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Cross-System Co-occurrence of Hot-Cold Direction in Medicinal Plants

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Research Article

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Abstract

Results

of 81 multi-system anchors, 68 were concordant and 13 divergent, a multi-system concordance rate of 84.0% (binomial $p = 3.81 \times 10^{-19}$); excluding one species substitution (Gentiana) gives 85.0%, and excluding 19 neutral anchors gives 82.3%, so the conclusion is robust. To assess historical transmission, we recomputed by origin cluster: merging Unani with Galenic yields seven clusters, concordance 85.9% (55/64); restricting to the four relatively independent clusters (TCM, Ayurveda, African, Andean) yields 90.2% (46/51). We state plainly, however, that this conservative estimate rests mainly on TCM and Ayurveda, which did historically exchange; current data cannot exclude transmission and can only establish strong cross-system co-occurrence of direction. Same-species agreement between TCM and Ayurveda: dichotomous $\kappa = 0.841$ ($n = 50$), three-class $\kappa = 0.681$ ($n = 56$), both far above chance. Most mechanistically suggestive is that independent Mexican and Andean ethnographies also encode hot-cold through water and habitat. In the kinship-controlled analysis, all four testable genera showed the expected soil-moisture direction, but with only four independent units (genera) the genus-level sign test gives $p = 0.0625$, which has no power to adjudicate significance; this is exploratory directional support, not confirmation. Exceptions that a single variable cannot explain also exist, such as Panax ginseng versus P. quinquefolius. A distinction must also be drawn between a plant's water demand and the wetness of its habitat: for cultivated crops the two are not equivalent. Our conclusion is cross-system co-occurrence and external corroboration of direction, not causal proof; disagreements and limitations are reported as they stand.

1 Introduction

Hot-cold is the most basic directional category in Chinese materia medica theory. A natural question follows: is classifying plants as cooling or warming a local convention internal to TCM, or a shared cognition that humans formed repeatedly under different geographies and historical conditions? If several medical systems with little direct contact assign the same direction to the same plant, such cross-cultural convergence would constitute strong evidence not easily explained by the accidents of a single culture.

In ethnobiology and medical anthropology, cross-cultural convergence is treated as an important signal for testing the reliability of a cognitive category: if independent observations converge on the same conclusion, that conclusion more likely corresponds to an objective, repeatedly perceivable property of the plant rather than an arbitrary symbolic assignment. It should be stressed that cross-cultural convergence demonstrates the robustness and external validity of the directional judgement; it does not by itself amount to a modern causal mechanism.

This study addresses one specific question: with species identity confirmed by Latin binomial, do eight medical systems agree on the hot-cold direction of the same plant? How strong is the agreement, and

where do disagreements concentrate? Rather than starting from chemical composition, the study uses cross-system directional comparison as its method, providing independent external validation for a framework that derives medicinal nature from habitat endowment.

2 Data and methods

2.1 Systems included and their independence

Eight medical systems are included. Their historical independence differs; to avoid overstatement, Table 1 annotates the degree of independence and possible transmission relations for each.

Table 1
Systems included and notes on their independence

System	Main region	Independence and scope notes
TCM	East Asia	Reference system for this study
Ayurveda	South Asia	Virya as Ushna/Sheeta; exchanges with Unani
Unani	Arab-Persian	Mizaj, degree 1–4; inherits the Galenic tradition
Western/Galenic	Europe-Mediterranean	Degree 1–4; cognate with Unani
Sowa Rigpa	Tibetan plateau	Nus-pa; semi-independent from TCM and Ayurveda
Latin American / Southeast Asian	Latin America, Southeast Asia	Ethnomedicine; partly influenced by Galenic
African traditional medicine	Sub-Saharan Africa	Predominantly indigenous classification; Swahili influenced by Arabic
Andean medicine	South American Andes	Quechua/Aymara indigenous polarity; relatively independent

2.2 Principle of species matching

All comparisons confirm species identity by Latin binomial; vernacular names or genus-level labels are never merged. Congeners may differ in direction — Artemisia and Gentiana both contain internal directional differences — so any substitution by a related species is flagged in the notes. In addition, chili pepper, potato and tomato are New World crops that reached the Old World only after the sixteenth century; their records in TCM and Ayurveda are therefore late, and the study marks this temporal context explicitly to avoid anachronism. Of the 85 anchors, four (cassia cinnamon, basil, Acorus tatarinowii, and Gentiana; 4.7%) draw on a congener rather than the same species in at least one system; the first three agree in direction and do not affect the concordance rate, whereas the Gentiana entry is counted as divergent and is reported separately as a sensitivity analysis giving 85.0%. Dried ginger and fresh ginger

are two preparations of the same species, Zingiber officinale; because the unit of analysis is the medicinal material, they are listed as two anchors, giving 84 species.

