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Sweet Flavor as a Strong Discriminator of Tonifying versus Eliminating Action

The Four Natures Add No Significant Independent Increment beyond the Five Flavors: A Family-Grouped Out-of-Fold Test on 427 Plant Records within the Textbook Label System

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Abstract

This study does not take chemical constituents as its starting point; instead, it begins with the measurable labels of medicinal properties themselves and examines the relationship among the four natures, the five flavors, and tonifying versus eliminating action. Habitat, as a more upstream antecedent framework, is examined independently in a companion line of work and is not used here. The nature of the measurement must first be defined: the four natures, five flavors, and functional classifications all come from the same textbook–Chinese Pharmacopoeia (2020 edition) label system, in which the sweet flavor is defined as that which can tonify, can moderate, and can harmonize. What this study measures is therefore the internal consistency and out-of-fold reproducibility within that label system, not causal relationships in the natural world. The analysis is restricted to the binary contrast of tonifying deficiency versus eliminating pathogenic factors: the primary analysis frame has n = 366 (80 tonifying-deficiency records and 286 from the twelve eliminative classes), and the focused frame has n = 172 (80 tonifying-deficiency and 92 heat-clearing records). Given the complete separation observed in the focused 172 frame—24 of 24 sweet-containing records on the hot side and 2 of 52 non-sweet records on the cold side—we use Firth's penalized likelihood with a Jeffreys prior, supplemented by Fisher's exact test. Results: on the cold side, where controls are available, the tonifying-versus-eliminating contrast between sweet-containing and non-sweet records gives a Fisher odds ratio of 17.19 ($p = 3.9 \times 10^{-6}$); the neutral group gives 25.0 ($p = 0.001$), with the two directions agreeing in sign and comparable in magnitude. On the hot side, 29 of 30 records tonify deficiency and only one is heat-clearing (and that record is non-sweet), so there is only a single eliminating record, insufficient as a control, and discriminative power on that side cannot be tested. The 36 neutral records, of which 28 are sweet-containing and 27 tonify deficiency while 9 do not, are reported separately as the neutral group. Under five-fold family-grouped GroupKFold, AUC is 0.644 for the four natures alone, 0.778 for the five flavors alone, and 0.789 for the combined model; the increment of the combined model over the five flavors alone is only 0.010 (95% CI -0.027 to 0.05). Under the symmetric scale (a comparable calibration), the increment is 0.025 and the standalone

discriminative power of the four natures falls to 0.599; the third calibration runs in the opposite direction to the baseline, and its value of 0.037 serves only as an upper-bound reference. None of the three reaches 0.06, which is used here only as a magnitude reference. The increment is an exploratory analysis, registered in research protocol v1.7 as the exploratory addendum H10. The single binary indicator of sweet presence has AUC 0.762, differing from the full five flavors by 0.016 (CI -0.028 to 0.081). When the frame is widened from 366 to 391 (adding 25 digestion-promoting records) and to 427 (all non-tonifying records), the sweet-flavor odds ratios remain 13.08 and 11.95 (both $p < 10^{-15}$), while the proportion of tonifying records among sweet-containing medicinals falls from 0.428 to 0.340. Under the pre-registered threshold (upper bound of the difference <= 0.06), the current upper bound of 0.081 does not meet the threshold for the carrier designation. We therefore do not use the stronger formulation that the sweet flavor alone accounts for tonifying action; instead we characterize the sweet flavor as a strong discriminator, while the bitter and pungent flavors may still retain some increment.

Keywords: four natures; five flavors; sweet flavor; tonifying and eliminating; continuous spectrum of property predilection (pianxing); Firth's penalized likelihood; label-internal consistency.

1. Introduction and research questions

The theory of Chinese medicinal properties is organized around core categories such as the four natures, the five flavors, meridian tropism (channel entry), and the ascending, descending, floating, and sinking tendencies. Most current empirical research takes chemical constituents as its starting point and explains medicinal properties through constituent–target–network pathways. That approach has advantages in measurability but its findings depend heavily on the experimental conditions under which those constituents are measured, and it offers relatively limited upstream explanation of why the same medicinal can display different functional biases. This paper is a label-layer test within an overall research framework that takes habitat endowment (生境禀受, the ecological conditions under which a medicinal is produced) as the upstream antecedent; the habitat layer is examined independently in a companion line of work and is not part of this paper.

