



Selective erosion of pharmacopeial knowledge: a two-millennium diachronic analysis of *Prunus dulcis* (Mill.) D.A. Webb in Northeastern Morocco

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Research

Abstract

Background: The persistence of ethnobotanical knowledge is a selective cultural process shaped by population needs, ecological factors, and modernisation. Quantitative diachronic analyses integrating historical written sources with contemporary field data remain rare for single-taxon studies in the Mediterranean region.

Methods: This study reconstructs the two-millennium transmission trajectory of *Prunus dulcis* (Mill.) D.A. Webb across four sources: Dioscorides (*De Materia Medica*, 1st century CE), Ibn Sina (*Canon of Medicine*, 11th century CE), Ibn Al-Baytar (*Kitab al-Jami'*, 13th century CE) and contemporary field data collected in Northeastern Morocco from 2017 to 2019, involving 1,177 informants.

Results: A total of 148 medicinal uses were documented across 14 ICPC-2 groups. Jaccard similarity among the three historical sources was high (between 0.769 and 0.857). Ibn Sina's absence from Ibn Al-Baytar's citation indicates this similarity reflects parallel convergence on shared sources rather than direct transmission. Similarity between contemporary NE Morocco and historical sources was markedly lower (between 0.167 and 0.25). Preparation knowledge showed the most severe erosion (between 0.083 and 0.111); non-medicinal uses proved more resistant.

Conclusions: These findings document a taxon-specific pattern of selective pharmacopeial knowledge attrition and demonstrates procedural knowledge is more vulnerable to erosion than declarative knowledge.

Keywords: Diachronic analyses; Ethnobotanical knowledge, *Prunus dulcis*; Northeastern Morocco, Knowledge erosion

Background

The persistence of medicinal plant knowledge across generations is not a passive process of accumulation but an active and adaptive one. Cultural transmission, defined as the social reproduction of technological knowledge, beliefs and behaviours from one individual to another, operates through distinct mechanisms that differentially conserve, transform or erase specific practices over time (Hewlett & Cavalli-Sforza 1986). In the domain of ethnobotany, this selectivity is shaped by

various factors, including ecological properties, population needs, and processes of modernisation, making the documentation of contemporary pharmacopoeia incomplete without a historical perspective.

As Leonti *et al.* (2020) argued, the cross-cultural exchange of plant resources has historically driven the diversification of medicinal floras and pharmacopoeias across the Mediterranean and beyond, a process governed by the deliberate circulation of the most polyvalent and culturally central species. This selective transmission means that the interpretation of current medicinal plant knowledge is only meaningful against the backdrop of its cultural history (Leonti 2011). Ethnobotanical surveys conducted without diachronic depth capture no more than a momentary snapshot of a long-term dynamic (Leonti & Casu, 2013).

Diachronic approaches in ethnobotany make it possible to assess what has been maintained, transformed or abandoned across documented cultural practices. Written sources are uniquely suited to this task, as Leonti and Casu (2013) established, textual codification has historically enabled physicians, explorers and scholars to document and transmit medicinal plant knowledge across centuries and civilisations, generating an evidence base that field surveys alone cannot recover.

The present study applies this theoretical perspective to analyse the two-millennium transmission trajectory of *Prunus dulcis* (Mill.) D.A. Webb in Northeastern Morocco. This region is characterised by the long coexistence of Amazigh, Arab and sub-Saharan African communities (El-Ghazouani *et al.* 2021), alongside religious traditions including Islam and Judaism (El-Hilaly *et al.* 2003). This region is the focus of our research group's field studies (Smaili *et al.* 2023; Mir *et al.* 2024) as rural communities in this area have historically maintained close relationships with plants for food, medicine and daily practices.

Prunus dulcis (Mill.) D.A. Webb is native to Central Asia (Barreca *et al.* 2020) and was domesticated as early as the Early Bronze Age in the Levant (Zohary & Hopf 2000). It has been documented in Mediterranean pharmacopoeias since at least the first century CE. Its well-established bioactive profile, including fixed oils, polyphenols, vitamins and minerals (Barreca *et al.* 2020), renders it a highly versatile taxon particularly likely to have undergone deliberate intercultural transmission (Leonti *et al.* 2020). Its continuous cultivation and economic importance in Northeastern Morocco further justify its selection as the focal species of this analysis. Four sources were selected to trace the diachronic record of its documented uses: Dioscorides (1st century CE; *De Materia Medica*), Ibn Sina (11th century CE; *Canon of Medicine*), Ibn Al-Baytar (13th century CE; *Kitab al-Jami'*) and contemporary ethnobotanical field data collected in Northeastern Morocco between 2017 and 2019.

Several diachronic ethnobotanical studies have documented the long-term trajectory of medicinal plant knowledge in the Mediterranean region, showing that textual codification exerts a conservative effect on pharmacopeial knowledge over centuries (Dal Cero *et al.* 2023; Benítez *et al.* 2023). In the Moroccan context, however, such analyses remain limited. To our knowledge, the only comparable studies include El-Gharbaoui *et al.* (2017) on the Lamiaceae, who found that 43% of medicinal uses in eastern Morocco could be traced to Ibn Al-Baytar's Compendium; Benítez *et al.* (2021) on the Asteraceae, who documented 38% overlap with Dioscorides, and 28% with Ibn Al-Baytar, and Mir *et al.* (2026) on the Apiaceae where we reported comparable diachronic patterns in the same three provinces. These studies compare contemporary field data with historical sources but do not extend the analysis to a diachronic context focused on a single taxon.

Furthermore, existing diachronic analyses rarely integrate sources from more than two distinct cultural traditions simultaneously. The Graeco-Roman, Persian-Islamic and Arab-Andalusian pharmacopeial traditions have typically been examined independently, measuring their convergences and divergences with respect to a single taxon.

Finally, previous diachronic studies have focused almost exclusively on medicinal use categories, without examining whether plant parts, modes of preparation, modes of administration and non-medicinal uses follow similar transmission trajectories. No study has applied separate quantitative similarity indices to these four analytical dimensions simultaneously, making it difficult to assess whether procedural knowledge erodes at the same rate as declarative knowledge.

The absence of a use from the contemporary data may reflect change over time or may simply never have been documented; comparison with the historical sources allows these to be told apart. The present study addresses these three gaps by conducting an integrated diachronic analysis of *Prunus dulcis* (Mill.) D.A. Webb, across four sources covering two millennia and representing distinct cultural traditions, applying separate Jaccard similarity indices to medicinal uses, plant parts, modes of preparation, modes of administration and non-medicinal uses simultaneously.

Three research questions guide this analysis: (1) How have the medicinal uses of *Prunus dulcis* (Mill.) D.A. Webb been transmitted and transformed across two millennia, and to what extent does contemporary practice in Northeastern Morocco reflect its classical pharmacopeial heritage? (2) Do plant parts, modes of preparation and modes of administration follow the same patterns of continuity or erosion as medicinal uses across the four sources? (3) Are non-medicinal uses more resistant to cultural disruption than medicinal uses over the same time span?

Materials and Methods

Study area and field data collection

The study area and the sociocultural profile of the surveyed populations have been described in detail in the field surveys from which the contemporary dataset is drawn (Smaili *et al.* 2023; Mir *et al.* 2024). Fieldwork took place between 2017 and 2019 in three provinces (Al Hoceima, Nador, and Jerada). The stations range from Beni Ensar in the north (35°15'56"N) to Aïn Beni Mathar in the south (34°01'N). We calculated the sample size with the formula of Del Águila and González-Ramírez (2014) for infinite populations, using a 5% margin of error and a 95% confidence level. Informants were chosen by stratified sampling (Etikan & Bala 2017). They had to live locally, and non-local individuals were not interviewed. We used open, semi-structured interviews (Martin 2004) with a survey form covering the informant's age, gender and education, the vernacular names, the traditional uses, the plant parts used, and the modes of preparation and administration. Amazigh names were transcribed in Tifinagh-IRCAM (Ameur *et al.* 2004) and Arabic names in Arabic script. Every participant gave prior informed consent before the interview, following the recommended standards for ethnopharmacological field research (Weckerle *et al.* 2018). In total, 1,177 informants were interviewed (410 in Al Hoceima, 387 in Nador and 380 in Jerada). The present analysis focuses on the subset of the data relating to *Prunus dulcis* (Mill.) D.A. Webb.

