely. Over time, potency diminishes, alters, or deteriorates entirely.

Thus, within Avicenna's framework, raw material age and storage duration acquired independent analytical value. This approach marks an important milestone in the historical evolution of the "shelf life" concept for pharmaceuticals.

In modern pharmacy, shelf life is established experimentally via chemical, physicochemical, and microbiological testing. Avicenna relied on empirical evaluation of preservation; however, the core concept of time-limited raw material quality remains historically profound.

Discussion

The results of this literature analysis allow Avicenna's approach to harvesting medicinal plants to be recognized as an early historical form of systematized pharmaceutical raw material science.

A pivotal achievement was his recognition of multi-stage quality assurance. Therapeutic outcomes were linked not merely to which plant was used, but equally to which organ was chosen, its maturity stage, when it was harvested, how it was processed, and under what conditions it was preserved.

This precise sequence establishes a conceptual bridge to modern pharmacognosy. Today, medicinal plant raw material quality is likewise viewed as the cumulative output of multiple factors: genetic traits, environmental growing conditions, harvest timing, morphological part, drying parameters, processing, packaging, and storage. However, modern systems rely on standardized analytical methods, whereas Avicenna's framework integrated centuries of empirical practice with a natural-philosophical medical paradigm.

Therefore, similarities in individual practical recommendations should not be interpreted as absolute equivalence between medieval and modern pharmacognosy. The true significance of Ibn Sina's legacy lies in his consistent articulation of the need to control parameters governing finished product quality.

The link between his harvesting principles and broader pharmacological methodology warrants particular emphasis. Avicenna asserted that drug action must be investigated using material uncompromised by external factors. In his criteria for testing medicines, he explicitly

noted that acquired characteristics—resulting from heat, cold, decay, or proximity to other substances—could alter observed pharmacological effects.

Hence, starting material quality became a prerequisite for validating therapeutic efficacy. Methodologically, this concept is vital: it is impossible to accurately characterize a drug if the test material is unstable or compromised.

Another key trait was his drive toward classification. Contemporary reviews of Avicenna's pharmaceutical legacy demonstrate that his system encompassed origin, composition, properties, dosage forms, administration routes, metrics, and compounding tools. The harvesting of plant raw materials was thus a component of a far broader pharmaceutical infrastructure.

Book II of the *Canon* serves as a key source for the history of pharmacology and pharmacognosy. Dedicated to simple drugs, it offers a structured catalog of materia medica. Investigations into individual plants and pharmacological groups described by Avicenna continue in current scientific literature, confirming sustained interest in his work as a historical repository of natural drug knowledge.

Historically, it is also notable that Avicenna did not isolate plant usage from preparation technology. Later pharmaceutical science evolved these branches into distinct disciplines: pharmacognosy, pharmaceutical technology, raw material standardization, and quality control.

At present, studying Avicenna's guidelines holds primary value for the history of science, pharmacognosy, and ethnopharmacology. They cannot be applied directly in place of modern regulatory standards for plant harvesting or drug manufacturing. For every medicinal species, modern harvest windows, drying methods, quality metrics, and storage conditions must be governed by active pharmacopeial monographs and empirical data.

Nonetheless, Avicenna's scientific legacy illustrates an enduring law in the development of pharmaceutical knowledge: drug standardization begins long before a medicine is administered to a patient—it commences at the point of selecting and procuring the starting raw material.

Conclusion

This literature review demonstrates that in Avicenna's pharmaceutical practice, the harvesting of medicinal agents was a systematized series of measures rather than a simple gathering of natural materials. Its main components included correct species identification, selection of the specific plant part, consideration of developmental stage and maturity, choice of an optimal harvest window, primary processing, preservation, and quality monitoring during storage.

Avicenna differentiated medicinal plant raw materials into leaves, roots, branches/shoots, flowers, fruits, seeds, and exudates, reflecting an early understanding of organ-specific pharmacognostic properties.

Of central importance was harvesting plant material at its peak physiological state, thereby linking drug quality to the plant's life cycle. Equally essential was preserving intrinsic properties post-harvest: unfavorable thermal exposure, spoilage, and contamination were recognized as factors capable of altering drug efficacy.

Comparative historical-pharmacognostic research indicates that many of Avicenna's overarching principles regarding plant collection and storage share conceptual parallels with modern quality assurance frameworks for medicinal plant materials.

Consequently, Avicenna's legacy represents a landmark in the evolution of scientific concepts surrounding raw material standardization. His contribution consisted of organizing cumulative empirical knowledge into a logical system where origin, quality, harvest time, storage, and preparation methods were treated as interconnected variables governing therapeutic success.

Modern study of these principles is valuable not only for the history of medicine, but also for pharmacognosy, pharmacy, and ethnopharmacology, providing insight into the historical origins of rational harvesting and quality control for herbal medicines.

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