The study centers on one concrete question: within the plant frame, can the functional distinction in Chinese medicine between tonifying and eliminating (draining pathogenic factors) be explained by the two measurable dimensions of four-nature intensity and flavor? Before the statistics, the measurement boundary must be made explicit: because the four natures, five flavors, and functional classifications share the same source, this study asks which variables within the label system carry the discriminative power for tonifying versus eliminating and

whether it can be reproduced on whole botanical families not seen before—not whether the sweet flavor naturally causes deficiency tonification. The starting point includes a falsifiable prior: if deficiency heat is milder than excess heat, the four-nature intensity of medicinals that clear deficiency heat should be systematically weaker than that of fire-draining medicinals. If this prior cannot be tested directly because of limits in the classification scheme, then the true dimension distinguishing deficiency from excess needs to be reconsidered.

2. Data and methods

2.1 Data sources and variables

The data come from the unified master table v5.1, which contains 1,045 records spanning plants, animals, fungi, algae, lichens, processed and purified materials, and minerals. This study uses the fields of four natures, primary flavor, full flavor profile, functional category, material class, and botanical name. The four natures are assigned intensity on an ordered scale (in absolute values); the mapping is given in Table 1. The signed direction (cold negative, hot positive) is retained for side-stratified analysis. The labels are based on the Chinese Pharmacopoeia (2020 edition), supplemented by authoritative Chinese materia medica textbooks.

Table 1. Four-nature intensity mapping (fixed ordered scale; absolute values)

Four nature	major cold	major heat	cold	hot	slightly cold	slightly warm	cool	warm	neutral
Intensity	3.0	4.0	1.5	2.5	0.75	0.5	0.5	1.0	0.0

2.2 Functional standardization, the sweet-containing criterion, and sample frames

Therapeutic actions are standardized into 19 major classes using keyword rules. Sweet flavor is treated as sweet-containing, defined by whether the character 甘 (sweet) appears anywhere in the full flavor profile field, rather than taking only the single primary flavor. After matching against the GBIF family resolution, botanical family names cover 100% of the plant frame; fungi and fungal-like organisms lack corresponding family names and are excluded from out-of-fold validation, so inference is restricted to the plant frame. The plant frame contains 427 records. Of the 112 botanical families, 54 are represented by a single record and 20 by two, so the out-of-fold estimate is genuinely extrapolative at the family level.

It should be noted that 427 is a count of records, not of independent species: the 570-medicinal source of the master table contains 40 groups of duplicate entries sharing the same name, botanical source, and functional category, totaling 82 rows, all within the plant frame (42 of them redundant); in addition, sharpleaf galangal fruit (Yizhi Ren, Alpinia oxyphylla Miq.) appears in

two records that differ only in whether the functional class is recorded as qi-regulating or interior-warming. Records in all sample frames of this paper are counted as entries under the established convention; the deduplication sensitivity analysis is reported in Section 3.8, part three.

The primary analysis is restricted to the binary contrast of tonifying deficiency versus eliminating pathogenic factors, so the frame consists of 80 tonifying-deficiency records plus 286 from the twelve eliminative classes, n = 366. The twelve eliminative classes and their counts are: heat-clearing 92, downward-draining 8, interior-warming 27, exterior-releasing 13, phlegm-transforming 17, blood-activating and stasis-resolving 44, qi-regulating 23, dampness-draining 15, dampness-transforming 9, wind-dampness dispelling 25, parasite-expelling 11, and emetic 2, totaling 286 and closing exactly with 366. Within the plant frame, six additional classes totaling 61 records are neither eliminative nor tonifying: spirit-calming 7, liver-calming and wind-extinguishing 3, astringent 1, cough-suppressing and wheeze-relieving 13, hemostatic 12, and digestion-promoting 25, giving 427 - 61 = 366. These six classes are not used as control categories, because the eliminating side of the binary contrast is defined here as eliminating pathogenic factors, whereas spirit-calming, hemostatic, cough-suppressing and wheeze-relieving, digestion-promoting, liver-calming, and astringent actions are symptomatic or stabilizing and binding functions; including them would change the definition of eliminating. It must be stated honestly that these 61 records have a sweet-containing proportion of 0.705 (higher than 0.454 in the retained group) and a tonifying count of zero—that is, the excluded group is precisely the one that is most sweet-containing and least tonifying—so their exclusion must rest on a functional definition rather than merely on the data distribution. These six classes are nevertheless listed in full in Table 3 and are included as a sensitivity analysis in Section 3.8.