Plant nomenclature was verified using the World Flora Online Plant List (WFO; <https://wfoplantlist.org/>, accessed 5 March 2026). The accepted name for the taxon in WFO is *Prunus amygdalus* Batsch, of which *Prunus dulcis* (Mill.) D.A. Webb is a synonym. The latter name is retained throughout this manuscript to ensure nomenclatural consistency with the previously published field surveys on which the contemporary dataset draws (Smaili *et al.* 2023; Mir *et al.* 2024), in which the taxon was reported under the taxonomy accepted at the time. A voucher specimen is deposited in the laboratory of the Faculty of Sciences at Abdelmalek Essaadi University of Tetouan, under voucher number (MP-Ro-007 JHN).

Historical Sources

Three historical written sources were selected to represent the major textual traditions that have shaped medicinal plant knowledge in Northeastern Morocco and the broader Mediterranean region (Table 1). *De Materia Medica* of Dioscorides (1st century) and *Kitab al-Jami'* of Ibn Al-Baytar (13th century) were consulted following the same protocol applied in our previously published diachronic analysis of the Apiaceae family (Mir *et al.* 2026), using the French translation of Dioscorides (Mathée 1553) and the English translation (Beck 2005) for cross-verification, and both the French translation (Leclerc 1877-1883) and the Arabic edition (Ibn Al-Baytar 1992) for Ibn Al-Baytar.

The Canon of Medicine of Ibn Sina (11th century), not previously integrated into diachronic analyses of Northeastern Moroccan ethnobotany, was examined using the complete Arabic edition (Ibn Sina 1999), with the partial English translation (Gruner 1973) used as a complementary reference.

Ibn Sina synthesised Graeco-Roman pharmaceutical knowledge through Islamic medical scholarship, introducing therapeutic reorganisations that represent a distinct intellectual contribution relative to both Dioscorides and Ibn Al-Baytar. Entries corresponding to almond (Lawz, لوز) and its derived preparations were systematically extracted.

The use of historical sources in ethnopharmacological research is well established (Heinrich *et al.* 2006; Leonti *et al.* 2010; Benítez *et al.* 2021). Particular attention was given to botanical identification across sources following standard recommendations (Bennett & Balick 2014; Rivera *et al.* 2014). Taxonomic ambiguity was addressed conservatively, with reference to Bellakhdar (1997), Beck (2005) and Sankary (1991).

Classification of Medicinal and Non-Medicinal Uses

All medicinal uses documented across the four sources were classified according to the International Classification of Primary Care (ICPC-2), as suggested by Staub *et al.* (2015) and subsequently applied in diachronic ethnobotanical studies (Benítez *et al.* 2023). The ICPC-2 was preferred over the International Classification of Diseases (ICD) because, as Leonti *et al.* (2020) demonstrated, the precise diagnostic tools required by the ICD are not available in ethnomedical contexts, rendering it unsuitable for classifying the symptom-based descriptions characteristic of both historical pharmacopeias and contemporary oral traditions. Classification was conducted independently by two coders, with disagreements resolved

through discussion and conservative assignment to the broader applicable category. To characterise the nature of change across the four temporal sources, the typology of Leonti and Casu (2013) following Bye *et al.* (1995) was adopted: continuity denotes the maintenance of the same use, disjunction denotes the same species placed in a new conceptual context, discontinuity denotes abandonment, and synchronism denotes substitution or adoption of new uses.

Non-medicinal uses were classified according to Pardo de Santayana *et al.* (2014). Only categories explicitly attested in the data were retained, yielding four categories: Human food, Animal food, Toxic and harmful, and Industry and crafts.

Table 1. Summary of the four documentary sources used in the diachronic analysis of *Prunus dulcis* (Mill.) D.A. Webb and the vernacular names recorded for the taxon in each source.

Source	Period	Tradition	Editions consulted	Vernacular names
Dioscorides	1st century CE	Graeco-Roman	<i>De Materia Medica</i> (Beck, 2005) (Mathée 1553)	Amygdale Eleon Amygdalinon (almond oil) Métopion (almond oil) Amygdala (Latin)
Ibn Sina	11th century CE	Persian-Islamic	<i>Canon of Medicine</i> (Ibn Sina 1999) (Gruner 1973)	Lawz, لوز Al-Lawz al-hulw, اللوز الحلو Al-Lawz al-murr, اللوز المر Dohn al-lawz, دهن اللوز Samgh al-lawz, صمغ اللوز Sawiq al-lawz, سويق اللوز
Ibn Al-Baytar	13th century CE	Arab-Andalusian	<i>Kitab al-Jami'</i> (Ibn Al-Baytar 1992) (Leclerc, 1877-1883)	Dohn al-lawz al-murr, دهن اللوز المر Dohn al-lawz al-hulw, دهن اللوز الحلو Samgh al-lawz, صمغ اللوز Lawz, لوز
NE Morocco	2017 – 2019	Contemporary Moroccan field data	Field survey 1,177 informants	Louz mor, لوز مر Ajouz, أجوز, ⵓⵔⵓⵣ Assmoum, أسمووم, (Almonds that have not yet matured), ⵓⵔⵓⵣ ⵏ ⵉⵎⵓⵎ, اللوز لي باقي ماطابش

Quantitative Analysis

Knowledge similarity between sources was quantified using the Jaccard similarity index (JI):

$$JI = \frac{C}{(A + B - C)}$$

where values range from 0 (no shared knowledge) to 1 (complete overlap). The index was calculated separately for four analytical dimensions: (i) medicinal uses at the ICPC-2 group level, (ii) plant parts used, (iii) modes of preparation and (iv) modes of administration. This multidimensional approach allows assessment of whether procedural knowledge follows the same diachronic trajectory as declarative knowledge.

Data were organised into binary presence/absence matrices using Microsoft Excel. All analyses were performed in R (version 4.2.2).

Results

Vernacular names and overview of uses

A total of 17 vernacular names were recorded across the four sources (Table 1): four in Dioscorides (Amygdalé, Eleon Amygdalinon, Métopion, Amygdala), six in Ibn Sina (Lawz, Al-Lawz al-hulw, Al-Lawz al-murr, Dohn al-lawz, Samgh al-lawz, Sawiq al-lawz), four in Ibn Al-Baytar (Dohn al-lawz al-murr, Dohn al-lawz al-hulw, Samgh al-lawz, Lawz) and three in NE Morocco (Louz mor, Ajouz, Assmoum). Several names in the Islamic sources refer to specific preparations rather than to the plant itself, reflecting a pharmacopeial distinction between raw material and derived products absent from the Graeco-Roman and contemporary data.

Across the four sources, a total of 148 individual medicinal uses were documented for *Prunus dulcis* (Mill.) D.A. Webb, distributed across 14 ICPC-2 groups (Table 2). Ibn Sina recorded the highest number (n = 55) across the largest number of ICPC-2 groups (n = 12), followed by Ibn Al-Baytar (n = 52, 14 groups), Dioscorides (n = 35, 11 groups) and NE Morocco (n = 6, 3 groups).

Table 2. Diachronic comparison of *Prunus dulcis* (Mill.) D.A. Webb medicinal uses across four sources (Dioscorides, 1st c. CE; Ibn Sina, 11th c. CE; Ibn Al-Baytar, 13th c. CE and NE Morocco, 2017-2019). (+): use recorded; (-): use not recorded.