2.3 Direction and intensity conventions

For the unified direction, warm and hot are grouped as the hot direction, cool and cold as the cold direction, and neutral as neutral. TCM intensity is taken from a fixed ordinal scale (from very cold to very hot, cold negative and hot positive); Unani and Galenic degree 1–4 map onto intensity levels; Ayurvedic Virya is mostly dichotomous and is taken from the classical qualitative statement. Cross-system comparison privileges direction and treats intensity as secondary, so that intensity scales of different systems are not forced into equivalence.

2.4 Rule for adjudicating concordance

Concordant means the same direction, with a neutral judgement not conflicting with other directions; preparations, parts or maturity stages that share a direction and differ only in intensity are still counted as concordant. Divergent means opposite directions, or conflicting hot and cold accounts within a single system (whether arising from maturity, plant part, or disputed sources); single-system means other systems lack a corresponding record. Where evidence is thin or disputed, the divergent label is retained and no selective adoption is made. The rule applies uniformly to all anchors.

3 Results

3.1 Overall concordance

Of the 85 anchors, 81 have records in two or more systems and four appear in a single system only. Under the uniform rule of Section 2.4, 68 of the 81 multi-system anchors are concordant and 13 divergent, giving a multi-system concordance rate of 84.0% (binomial $p = 3.81 \times 10^{-10}$). Of the 13 disagreements, nine are of the opposite-direction type and four are dual accounts within a single system (Piper longum, Mentha haplocalyx, Rheum palmatum, Solanum lycopersicum). One further entry, Gentiana, is in fact a substitution between TCM Gentiana scabra and Unani G. lutea rather than a same-species disagreement; excluding it gives 68/80 = 85.0%. Overall statistics are given in Table 2.

Table 2
Overall cross-cultural concordance statistics

Indicator	Value
Total anchor plants	85
Systems included	8
With multi-system records	81
Direction concordant	68
Divergent	13 (opposite-direction 9 + intra-system dual accounts 4)
Single system	4
Multi-system concordance rate	84.0%

3.2 Strong global agreement in the hot direction

Strong agreement in the hot direction clusters around aromatic, pungent, or drought-growing plants. Table 3 lists representative anchors and their judgements across systems.

Table 3
Representative anchors with concordant hot direction

Species	Latin name	TCM	Ayurveda	Unani	Andes
Dried ginger	Zingiber officinale (dried)	Hot	Ushna	Hot 4 Dry	-
Fresh ginger	Zingiber officinale (fresh)	Warm	Ushna (fresh, milder)	Hot 2–3	-
Garlic	Allium sativum	Warm	Ushna	Hot 4 Dry	Hot
Onion	Allium cepa	Warm	Ushna	Hot 4	Warm/Hot
Black pepper	Piper nigrum	Hot	Ushna	Hot 4 Dry 4	-
Cassia cinnamon	Cinnamomum cassia	Very hot	Ushna	Hot 3 Dry 2	-
Turmeric	Curcuma longa	Warm	Ushna	Hot Dry	-
Nutmeg	Myristica fragrans	Warm	Ushna	Hot 3	-
Basil	Ocimum basilicum	Warm	Ushna	Hot 2 Dry	-

3.3 Convergence in the cold direction

Agreement in the cold direction clusters around succulent, cooling, or bitter plants; Table 4 lists representative anchors.

Table 4
Representative anchors with concordant cold direction

Species	Latin name	TCM	Ayurveda	Western/Galenic	Africa
Purslane	Portulaca oleracea	Cold	-	Cool 2	-
Cucumber	Cucumis sativus	Cool	Sheeta	Cool 2	Cool
Watermelon	Citrullus lanatus	Cold	Sheeta	Cool 2	Cool
Chicory	Cichorium intybus	Cool	Sheeta	Cool 2	-
Endive	Cichorium endivia	Cold	Sheeta	Cool 2	-
Lettuce	Lactuca sativa	Cool	Sheeta	Cool 2	-
Asian pear	Pyrus pyrifolia	Cool	Sheeta	Cool 1	-
Plantain	Plantago asiatica	Cold	Sheeta	Cool 2 (plantain)	-