A focused frame of n = 172 (80 tonifying deficiency, 92 heat-clearing) is used for the complete-separation diagnosis; a side-stratified frame of n = 136 (the 172 frame excluding neutral records) is used for cold–hot stratification; and a direction frame of n = 328 (the plant frame excluding 99 neutral records; 171 cold, 157 hot) is used for direction analysis. Each record is assigned to a single class by its standardized functional category, and tonifying and eliminating are mutually exclusive.

2.3 Complete separation, Firth's likelihood, and the analysis workflow

The analysis has six layers. First, assess the operability of the prior. Second, construct flavor and intensity profiles for each functional class. Third, build contingency tables from sweet-containing status crossed with intensity and stratify them by the three directions of cold, neutral, and hot, with the neutral group reported separately. Fourth, evaluate the out-of-fold AUC of the four natures alone, the five flavors alone, the combined model, and the single binary sweet indicator

under five-fold family-grouped GroupKFold. For the flavor models, the full flavor profile is converted into three binary indicators (sweet, bitter, and pungent), rather than a one-hot encoding of the primary flavor. Fifth, identify complete separation and replace ordinary maximum likelihood with Firth's penalized likelihood (adding the Jeffreys-prior term 0.5 log|I(β)| to the log-likelihood, with step-halving iterations to ensure convergence), supplemented by Fisher's exact test; the Firth procedure is a custom Python implementation following Firth (1993). Sixth, estimate confidence intervals for non-separation indicators using 1,000 bootstrap resamples and conduct sensitivity analyses in two ways: changing the scale and changing the sample frame. Ordinary logistic regression with $C = 10^6$ approximates no regularization; Firth is used for the separation diagnosis and does not depend on tuning.

3. Results

3.1 Operability of the prior hypothesis

The textbook chapter lists are matched against the master table, and the four-nature intensities of the matched records are summarized in Table 2. Under the standardized classification, the textbook deficiency-heat-clearing medicinals are split between functional classes (for example, sweet wormwood is assigned to heat-clearing and lycium root bark to tonifying deficiency); only one record (sweet wormwood) actually carries the deficiency-heat-clearing functional subclass, and no record carries a fire-draining subclass, so the textbook groups cannot be reproduced by directly selecting standardized functional classes. The two matched groups (2 and 3 records) are both too small for a class-level test; this results from the mismatch between the functional-class scheme and the textbook chapter groupings, not from the proposition being rejected. The question is entered into the hypothesis library as H6 and will be tested after the classification scheme is revised and the sample is expanded.

Table 2. Four-nature intensity of the textbook groups (portion matched in the master table)

Medicinal group	Records located in the master table (matched by medicinal name)	Mean intensity	Median intensity
Deficiency-heat-clearing medicinals	2	1.5	1.5
Fire-draining heat-clearing medicinals	3	1.5	1.5
Toxin-resolving heat-clearing medicinals	9	1.33	1.5
Dampness-drying heat-	4	1.5	1.5

clearing medicinals			

3.2 Flavor profiles across functional classes (sweet-containing criterion)

The flavor structure and four-nature intensity of the functional classes show systematic differences, as presented in Table 3. The tonifying-deficiency class has a sweet proportion of 0.89 and a median intensity of 0.75; the interior-warming, dampness-transforming, exterior-releasing, and qi-regulating classes have high pungent proportions; the downward-draining class has a bitter proportion of 1.0 and median intensity of 1.5; the digestion-promoting class has a sweet proportion of 0.88 and a median four-nature intensity of 0.0 (neutral), resembling the high sweet-containing profile of tonifying deficiency while differing in function, and this group is handled separately in the sensitivity analysis in Section 3.8.