ICPC-2 Group / Condition	Dioscorides (1 st c. CE)	Ibn Sina (11 th c. CE)	Ibn Al-Baytar (13 th c. CE)	NE Morocco (2017-2019)
A. General and Unspecified				
Weakness (A04)	-	-	-	+
Prevention of intoxication (A86)	+	+	+	-
Rabid dog bite (A86)	+	-	+	-
Cerebral tonic (A98)	-	-	+	-
General analgesic (A98)	+	-	-	-
Nutritive (A98) / Therapeutic food (A98)	-	+	-	-
Opening of obstructions (A99)	-	+	-	-
Resolutive (A99)	-	+	-	-
B. Blood, Blood forming, Organs and immune mechanism				
Spleen tumors (B87)	-	-	+	-
Spleen disease (B99)	+	-	+	-
Spleen obstruction (B99)	-	+	-	-
D. Digestive				
Colic (D01)	+	+	+	-
Epigastric pain (D02)	-	+	+	-
Heartburn (D03)	+	-	-	-
Flatulence (D08)	-	-	+	-
Emetic (D09)	-	+	-	-
Vomiting (D10)	-	+	-	-
Diarrhoea (D11)	-	+	-	-
Constipation (D12) / Laxative (D12)	+	+	+	-
Strengthens the gum (D19)	-	-	+	-
Strengthens the mouth (D20)	-	-	+	-
Dropsy (D97)	-	+	-	-
Liver disease (D97)	+	-	+	-
Liver obstruction (D97)	-	+	+	-
Digestive (D99)	-	+	-	-
Intestinal engorgement (D99)	-	-	+	-
Purging of viscous phlegm (D99)	-	+	-	-
Stomach obstructions (D99)	-	-	+	-
F. Eye				
Visual disturbance (F05)	-	-	+	-
Ocular emollient (F99)	-	+	-	-
Visual impairment (F99)	+	-	-	-
Visual strengthening (F99)	-	+	-	-
H. Ear				
Ear pain (H01)	+	+	+	-
Tinnitus (H03)	+	+	+	-
Prevention of ear diseases (H29)	-	+	-	-
Ear discharge and wounds (H70)	-	+	-	-
Foreign body in ear (H76)	-	+	-	-
Excessive ear wax (H81)	-	+	-	-
Deafness (H86)	-	+	-	-
L. Musculoskeletal				

Pain from cold (L18)	-	+	-	-
Joint sprain (L79)	-	+	-	-
Gibbosity (L85)	-	-	+	-
Contusion (L99)	-	+	-	-
Facial spasm (L99)	-	-	+	-
Muscle contractures (L99)	-	-	+	-
N. Neurological				
Headache (N01)	+	+	+	-
Spasm (N07)	-	+	-	-
Paralysis (N18)	-	+	-	-
Phrenitis (N99)	-	-	+	-
P. Psychological				
Soporific (P06)	+	-	+	-
R. Respiratory				
Cough (R05)	+	+	-	-
Dry cough (R05)	-	-	+	-
Throat irritation (R05)	-	-	+	-
Tracheal irritation (R05)	-	-	+	-
Haemoptysis (R24)	+	+	+	-
Expectoration (R25)	-	+	+	-
Pneumonia (R81)	-	+	-	-
Pleurisy (R82)	-	+	+	-
Chronic cough (R79)	+	+	+	-
Asthma (R96)	+	+	+	-
Lung inflammation (R99)	+	-	-	-
Pulmonary affections (R99)	-	-	+	-
Pulmonary obstruction (R99)	-	+	-	-
Thoracic affections (R99)	-	-	+	-
S. Skin				
Melasma (S08)	-	-	+	+
Dandruff (S24)	+	-	-	-
Hair care (S24)	-	-	-	+
Beautifies the skin (S29)	-	-	-	+
Brown spot (S29)	-	-	-	+
Anthrax (S76)	-	-	+	-
Corrosive ulcers (S76)	+	-	-	-
Erysipelas (S76)	-	+	-	-
Herpes zoster (S76)	+	-	-	-
Malignant wounds (S76)	-	-	+	-
Ringworm / Tinea (S76)	+	-	+	-
Alopecia (S99)	-	+	-	-
Beard growth (S99)	-	+	-	-
Chronic skin diseases (S99)	-	+	-	-
Desquamation (S99)	-	-	+	-
Facial wrinkles (S99)	+	+	-	-
Freckles (S99)	+	+	+	-
Moist wounds of the head (S99)	-	-	+	-
Nocturnal pustules (S99)	+	-	-	-
T. Endocrine/Metabolic and Nutritional				
Weight gain (T07)	-	+	+	-
Diabetes (T90)	-	-	-	+
U. Urological				
Dysuria (U01)	+	-	+	-
Urinary retention (U08)	+	+	-	-

Bladder pain (U13)	-	-	+	-
Kidney pain (U14)	+	+	+	-
Urinary calculus (U95)	+	+	+	-
Diuresis (U99)	+	+	+	-
Kidney and bladder cleansing (U99)	-	+	-	-
X. Female Genital				
Uterine pain (X01)	+	+	+	-
Emmenagogue (X05)	+	+	+	-
Rectal pessary (X05)	-	+	-	-
Breast tumor (X19)	-	-	+	-
Uterine contraction (X99)	-	+	-	-
Uterine inflammation (X99)	+	-	-	-
Uterine suffocation (X99)	+	+	-	-
Uterine torsion (X99)	+	-	+	-
Y. Male Genital				
Increase of sperm (Y99)	-	-	+	-

Diachronic transmission of medicinal uses

The alluvial diagram (Figure 1) illustrates a progressive increase in the number of ICPC-2 groups documented from Dioscorides (11 groups) through Ibn Sina (12 groups) to Ibn Al-Baytar (14 groups), followed by a sharp reduction in NE Morocco (3 groups). Ten ICPC-2 groups are shared across all three historical sources: A (General and unspecified), B (Blood and haematopoietic), D (Digestive), F (Eye), H (Ear), N (Neurological), R (Respiratory), S (Skin), U (Urological) and X (Female genital). Group L (Musculoskeletal) is first documented in Ibn Sina and retained in Ibn Al-Baytar. Group T (Endocrine, metabolic, nutritional) is absent from Dioscorides, appears in Ibn Sina and Ibn Al-Baytar (T07: Weight gain), and is the only metabolic category documented in NE Morocco (T90: Diabetes). In the contemporary data, only groups A (General and Unspecified), S (Skin) and T (Endocrine/Metabolic and Nutritional) are represented.

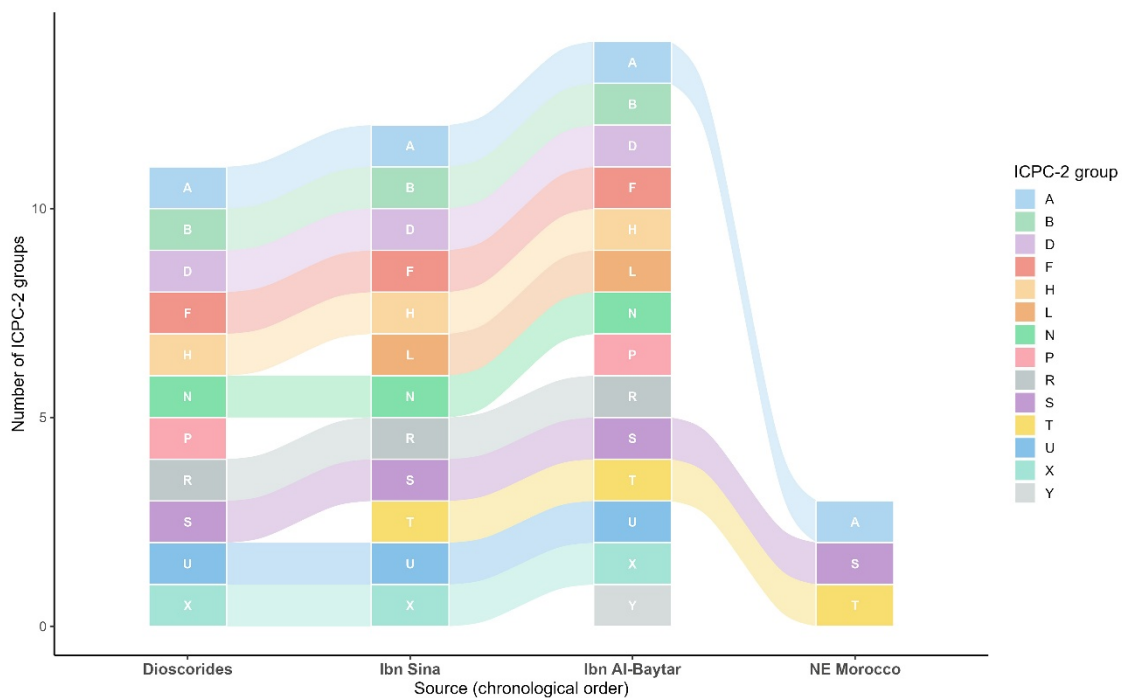


Figure 1. Alluvial diagram of ICPC-2 medicinal use groups of *Prunus dulcis* (Mill.) D.A. Webb across four sources in chronological order (Dioscorides 1st c. CE; Ibn Sina, 11th c. CE; Ibn Al-Baytar, 13th c. CE; NE Morocco, 2017-2019).