3.4 Independent discovery of water and habitat coding

Among all external evidence, the most theoretically significant is the independent appearance of water and habitat coding. Classic ethnography in Mexico found that hot-cold is inferred locally from the water a plant requires and the wetness of its habitat: onion, garlic and pepper grown under relatively dry conditions are classed as hot, while water-demanding tomato is classed as cool. Quechua communities in the Andes likewise organize plants along a hot-cold polarity and use bathing to prevent cold-related illness. Peer-reviewed work further reports that climatic conditions shape hot-cold classification. These independent records align closely with a framework that derives hot-cold from habitat moisture and habitat endowment, and they did not spread from a single theoretical source. A careful distinction is required: the Mexican ethnography is framed in terms of the water a plant requires (a demand-side trait), whereas the ENP framework is framed in terms of the wetness of the plant's actual growing environment (a supply-side property). For wild plants the two are broadly equivalent, since a water-demanding species can survive only in moist habitats; for irrigated crops they are not, since a water-demanding crop can be grown in a dry region. This study therefore treats the evidence as an echo at the level of cognitive rule, not as direct proof about supply-side habitat.

3.5 Origin clusters and control for transmission

Because the systems differ in independence and historical transmission is possible, we recomputed by origin cluster. The eight systems are merged into seven clusters by historical relation: TCM; Ayurveda; Unani-Galenic (cognate, merged into one cluster); Sowa Rigpa; Latin American and Southeast Asian; African; Andean. A conservative estimate further retains only the four relatively independent clusters: TCM, Ayurveda, African and Andean. Statistics include only anchors with an unambiguous direction (neutral and dual-account entries excluded) and judgements in at least two clusters. Results: the seven-cluster concordance rate is 85.9% (55/64); the four-cluster rate is 90.2% (46/51). It must be stated plainly that the conservative estimate rests mainly on TCM and Ayurveda, which did historically

exchange (the eastward transmission of Buddhism and translated scriptures, with Sowa Rigpa as an intermediary), and no independent combination free of both TCM and Ayurveda exists. A high concordance rate therefore cannot prove non-transmission; current data cannot separate independent convergence from transmission, and can only establish strong cross-system co-occurrence of direction. Same-species agreement between TCM and Ayurveda: dichotomous $\kappa = 0.841$ ($n = 50$), three-class $\kappa = 0.681$ ($n = 56$), both far above chance.

3.6 Habitat comparison under kinship control (eight directionally opposed genera)

The complete 85-anchor, system-by-system dataset is provided in the companion file Cross-Cultural_Hot-Cold_Comparison_Table_v3.2.xlsx, with five worksheets: Notes and Methods, Master Comparison Table, Literature Sources, Concordance Statistics, and Coverage Matrix. Every anchor carries a Latin binomial and a source code for verification and reanalysis. The per-genus and per-species detail and genus-level statistics for the kinship-controlled analysis in Section 3.6 appear in the companion file Kinship-Controlled_Habitat_Comparison_8_Opposed_Genera_v1.2.xlsx. The mechanistic classification of the 13 disagreements and the three rules awaiting test in Section 3.7 appear in the companion document A_Unified_Explanatory_Framework_for_Hot-Cold_Disagreement_v1.3.docx. The habitat-blind worksheet designed for the planned two-rater review is held by the author and is available on request; it is a tool template only, contains no review results, and is not evidence for this study.

3.7 Disagreements and their types

Of the 13 divergent anchors, nine are of the opposite-direction type (Table 5) and four are dual accounts within a single system (Piper longum: Ayurveda gives opposite directions for dried and fresh material; Mentha haplocalyx and Rheum palmatum: Unani holds both cold and hot accounts; Solanum lycopersicum: Latin American sources call red fruit hot and green fruit cool). Disagreement is not random noise; it mostly tracks fresh versus dried preparation, plant part, maturity, emphasis on taste versus bodily sensation, and congener substitution.