Table 3. Flavor proportions and four-nature intensity by functional class in the plant frame (sweet-containing criterion; each flavor is the proportion of records containing that flavor, with repeat counting allowed, so column sums have no total meaning; the dagger marks n < 5, not interpreted because of insufficient sample)

Functional class	n	Sweet prop.	Bitter prop.	Pungent prop.	Median intensity
Dampness-draining	15	0.67	0.47	0.07	0.75
Dampness-transforming	9	0.0	0.33	1.0	1.0
Phlegm-transforming	17	0.47	0.53	0.65	1.0
Spirit-calming	7	0.71	0.29	0.29	0.75
Liver-calming and wind-extinguishing†	3	0.67	0.33	0.33	0.5
Astringent†	1	1.0	0.0	0.0	1.0
Cough-suppressing and wheeze-relieving	13	0.54	0.69	0.23	1.0
Hemostatic	12	0.5	0.58	0.08	0.25
Downward-draining	8	0.0	1.0	0.12	1.5
Blood-activating and stasis-resolving	44	0.34	0.52	0.55	1.0

Digestion-promoting	25	0.88	0.0	0.16	0.0
Emetic†	2	0.0	1.0	1.0	1.25
Heat-clearing	92	0.38	0.59	0.21	0.75
Interior-warming	27	0.11	0.15	1.0	1.0
Qi-regulating	23	0.09	0.61	0.96	1.0
Wind-dampness dispelling	25	0.48	0.44	0.48	0.0
Tonifying deficiency	80	0.89	0.3	0.16	0.75
Exterior-releasing	13	0.54	0.38	0.77	1.0
Parasite-expelling	11	0.27	0.64	0.55	1.0

3.3 Sweet-containing contingency tables for tonifying versus eliminating (focused frame)

Contingency tables are built from sweet-containing status crossed with intensity level (baseline intensity ≥ 1 defined as high), and the tonifying proportions in each cell of the focused frame are given in Table 4. The most striking difference comes from the sweet flavor: the sweet-containing cells range from 0.636 to 0.685, far above the non-sweet cells of 0.135 to 0.138; the non-sweet low and non-sweet high cells are nearly identical (0.138 and 0.135), so intensity has almost no effect on tonifying versus eliminating for non-sweet medicinals.

Table 4. Tonifying proportions within the sweet-containing-by-intensity contingency cells of the focused frame (n = 172)

Flavor	Intensity	n	Tonifying prop.
Non-sweet	Low	29	0.138
Non-sweet	High	37	0.135
Sweet-containing	Low	73	0.685
Sweet-containing	High	33	0.636

3.4 Three-direction stratification by cold, neutral, and hot (the neutral group)

The signed four natures are used to stratify the cold and hot sides, while the 36 neutral records are reported separately as the neutral group; the results are shown in Table 5. The neutral group contains 28 sweet-containing records, 27 tonifying-deficiency records, and 9 non-tonifying records (3 in the sweet-containing group and 6 in the non-sweet group), forming the group that

carries sweet-neutral tonification. Attention must be paid to the control structure on each side: among the 106 records on the cold side, 82 are eliminating (32 sweet-containing, 50 non-sweet), which can serve as controls; among the 30 records on the hot side, 29 tonify deficiency and only one is heat-clearing, and that record is non-sweet, meaning there is only a single eliminating record on the hot side, insufficient as a control; the neutral group contains 9 non-tonifying records, so its tonifying proportion is not a pure 0/1 structure.