The Jaccard similarity heatmap (Figure 2) shows high pairwise similarity among the three historical sources: 0.769 between Dioscorides and Ibn Sina, 0.786 between Dioscorides and Ibn Al-Baytar and 0.857 between Ibn Sina and Ibn Al-Baytar. Similarity values between NE Morocco and the three historical sources are markedly lower: 0.167 with Dioscorides, 0.214

with Ibn Al-Baytar and 0.25 with Ibn Sina. The Upset plot (Figure 3) shows that eight ICPC-2 groups are shared simultaneously by all three historical sources (A, B, D, H, N, R, S and U). Group P (Psychological) is shared exclusively between Dioscorides and Ibn Al-Baytar. NE Morocco shares at least one group with each historical source but no group is shared by all four sources simultaneously.

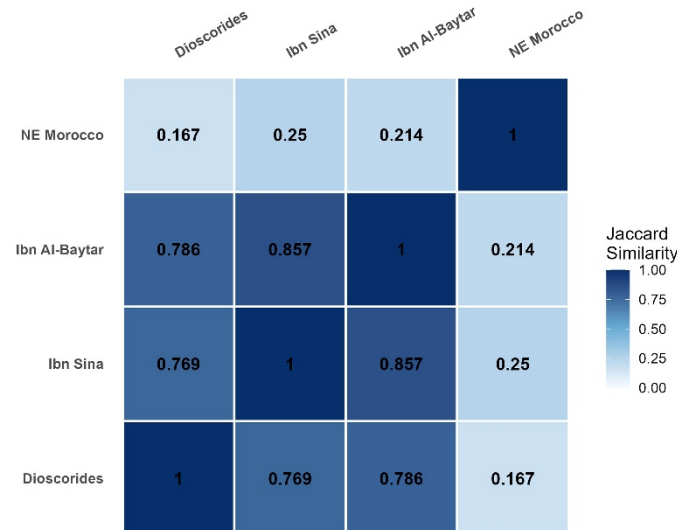


Figure 2. Jaccard similarity heatmap for medicinal uses of *Prunus dulcis* (Mill.) D.A. Webb across four sources in chronological order (Dioscorides 1st c. CE; Ibn Sina, 11th c. CE; Ibn Al-Baytar, 13th c. CE; NE Morocco, 2017-2019).

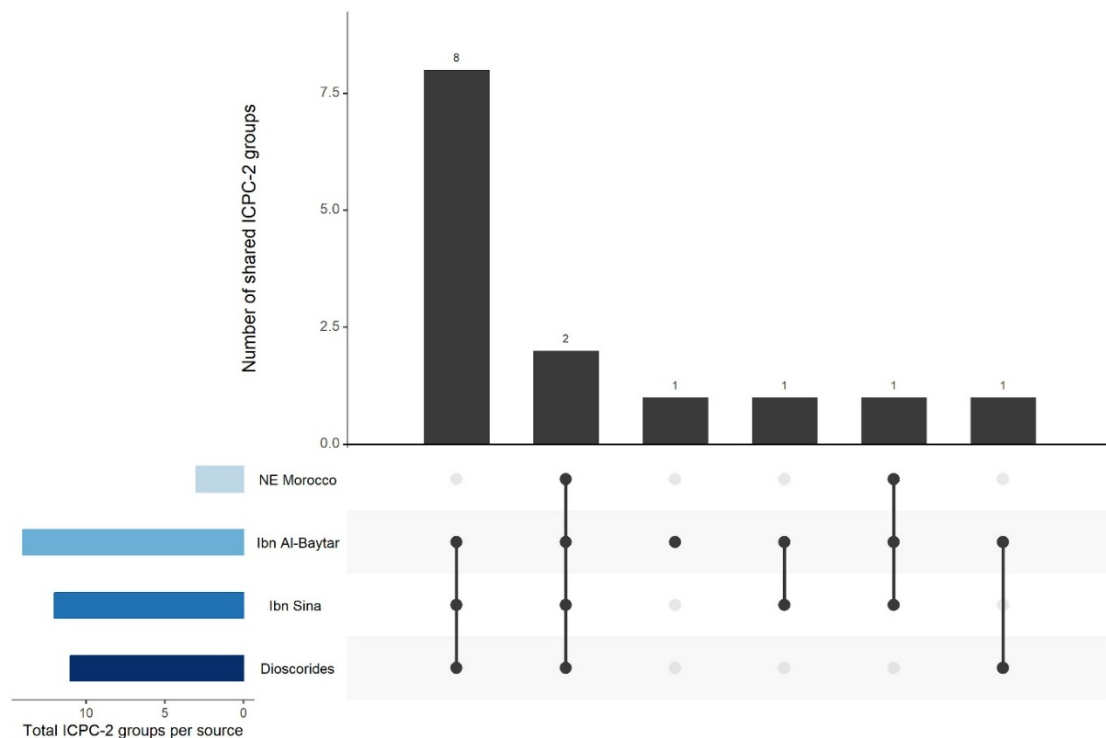


Figure 3. UpSet plot showing shared ICPC-2 groups among four sources documenting the medicinal uses of *Prunus dulcis* (Mill.) D.A. Webb.

Analysis of the authorities explicitly cited by Ibn Al-Baytar in his *Kitab al-Jami'* entry on *Prunus dulcis* (Mill.) D.A. Webb (Table 3) reveals a citation system across nine centuries of pharmacology. Starting with Dioscorides (1st century CE), Galen (2nd century CE), Ishak Ibn Amran (9th century CE), Ibn Massouih (9th century CE), Al-Razi in his book *Kitab al-Masuri* and his *Kitab al-Aghdhiya* (10th century CE), Massih (10th century CE), Massih Ibn Al-Hakem (10th century CE), Ibn Rochd (12th

century CE), and anonymous or unidentified authorities cited by Ibn Al-Baytar. Ibn Sina (11th century CE) is entirely absent from this citation system for this taxon, despite predating Ibn Al-Baytar by approximately two centuries and constituting one of the most authoritative pharmacological references of the Islamic tradition.

Table 3. Authorities explicitly cited by Ibn Al-Baytar in Kitab al-Jami' on *Prunus dulcis* (Mill.) D.A. Webb

Authority cited	Period	Tradition	Entry cited
Dioscorides	1st century CE	Graeco-Roman	Lawz, Samgh al-lawz, Dohn al-lawz al-morr
Galen	2nd century CE	Graeco-Roman	Lawz
Ibn Massouih	8th century CE	Arabo-Islamic	Lawz
Massih	9th century CE	Arabo-Islamic	Lawz
Ishak ibn Amran	10th century CE	Arabo-Islamic	Lawz
Al-Razi	10th century CE	Arabo-Islamic	Lawz
Ibn Rochd (Averroes)	12th century CE	Arabo-Islamic	Lawz
Anonymous / Other	-	-	Dohn al-lawz al-halou
Ibn Al-Baytar	13th century CE		
Ibn Sina (Avicenna)	11th century	Arabo-Islamic	Absent in this entry

Non-medicinal uses analysis

The chord diagram (Figure 4) illustrates the distribution of non-medicinal uses across the four sources and four Pardo de Santayana et al. (2014) categories (Table 4). Human food is documented in three sources (Ibn Sina, Ibn Al-Baytar and NE Morocco). Industry and crafts are documented in three sources (Dioscorides, Ibn Sina and NE Morocco), encompassing the preparation of the perfume of Métopion in Dioscorides, the use of almond gum as a binding agent in Ibn Sina, and cosmetic preparation in NE Morocco. Toxic and harmful is documented in two sources (Dioscorides and Ibn Al-Baytar), in both cases referring to the lethal effect of bitter almond preparations on foxes. Animal food is documented in two sources (Ibn Sina and NE Morocco). No non-medicinal use is simultaneously documented in all four sources.