Table 5
Nine anchors with opposite-direction disagreement

Species	Latin name	TCM	Ayurveda	Unani
Saffron	Crocus sativus	Neutral	Divergent Ushna/Sheeta	Warm 2
Fennel	Foeniculum vulgare	Warm	Sheeta	Hot 2 Dry1
Coriander	Coriandrum sativum	Warm	Sheeta	Cold Moist
Gentian	Gentiana scabra	Cold	-	Hot 2–3
Spinach	Spinacia oleracea	Warm	Divergent (cool/hot)	Slightly cool (Persian)
Pumpkin	Cucurbita moschata	Warm	Sheeta	Cold Moist
Radish	Raphanus sativus	Cool	-	Hot 3
Areca nut	Areca catechu	Warm	Sheeta (mainstream)	Cold 3 Dry
Mango	Mangifera indica	Cool	Divergent (ripe hot / unripe cool)	-

4 Discussion

4.1 External support for the habitat-endowment framework

The high directional agreement across eight systems, and especially the independent appearance of water and habitat coding on different continents, provides external validity for a framework that derives medicinal nature from habitat endowment. Its significance is that hot-cold direction no longer rests solely on the authoritative label of a single system, but gains cross-cultural corroboration that can be observed repeatedly. This brings the direction of bias closer to a plant property that different populations can identify reliably, rather than a purely cultural convention.

4.2 Sources of disagreement

Disagreements arise from five explicable situations; it must be stressed that these mechanisms are currently post hoc groupings whose predictive power awaits prospective testing on independent samples. First, fresh versus dried material usually alters intensity rather than direction, as with ginger, where both fresh and dried forms are hot and the entry remains concordant; but in Ayurveda Piper longum reverses direction between dried and fresh material, and is counted as a dual-account disagreement under the Section 2.4 rule. Second, different plant parts (leaf, seed, root) have different tendencies and in a few cases reverse the direction. Third, maturity differs, as with mango, cool when unripe and hot when ripe. Fourth, systems weight taste irritation and postprandial sensation differently.

Fifth, congeners are classified separately, and one Gentiana entry is in fact a species substitution, already excluded. Retaining disagreements rather than discarding them helps delimit the boundary conditions of the theory; but for these mechanisms to become falsifiable predictions they must be specified in advance and tested on a new random sample, not confirmed on the same data that generated them.

4.3 Relation to adjacent studies

This study connects two lines of work. The ENP study, which derives hot-cold from habitat endowment, explains the antecedent of direction, and this study supplies cross-cultural external validation of that directional judgement; the study of five-flavour dominance over tonifying and draining addresses which property governs tonifying versus draining function within a system, its object being function rather than direction. The three propositions are distinct and independent, yet form a whole by citation: habitat derives direction, cross-cultural data validate direction, and five flavours explain function.

5 Limitations and outlook

First, the systems differ in independence and several exchanged theory historically, so the strength of convergence must be assessed system by system and not all systems treated as fully independent. Second, the anchor plants are not a random sample; they were included on condition of being matchable in the master table and documented in the literature, so extrapolation to all plants requires caution. Third, intensity scales differ across systems; this study compares direction primarily, and precise cross-system mapping of intensity remains to be established. Fourth, some entries rest on classical citations and professional sources; although cross-checked across sources, they should be further confirmed by two-rater blinded review and subsequent sample expansion. Future work can proceed along three lines: sample expansion, blinded review, and a unified account of disagreement.

6 Conclusion

Across 85 anchors (84 species) matched strictly by Latin binomial, eight medical systems co-occur strongly in hot-cold direction: under the uniform dual-account rule the multi-system concordance rate is 84.0% (85.0% excluding Gentiana, 82.3% excluding neutral anchors), 85.9% across the seven origin clusters, and 90.2% across the four relatively independent clusters. Because the conservative estimate rests mainly on TCM and Ayurveda, which did historically exchange, transmission cannot be fully excluded; the term 'independent convergence' is therefore not warranted, and the accurate characterization is cross-system directional co-occurrence (same-species κ 0.841 dichotomous, 0.681 three-class). Most mechanistically suggestive is the independent appearance of water and habitat coding on different continents, which hints that the systems may share a cognitive rule inferring hot-cold from habitat; under kinship control all four testable genera show the expected soil-moisture direction, but the genus-level sign test has no power to adjudicate significance ($p = 0.0625$), so this is exploratory qualitative support rather than confirmation. The 13 disagreements (dual accounts included) can be explained by fresh versus dried material, plant part, maturity, disputed sources and congener differences,

but the framework remains a hypothesis awaiting prospective testing. Cross-system co-occurrence provides robust external evidence for a measurable framework of directional bias; that evidence is co-occurrence and corroboration of direction, not causal proof, and its boundaries and limitations are stated as they stand.

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Supplementary Files

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- CrossCulturalHotColdComparisonTablev3.2.xlsx
- KinshipControlledHabitatComparison8OpposedGenerav1.2.xlsx
- AUnifiedExplanatoryFrameworkforHotColdDisagreementv1.3.docx
- Appendix.docx