Table 5. Tonifying proportions for sweet-containing and non-sweet records across the cold, neutral, and hot directions (n = 172; cells show tonifying/total, with tonifying proportion in parentheses)

Direction	Flavor	Tonifying/total (tonifying prop.)
Cold	Non-sweet	2/52 (0.038)
Cold	Sweet-containing	22/54 (0.407)
Hot	Non-sweet	5/6 (0.833)
Hot	Sweet-containing	24/24 (1.0)
Neutral	Sweet-containing	25/28 (0.893)
Neutral	Non-sweet	2/8 (0.25)

3.5 Family-grouped out-of-fold results: three models, the single binary indicator, and difference confidence intervals

The out-of-fold AUC values under five-fold family-grouped GroupKFold are summarized in Table 6. On the cold–hot direction frame, the four natures score 1.000 and the five flavors 0.866; the four-nature value in this cell is label-internal consistency. It should be noted that the 0.866 discriminative power of the five flavors does not rule out high collinearity with the four natures, so it cannot be taken as evidence that the flavors independently discriminate cold from hot. In the wide primary analysis frame, the four natures alone score 0.644, the five flavors alone 0.778, and the combined model 0.789; the combined model exceeds the five flavors alone by only 0.010 (exact difference 0.0104), meaning the four natures contribute almost no increment in the wide frame, while their standalone discriminative power is clearly low (0.644)—another negative result reported by this study. The single binary sweet indicator scores 0.762, differing from the full five flavors by 0.016, with a confidence interval of -0.028 to 0.081 that crosses zero.

The nature of this item must be made explicit: the conclusion on the four-nature increment is an exploratory analysis that was not included among the first nine pre-registered hypotheses; it has been entered in research protocol v1.7 as the exploratory addendum H10 (the protocol is not pre-registered on a public platform, and its non-confidential portions can be provided on reasonable request). Its criterion is whether the 95% CI of this difference contains zero (if it does, the result

is recorded as no significant independent increment); no separate threshold is set, and the alternative scales serve only as sensitivity analyses.

Table 6. Out-of-fold AUC: three models and the single binary indicator (family-grouped GroupKFold)

Task / model	Out-of-fold AUC	Note
Cold–hot, four natures, n = 328	1.0	Label-internal consistency; not external validation
Cold–hot, five flavors	0.866	Possibly collinear with the four natures; not independent evidence
Tonifying 366, natures only	0.644	Primary analysis
Tonifying 366, flavors only	0.778	Primary analysis
Tonifying 366, combined	0.789	Δ 0.010; CI [-0.027, 0.05]
Tonifying 366, sweet only	0.762	Difference from full flavors 0.016; CI [-0.028, 0.081]
Tonifying 172, natures only	0.619	Focused frame
Tonifying 172, flavors only	0.696	Focused frame
Tonifying 172, combined	0.733	Δ 0.037; CI [-0.021, 0.106]
Tonifying 172, sweet only	0.667	Difference from full flavors 0.029; CI [-0.018, 0.108]

3.6 Firth's penalized likelihood: coefficients under three calibrations

For the complete separation, Firth's penalized likelihood yields finite coefficients, and the three calibrations are summarized in Table 7. It should be noted that the three calibrations are three different parameterizations (binary on 136, three-direction on 172, and three-valued on direction), not repeated measurements of the same parameter; the three point estimates should therefore not be assembled into an interval as evidence of robustness. The point estimates of the sweet-containing main effect under the three parameterizations are 1.643, 1.735, and 1.955, consistent in direction and all far above zero (corresponding to the greater-than-0.8 half of H8). The interaction terms are -0.659, -0.656, and -0.019; because the hot side contains only one eliminating record and lacks a control, the interaction is not estimable on that side, and these three values should not be read as a negative interaction—their meaning is that the marginal effect of the sweet flavor cannot be tested on the hot side.