Figure 4. Chord diagram of non-medicinal uses of *Prunus dulcis* (Mill.) D.A. Webb across four sources and four categories.

Table 4. Diachronic comparison of *Prunus dulcis* (Mill.) D.A. Webb non-medicinal uses across four sources (Dioscorides, 1st c. CE; Ibn Sina, 11th c. CE; Ibn Al-Baytar, 13th c. CE and NE Morocco, 2017-2019). (+): use recorded; (-): use not recorded.

Non-medicinal uses	Dioscorides (1st c. CE)	Ibn Sina (11th c. CE)	Ibn Al-Baytar (13th c. CE)	NE Morocco (2017-2019)
Human Food				
Nutritious food	-	+	+	+
Animal Food				
Fodder / Useful for livestock	-	+	-	+
Toxic and Harmful				
Kills foxes (bitter almond preparation)	+	-	+	-
Harmful to weakened organs	-	-	+	-
Industry and Crafts				
Preparation of the Egyptian perfume known as Métopion	+	-	-	-
Gum as binding agent	-	+	-	-
Cosmetic applications	-	-	-	+

Plant parts, modes of preparation and modes of administration

The richness barplots (Figure 5) display item counts per source across the three practical dimensions (Table 5). For plant parts (Figure 5A), Ibn Sina records the highest richness (n = 4; almond, gum, root, wood), followed by Ibn Al-Baytar (n = 3; almond, gum, root), Dioscorides (n = 2; almond, root) and NE Morocco (n = 1; almond). The seed (almond) is the only plant part present in all four sources.

For modes of preparation (Figure 5B), Ibn Al-Baytar records the highest richness (n = 9), followed by Ibn Sina (n = 8), Dioscorides (n = 6) and NE Morocco (n = 4). The NE Morocco preparation described as immature almonds mixed with hay and exposed to sun for two days, has no recorded equivalent in any of the three historical sources. For modes of administration (Figure 5C), Ibn Sina records the highest richness (n = 8), followed by Dioscorides (n = 5), Ibn Al-Baytar (n = 4) and NE Morocco (n = 2).

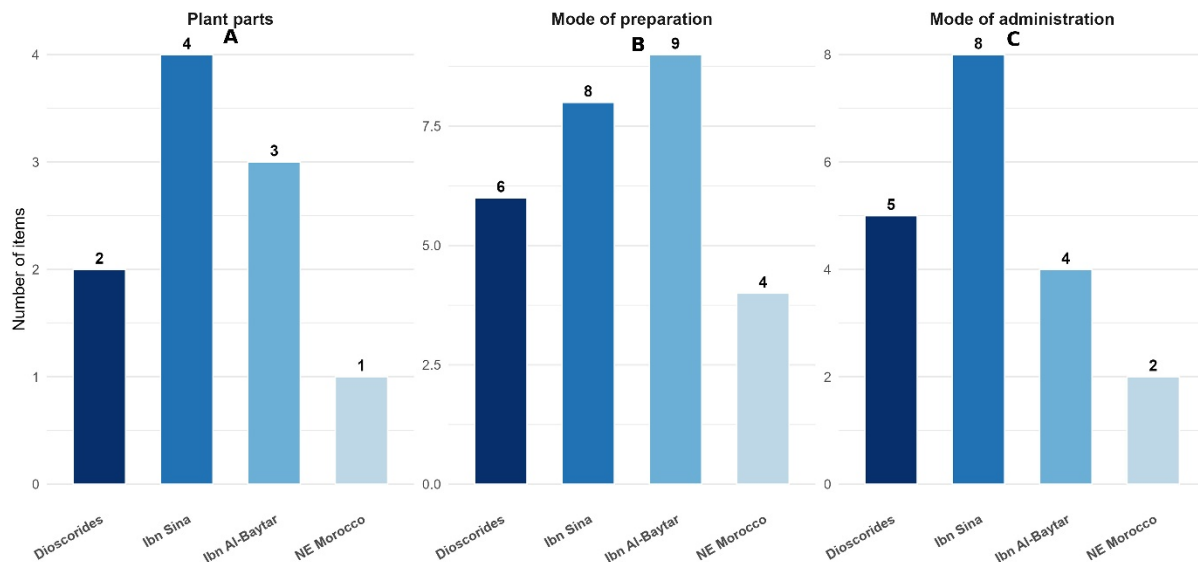


Figure 5. Knowledge richness of *Prunus dulcis* (Mill.) D.A. Webb per source for (A) plant parts, (B) modes of preparation, and (C) modes of administration.

The Jaccard similarity heatmap (Figure 6) show contrasting patterns across the three dimensions. For plant parts (Figure 6A), similarity among historical sources ranges from 0.50 and 0.75. For modes of preparation (Figure 6B), similarity values between NE Morocco and all historical sources are the lowest recorded across all dimensions in this study (0.083 with Ibn Al-Baytar, 0.091 with Ibn Sina and 0.111 with Dioscorides). For modes of administration (Figure 6C), NE Morocco shows comparatively higher similarity with Ibn Al-Baytar (0.50) and Dioscorides (0.40).

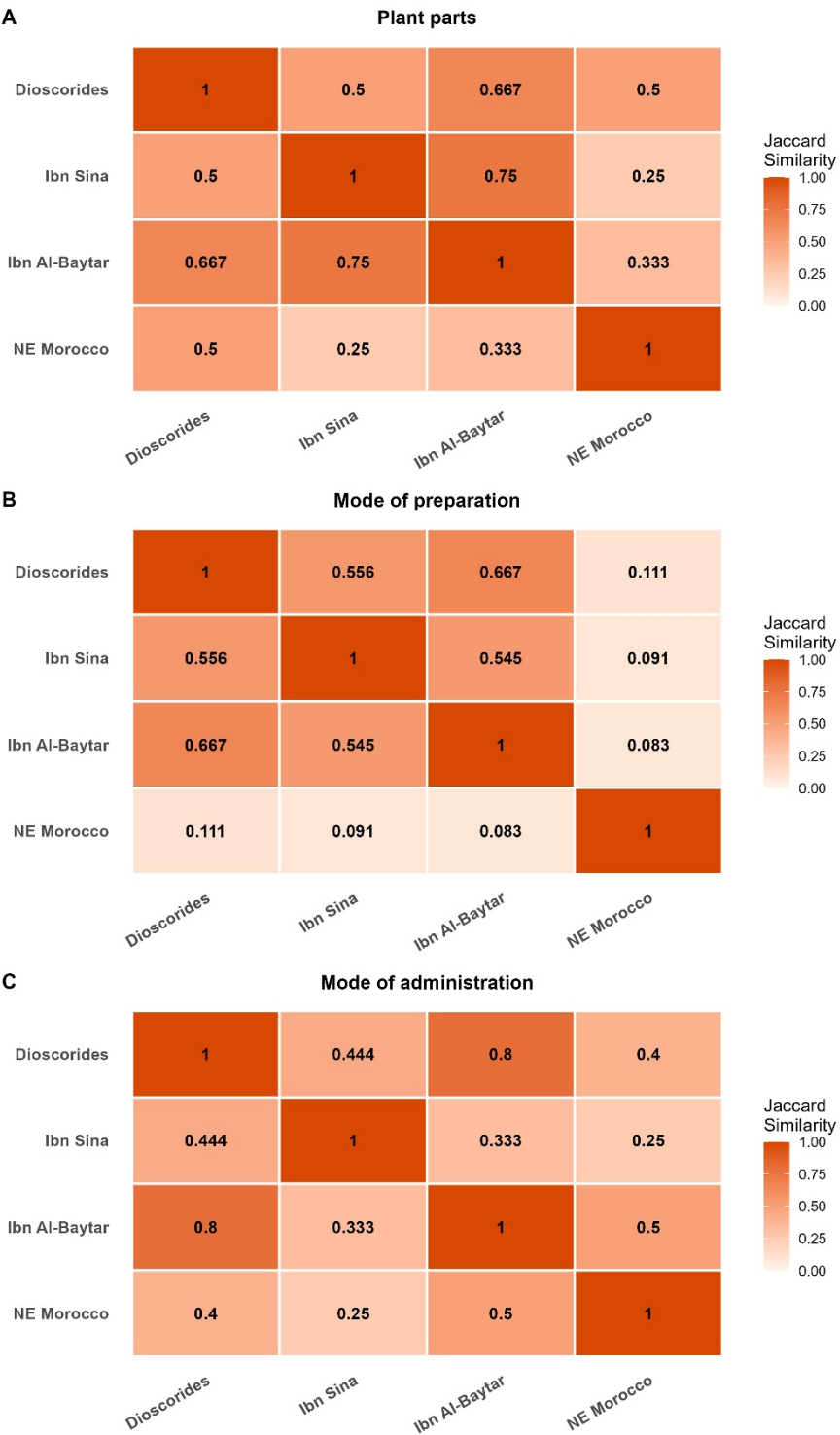


Figure 6. Jaccard similarity heatmap for (A) plant parts, (B) modes of preparation, and (C) modes of administration of *Prunus dulcis* (Mill.) D.A. Webb across four sources.

Table 5. Diachronic comparison of *Prunus dulcis* (Mill.) D.A. Webb plant parts, modes of preparation, and modes of administration across four sources (Dioscorides, 1st c. CE; Ibn Sina, 11th c. CE; Ibn Al-Baytar, 13th c. CE and NE Morocco, 2017-2019). (+): use recorded; (-): use not recorded.

	Dioscorides (1st c. CE)	Ibn Sina (11th c. CE)	Ibn Al-Baytar (13th c. CE)	NE Morocco (2017-2019)
Plant parts used				
Almond (seed)	+	+	+	+
Root	+	+	+	-
Gum	-	+	+	-
Wood	-	+	-	-
Modes of preparation				
Raw	+	+	+	-
Oil	+	+	+	+
Decoction	+	+	+	-
Electuary	+	+	+	-
Pounding	+	+	+	-
Mixture	+	-	+	-
Ash	-	+	-	-
Broth	-	+	-	-
Roasting	-	+	+	-
Peeling	-	-	+	-
Powder	-	-	+	-
Chewing	-	-	-	+
Consumption	-	-	-	+
Traditional preparation (immature almonds + hay + 2 days sun)	-	-	-	+
Modes of administration				
Oral	+	+	+	+
Topical	+	+	+	+
Instillation	+	+	+	-
Vaginal pessary	+	-	+	-
Poultice	+	+	-	-
Errhine (nasal)	-	+	-	-
Friction	-	+	-	-
Massage	-	+	-	-
Rectale	-	+	-	-

Discussion

Historical transmission continuity

The high Jaccard similarity values recorded among the historical sources (Dioscorides/Ibn Sina = 0.769; Dioscorides/Ibn Al-Baytar = 0.786; Ibn Sina/Ibn Al-Baytar = 0.857) can be explained by the conservative effect of oblique textual transmission. As Leonti (2011) demonstrated, textual codification exercises a conservative effect on pharmacopeial content across successive generations of readers. In the context of historical pharmacopoeias, this mechanism operates differently from oral transmission: face-to-face knowledge transfer introduces gradual variation through individual interpretation and selective retention, while written knowledge is more stable across generations as it is protected from the environmental and social disruptions that typically accelerate oral knowledge erosion.

The quantitative reach of this effect is important. Leonti (2011) documented that 116 of the 120 medicinal taxa used in Sardinia, Sicily and Campania can be traced back to Dioscorides through Matthioli (1568), representing 96.7% of medicinal taxa used in southern Italy. Our data suggest a comparable dynamic for *Prunus dulcis* (Mill.) D.A. Webb, as ten of the eleven ICPC-2 groups documented in Dioscorides are retained in Ibn Al-Baytar twelve centuries later. This finding is consistent with the results of our parallel diachronic analysis of the Apiaceae family conducted in the same three provinces, in which the highest Jaccard value was also obtained for the Dioscorides/Ibn Al-Baytar comparison (Digestive group = 0.72), confirming the strength of the Graeco-Roman to Arab-Andalusian textual transmission across botanical families (Mir *et al.* 2026). The

convergence of results across two distinct taxonomic families studied with identical methods on identical field data constitutes robust evidence that this form of transmission was systematic and not specific to a particular taxon.

This inter-source cohesion further reflects the deliberate intercultural exchange of pharmacological knowledge. Leonti *et al.* (2020) demonstrated that valuable plants have been deliberately exchanged across cultures since at least the Neolithic, with the most versatile species being most likely to enter and persist in successive pharmacopoeias. *Prunus dulcis* (Mill.) D.A. Webb exemplifies this category through its medicinal, alimentary, industrial and craft roles across three distinct civilisational traditions.

Ibn Al-Baytar's elevated Jaccard similarity with both Dioscorides and Ibn Sina does not reflect mere compilation but a deliberate synthetic project. Having studied Greek, Persian and Arab medicinal traditions before producing his Compendium (Gonzalez & Lanly 1997), Ibn Al-Baytar subjected his sources to critical evaluation while integrating observations from his extensive fieldwork across North Africa and the Levant. The progressive enrichment of documented knowledge (from 11 ICPC-2 groups in Dioscorides to 14 in Ibn-Al Baytar) is consistent with the cumulative elaboration of pharmacopeial knowledge described by Leonti and Verpoorte (2017), in which successive scholars integrated earlier traditions while contributing observations from their own cultural contexts. The Compendium is therefore best understood as an act of critical synthesis rather than passive transmission.

This critical and empirical dimension of Ibn Al-Baytar's work is explicitly documented in his own text. In his entry on Ammi spp. (**Aāthirilāl**), he records a therapeutic preparation transmitted within a specific Berber tribe of the Maghreb (Beni bou Ch'aïb of Oudjehân of Bougie) whose members jealously guarded their secret, transmitted it from father to son, and released the remedy only against an agreed price in advance (Ibn Al-Baytar 1992; Leclerc 1877-1883). Ibn Al-baytar does not claim discovery, he claims documentation of living oral pharmacopeial knowledge through direct contact with the populations who held it. He further reports personal clinical use of the preparation: "I employed it several times and applauded myself for having done so" (Ibn Al-Baytar 1992; Leclerc 1877-1883). In the same entry, he explicitly contradicts an established authority on a question of botanical identification: "Le Chérif pretends that the **Aāthirilāl** is a plant of the genus the Greeks call **Daufus** (دوفس), but this is not the case" (Ibn Al-Baytar 1992; Leclerc 1877-1883). These three dimensions (field documentation, personal clinical practice, and critical evaluation of prior authorities) characterise a scholar who integrated population pharmacopeial knowledge into a systematic written synthesis, not a compiler who reproduced it.

Table 3 shows the authorities cited by Ibn Al-Baytar in his *Kitab al-Jami'* entries on *Prunus dulcis* (Mill.) D.A. Webb. Ibn Sina is entirely absent from these cited authorities, despite the high Jaccard similarity between the two sources (JI = 0.857). This suggests that the similarity does not reflect direct textual transmission. Both scholars likely drew from the same earlier authorities independently, arriving at shared ICPC-2 groups through parallel access to a common prior corpus. When analysing Ibn Al-Baytar's work, it is therefore important to check which authors he cites, as this can reveal different transmission mechanisms behind similar Jaccard values.