Table 7. Firth coefficients (sweet-containing, direction, and interaction; finite estimates under separated data; the interaction is limited by the hot-side control)

Calibration	Sweet-containing	Direction (hot)	Sweet × direction

136 binary (cold/hot)	1.643	2.951	-0.659
172 three-direction (vs cold)	1.735	2.887	-0.656
Three-valued direction (-1/0/1)	1.955	1.446	-0.019

3.7 Fisher's exact tests

The exact 2×2 tests of tonifying versus eliminating for sweet-containing and non-sweet records in each direction are given in Table 8. The cold-side odds ratio is 17.188 ($p = 3.9 \times 10^{-6}$) and the neutral value 25.0 ($p = 1.0 \times 10^{-3}$), with the sweet flavor showing strong and directionally consistent discriminative power on the two sides that have controls; the hot-side p is 0.2, and with only one eliminating record and insufficient controls on that side, discriminative power is not interpreted. Exact conditional (equal-tail) 95% confidence intervals are reported in Table 8; they were computed with scipy.stats.contingency.odds_ratio (kind='conditional'), the same function for every table, and the wide intervals reflect the small number of non-sweet tonifying records.

Table 8. Stratified Fisher exact tests (tonifying/eliminating for sweet-containing versus non-sweet records)

Direction	2×2 (sweet tonifying/eliminating; non-sweet tonifying/eliminating)	Odds ratio	95% CI	p value
Cold	[22, 32]; [2, 50]	17.188	3.72–156.85	3.86e-06
Neutral	[25, 3]; [2, 6]	25.0	2.54–314.58	1.01e-03
Hot	[24, 0]; [5, 1]	Insufficient controls	0.10–∞	0.20

3.8 Sensitivity: four-nature scales and sample-frame boundaries

To address the question of whether the conclusions depend on a particular scale or a particular sample frame, two sets of sensitivity analyses were conducted (Tables 9 and 10).

First, the four-nature intensity scale is not the only reasonable specification: the baseline scale contains asymmetric jumps (major heat at 4.0 is higher than major cold at 3.0, and warm at 1.0 jumps to hot at 2.5). A symmetric scale (major cold and major heat both set to 4, cold and hot both to 2.5, and slightly cold, slightly warm, cool, and warm all to 1) and a signed-rank calibration were therefore used to rerun the three models on the 366 frame. The results are shown in Table 9: the standalone discriminative power of the four natures is 0.644, 0.599, and 0.443, while the combined discriminative power is 0.789, 0.803, and 0.815. Two things moving in

opposite directions must be distinguished: the increment of the combined model over the five flavors alone changes across scales as 0.010, 0.025, and 0.037, which is rising, whereas the standalone discriminative power of the four natures goes 0.644 → 0.599 → 0.443, which is falling. It is therefore inappropriate to write that relaxing the scale strengthens the negative result; the prudent formulation is that the increment does not exceed 0.025 under the comparable calibration and does not exceed 0.037 under all calibrations. It should also be noted that the third calibration is of a different kind from the first two: it records the entire cold side as negative and the hot side as positive, running opposite to the baseline absolute-value convention, so its increment serves only as an upper-bound reference and cannot be read in parallel with the first two rows. This item is an exploratory analysis, not included among the first nine pre-registered hypotheses, and is recorded in protocol v1.7 as the exploratory addendum H10.

Table 9. Four-nature scale sensitivity (366 frame; out-of-fold AUC under five-fold family-grouped GroupKFold)

Scale	Four natures only	Five flavors only	Combined	Combined minus flavors only
Baseline (fixed; absolute values)	0.644	0.778	0.789	0.010
Symmetric (major cold/heat both 4)	0.599	0.778	0.803	0.025
Signed-rank (cold–hot symmetric; reversed vs baseline)	0.443	0.778	0.815	0.037

Note: under the signed-rank calibration, the four-nature-only OOF AUC is 0.443, below 0.5, because this calibration records the cold side as negative and runs opposite to the baseline absolute-value convention; it is not a reversed model. Measured as max(AUC, 1 - AUC), the value is 0.557. The increment of 0.037 under this calibration is likewise not of the same kind as the first two rows because of the reversed direction and serves only as an upper-bound reference. The increments under all three calibrations fall short of 0.06, which is used only as a magnitude reference.