The case of weight gain (T07) illustrates this result at the level of an individual ICPC-2 group. This category is absent from Dioscorides and present in both Ibn Sina and Ibn Al-Baytar, which might suggest at first direct transmission from one to other, especially that Ibn Al-Baytar mention Ibn Sina in other taxon. However, the authorities cited by Ibn Al-Baytar in Table 3 show that his source for the nutritive properties of the almond is not Ibn Sina but earlier Arabo-Islamic authorities that both scholars consulted independently. Ibn Sina and Ibn Al-Baytar therefore, arrived at the same therapeutic property via the same prior tradition rather than through sequential transmission. This divergence from Dioscorides constitutes what Leonti and Casu (2013) termed disjunction: the same species placed in a new conceptual context, producing apparent continuity that conceal a substantive reinterpretation of the underlying therapeutic rationale, one that reached Ibn Al-Baytar not through Ibn Sina but through their shared antecedent sources.

At the level of transmission mechanism, Hewlett and Cavalli-Sforza (1986) documented that vertical transmission from parent to child is by far the most important mechanism, accounting for approximately 80% of the cases studied, characteristically assuring slow cultural evolution. The knowledge transfer linking the three historical sources operates through a different but structurally analogous mode: oblique one-to-many transmission, in which each author addressed the scholarly community of later centuries rather than direct biological or social successor, structurally favouring conservation over innovation while allowing for the cumulative enrichment and critical reinterpretation documented here.

The discontinuity in contemporary NE Morocco data

In contrast, Jaccard similarity between contemporary Northeastern Morocco and all three historical sources is markedly lower (Dioscorides = 0.167; Ibn Sina = 0.25; Ibn Al-Baytar = 0.214), indicating strong medicinal knowledge discontinuity. These values are lower than those documented in parallel diachronic studies conducted in the same territory. El-Gharbaoui *et al.* (2017) documented that 43% of medicinal uses of the Lamiaceae in eastern Morocco can be inferred to derive from Ibn Al-Baytar. Our own Apiaceae analysis in the same three provinces documented a Jaccard value of 0.5 between Ibn Al-Baytar and contemporary data for digestive uses alone (Mir *et al.* 2026). The cross-cultural Asteraceae analysis of Benítez *et al.* (2021) found a 38% overlap with Dioscorides, and 28% with Ibn Al-Baytar. Against these family-level continuity values, the taxon-level Jaccard values obtained for *Prunus dulcis* (Mill.) D.A. Webb are significantly lower, demonstrating that knowledge attrition is taxon-specific and cannot be predicted from family-level continuity estimates.

The most significant illustration of this taxon-specific erosion is the complete absence of the digestive disease group (D) from contemporary NE Morocco data for *Prunus dulcis* (Mill.) D.A. Webb, despite its consistent documentation in all three historical sources and its status as the most diachronically stable knowledge category across all parallel family analyses in the region (El-Gharbaoui *et al.* 2017; Benítez *et al.* 2021; Mir *et al.* 2026). The absence of digestive uses in contemporary NE Morocco is unexpected. We suggest that the commercial normalisation of almond as a food product may have paradoxically contributed to this erosion. A plant consumed daily as food may no longer be perceived as a medicinal resource. However, this hypothesis requires further investigation. The gastroprotective properties of *Prunus dulcis* (Mill.) D.A. Webb against non-Steroidal Anti-Inflammatory drug (NSAID)-induced epithelial damage have been documented experimentally (Abdullah *et al.* 2020), suggesting that pharmacological irrelevance is not the explanation for this absence. Knowledge transformation, market substitution, and cultural rupture remain plausible alternatives, individually or in combination. Further diachronic analyses of other edible species in the same region would help to test this hypothesis.

The macro-level picture of Moroccan pharmacopeial continuity further contextualises this taxon-specific rupture. Bellakhdar (1997) reported that 77.7% of simple medicinal preparations in Morocco could be traced to classical Islamic sources. The Jaccard values obtained here for *Prunus dulcis* (Mill.) D.A. Webb (0.167 – 0.25) indicate that this macro-continuity conceals profound taxon-level heterogeneity. The pharmacopoeia as a whole may retain a high proportion of historically documented species while specific uses associated with individual taxa show substantial erosion.

The strong discontinuity further reflects a historically specific structural rupture. El-Gharbaoui *et al.* (2017) identified the marginalisation of Islamic medicinal traditions by Western medicine during 19th and 20th centuries as a primary driver of traditional pharmacopeial erosion in this region, a disruption confirmed by the consistently low contemporary Jaccard values across all family-level analyses conducted in the same territory (El-Gharbaoui *et al.* 2017; Benítez *et al.* 2021; Mir *et al.* 2026). The field surveys on which the present contemporary data draw (Smaili *et al.* 2023; Mir *et al.* 2024) documented 45% illiteracy among informants and predominantly oral and market-mediated transmission of medicinal plant knowledge; a context structurally hostile to the survival of complex written pharmacopeial traditions. At the individual level, Reyes-García *et al.* (2007) documented a consistent negative association between local ecological knowledge and acculturation markers such as schooling and national language fluency, processes intensively documented in the Amazigh communities of Northeastern Morocco (Smaili *et al.* 2023).

The tension between knowledge loss and knowledge persistence documented by Reyes-García *et al.* (2007) with some studies finding erosion through market integration, others finding stability despite socioeconomic change, cautions against interpreting our low Jaccard values as straightforward evidence of decline. They may reflect transformation rather than erosion of the contemporary ethnobotanical knowledge of Northeastern Morocco. Drawing on the typology of Leonti and Casu (2013), the contemporary NE Morocco medicinal uses do not constitute simple survival of historical knowledge but a mixed assemblage. The skin uses documented in the contemporary data (S29, S24) may constitute a synchronism, reflecting the independent adoption of new uses with no direct equivalent in the historical sources. The documentation of diabetes (T90) also constitutes a synchronism, as it integrates *Prunus dulcis* (Mill.) D.A. Webb into the treatment of a condition entirely absent from historical sources. Leonti (2024) cautioned that there is nothing inherently wrong or dramatic about abandoning outdated traditions and practices, a perspective that guards against romanticising the documented erosion.

Relative resistance of non-medicinal uses

Non-medicinal uses proved more resistant to cultural erosion than medicinal uses across the four sources. While no non-medicinal use category is simultaneously documented in all four sources, three of four categories identified each appear in at least two sources, and the contemporary NE Morocco data share at least one category with each historical source. This

asymmetric resistance is consistent with the food as medicine principle documented across Old World pharmacopoeias (Leonti *et al.* 2020), and with the structural patterns that emerges from the convergence of parallel diachronic analyses conducted in the same region across different families (El-Gharbaoui *et al.* 2017; Benítez *et al.* 2021; Mir *et al.* 2026), the taxa with the highest diachronic continuity were systematically those whose uses were embedded in alimentary or culinary practice.

The commercial anchoring of *Prunus dulcis* (Mill.) D.A. Webb in Northeastern Morocco provides a concrete structural explanation for this resistance. Morocco ranks fourth globally in almond production, with 96,523 tonnes recorded by FAOSTAT (Sakar *et al.* 2017). The continuous cultivation and commercial importance of *Prunus dulcis* (Mill.) D.A. Webb in Northeastern Morocco provides a concrete basis for the relative stability of alimentary and cosmetic uses. The involvement in the sale of farm products is positively associated with the maintenance of ethnobotanical knowledge (Reyes-García *et al.* 2007), suggesting that commercial integration can buffer non-medicinal knowledge against erosion. The cosmetic uses documented in NE Morocco supported by well-established pharmacological evidence base for almond oil as an emollient, antioxidant, and skin-protective agent (Barreca *et al.* 2020) may represent a contemporary reinvention proving that ethnobotanical knowledge is not static (Leonti 2011).

Plant parts, modes of preparation and modes of administration

Unlike previous diachronic analyses conducted in this region, which focused exclusively on medicinal use categories, the present study calculated separate Jaccard similarity indices for four analytical dimensions. This multi-dimensional approach shows for the first time for a single taxon in the Mediterranean, that modes of preparation erode faster than medicinal use categories. Modes of preparation showed the most severe collapse (JI = 0.111 with Dioscorides, JI = 0.091 with Ibn Sina, JI = 0.083 with Ibn Al Baytar), lower than values for medicinal use categories (0.167 – 0.25), plant parts (0.33 – 0.50) and modes of administration (0.25 – 0.50). This shows that declarative categorial knowledge is more resistant to cultural erosion than procedural knowledge.

It is a culture-specific way of doing things that characterises the local or the traditional (Leonti., 2024). If correct, the severe erosion of preparation knowledge (JI = 0.083 – 0.111) represents a more profound cultural rupture than use-category Jaccard values alone would suggest that contemporary NE Morocco informants retain a residual awareness of *Prunus dulcis* (Mill.) D.A. Webb as therapeutically relevant while having lost the specific operational knowledge that characterised its pharmacopeial application across two millennia.

The mechanisms underlying this asymmetric erosion can be reconstructed through transmission theory. Hewlett and Cavalli-Sforza (1986) data are consistent with this interpretation, as in their study of Aka foragers, specialised skills such as ntuma (great elephant hunting) and nganga (traditional healing), which require observing rare skilled practitioners in action, showed the highest dependence on non-parental transmission, suggesting that when the transmitting generation ceases to practise publicly, the observational learning that would normally reproduce complex procedural competencies fails to activate. Electuaries, decoctions, and ash preparations require supervised practice to transmit effectively. By contrast, the knowledge that almonds are good for the skin can survive as a cultural proposition without any accompanying procedural competence. El-Gharbaoui *et al.* (2017) noted that contemporary practitioners in eastern Morocco often source medicinal plants from markets, reflecting a cultural orientation toward ready-made preparation over self-compounded ones. It represents a shift that eliminates preparation knowledge from the active repertoire. This market-mediated simplification was independently observed across our field surveys (Smaili *et al.* 2023; Mir *et al.* 2024), confirming that it constitutes a structural feature of medicinal plant use in contemporary Northeastern Morocco.

Modes of administration showed comparatively higher similarity (JI = 0.40 with Dioscorides; JI = 0.50 with Ibn Al-Baytar). Oral and topical administration are the two modes retained in NE Morocco as they are the simplest and most intuitive modes requiring no specialist procedural knowledge. Their persistence may reflect the independent rediscovery of the most accessible application modes for a common plant, a case of synchronism in the framework of Leonti and Casu (2013) rather than active transmission.

Pharmacological relevance of contemporary uses

Of the three ICPC-2 groups retained in Northeastern Morocco, General and unspecified (A); Skin (S) and Endocrine, metabolic, nutritional (T), two find partial support in the pharmacological literature, a convergence that is relevant for transmission theory. The persistence of these specific groups across two millennia of cultural erosion may not be coincidental. Benítez *et al.* (2021) observed that medicinal uses with pharmacological effectiveness tend to be more

propagated, both through oral tradition and through written sources, suggesting that biological efficacy itself acts as a selective filter on cultural transmission.

The dermatological uses documented in contemporary NE Morocco find direct pharmacological support in the literature on almond oil. Clinical evidence supports the topical application of almond oil for skin hydration of preterm infants (Caglar *et al.* 2020), reduction of striae gravidarum (Timur Tashan & Kafkasli, 2012; Hajhashemi *et al.* 2017), and management of uremic pruritus (Afrasiabifar *et al.* 2017), with randomised controlled trials confirming significant effect in each of these conditions. The traditional maintenance of skin and cosmetic uses in Northeastern Morocco documented across both contemporary field data and across three historical sources is therefore consistent with a biological substrate that has proven sufficient to sustain cultural transmission independently of formal pharmacological knowledge.

The documentation of diabetes (T90) in contemporary NE Morocco represents a discontinuity as it is a treatment of a disease absent from all three historical sources. However, this independently developed contemporary use is consistent with pharmacological evidence that has accumulated over the past two decades. Clinical trials and epidemiological studies have reported positive effects of almond consumption on glycaemia, insulinemia, body weight management and markers of metabolic syndrome (Barreca *et al.* 2020) which constitutes a form of ethnopharmacological validation that strengthens the credibility of the contemporary NE Morocco dataset.

By contrast, the digestive uses (D) that dominated the historical sources and proved the most diachronically stable category across all three historical sources are entirely absent from the contemporary NE Morocco data. As discussed above, pharmacological irrelevance is unlikely to explain this, given the documented gastroprotective properties of *Prunus dulcis* (Mill.) D.A. Webb (Abdullah *et al.* 2020). The collapse of group D more likely reflects knowledge transformation, market substitution, or cultural loss (Reyes-García *et al.* 2007; Smaili *et al.* 2023; Mir *et al.* 2024).

Theoretical implications and perspectives for knowledge conservation

The diachronic patterns documented in this study have several implications beyond the specific case of *Prunus dulcis* (Mill.) D.A. Webb in NE Morocco. The differential erosion rates observed across the four sources suggest a practical hierarchy for documenting priorities. If procedural knowledge is the most vulnerable as the Jaccard values (0.083 – 0.111) suggest, then documentation studies that focus exclusively on use categories will systematically miss the knowledge most at risk of irreversible loss. Albuquerque and Nobrega Alves (2024) have argued that ethnobiology has the potential to inform conservation policies across critical domains; the specific dimension erosion documented here suggests that this potential requires documentation methodologies designed to capture procedural knowledge through observation and participatory methods rather than interview-based approaches alone.

In this study, we tried to avoid the two errors identified by Leonti (2024), including romanticisation of traditional knowledge and considering it as pre-scientific. The two-millennium trajectory of *Prunus dulcis* (Mill.) D.A. Webb documents a tradition of remarkable pharmacological richness and a contemporary situation in which most of that richness has been lost to active practice, not because it lacked value, but because the social infrastructure that sustained its transmission has been fundamentally restructured. Whether this represents a cultural loss or an adaptation is an open question that this study can raise but not resolve.

Conclusion

This study set out to address three research questions concerning the two-millennium transmission trajectory of *Prunus dulcis* (Mill.) D.A. Webb in Northeastern Morocco. In response to the first question, medicinal knowledge proved far more eroded than historical sources suggest as Jaccard similarity values between contemporary NE Morocco and the three historical sources (0.167 – 0.25) are significantly lower than family-level continuity values previously documented in same territory, demonstrating that taxon-level erosion is severe and cannot be predicted from broader botanical surveys. In response to the second question, plant parts, modes of preparation and modes of administration do not follow the same erosion trajectory as medicinal use categories. Preparation knowledge showed the most severe collapse (JI = 0.083 – 0.111), revealing a previously undocumented hierarchy of vulnerability in which procedural knowledge erodes faster than declarative knowledge. In response to the third question, non-medicinal uses proved more resistant to cultural erosion than medicinal uses, with alimentary and cosmetic applications showing cross-temporal stability consistent with the food-continuum documented across Mediterranean ethnobotany.

These results show that ethnobotanical knowledge erosion is selective. The mechanisms identified in this study, including the commercialisation of food plants, the simplification of preparation practices, and the marginalisation of Islamic medical traditions, may also apply to other taxa and regions undergoing comparable socio-cultural transformation.

Ethnobotanical surveys based on interviews capture what people say but not what they actually do. Participatory and observational methods are needed to document preparation knowledge, which is the most vulnerable to irreversible loss. This study focused on a single taxon. Whether the same results would be found for other species in Northeastern Morocco remains an open question for future research.

Declarations

List of abbreviations: ICPC-2 - International Classification of Primary Care; JI - Jaccard Index; WFO – World Flora Online; NSAID – Non-Steroidal Anti-Inflammatory; NE - Northeastern; CE - Common Era; c. - Century

Ethics approval and consent to participate: Ethnobotanical surveys were conducted in accordance with ethical guidelines. Participation was voluntary, and informed consent was obtained from all participants prior to the interviews.

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