Second, the sample-frame boundary: adding the 25 digestion-promoting records—the largest and highly sweet-containing group among the six non-eliminative classes—gives n = 391, and including all non-tonifying records gives n = 427. The tonifying-versus-eliminating odds ratios for sweet-containing versus non-sweet records fall from 15.861 to 13.081 and 11.948 (the odds ratio is the cross-product ratio, and p is the two-sided Fisher exact test value), all still above 10 with $p < 10^{-15}$. As the frame widens, the sweet-containing proportion among non-tonifying records rises from 0.332 to 0.376 and 0.398, and the tonifying proportion among sweet-

containing medicinals falls from 0.428 to 0.378 and 0.340, but the discriminative structure does not reverse.

Table 10. Sample-frame boundary sensitivity (tonifying/eliminating for sweet-containing versus non-sweet records; Fisher exact tests; two-sided p)

Sample frame	n	Sweet-containing tonifying records (sweet/total tonifying)	Tonifying prop. among sweet-containing	Odds ratio	95% CI	p value
Wide tonifying frame 366	366	71/80 (0.887)	71/166 (0.428)	15.861	7.43–37.41	1.1e-19
With digestion-promoting 391	391	71/80 (0.887)	71/188 (0.378)	13.081	6.18–30.72	2.5e-17
All non-tonifying 427	427	71/80 (0.887)	71/209 (0.34)	11.948	5.68–27.96	2.0e-16

Third, the effect of record-level duplication. The 40 groups of duplicate entries in the master table sharing the same name, botanical source, and functional category (42 rows in the plant frame), together with the two sharpleaf galangal fruit records that differ only in functional class, weight both sides simultaneously when counted as records. Recomputed after deduplication on the key of name plus botanical source plus functional category: the 366 frame has n = 330 and odds ratio 15.337; the 391 frame has n = 352 and 12.865; the 427 frame has n = 385 and 11.680; tonifying records fall from 80 to 73, with all three p values below 10^{-13}. If the two sharpleaf galangal fruit records are also merged, the 366 frame has n = 329 and odds ratio 15.246. Neither direction nor magnitude changes, so the primary analysis is still reported on the record convention; however, when the 427 and 366 figures are cited, they must be noted as record counts rather than independent species.

4. Discussion

Taken together, within the textbook label system, the sweet flavor has strong discriminative power for tonifying versus eliminating on the cold and neutral directions, where controls are available, with consistent magnitudes (odds ratios of 17–25); the hot side, whose sample composition is itself skewed toward tonifying and which has only a single eliminating record,

insufficient as a control, cannot be used to test the discriminative power of the sweet flavor on that side, and it should not be described as an effect of the hot direction dominating tonifying action.

Another negative result worth recording concerns the four natures: within the 366 frame, the four-natures-only AUC is 0.644, and the combined model exceeds the five flavors alone by only 0.010, while under the symmetric scale the increment is 0.025 and the standalone discriminative power of the four natures falls to 0.599. That is, beyond the five flavors, the independent increment of the four natures for tonifying versus eliminating is small; the value of the four natures lies more in providing the background of cold and hot direction than in independent discriminative power for this functional axis. This does not conflict with the common formulation that the four natures and five flavors divide and complement each other, but it indicates that on the specific functional axis of tonifying versus eliminating, the flavors carry greater weight.

The following medicinal interpretation is offered only as a discussion example and not as evidence for the conclusions. Taking unprocessed rehmannia root: its flavor profile contains sweet and its nature is cold, placing it in the sweet-containing cold-side cell; the sweet flavor retains its yin-nourishing character, while the cold direction makes its function lean toward clearing, so it leans toward clearing combined with yin nourishment, and its purely eliminating force is weaker than the bitter-cold, non-sweet combinations such as gypsum and goldthread. The difference between deficiency heat and excess heat therefore lies not in four-nature intensity but in the tonifying-versus-eliminating structure indicated by the flavors.

The boundaries of this study must be emphasized: the correspondence between sweet-containing and tonifying deficiency is an internal consistency within the same label system and cannot be used to infer natural causation. To break this circularity, future work could use objective proxies independent of the textbook, such as sweetness or polysaccharides, or use the sweet flavor in independent medical systems such as Ayurveda as a cross-cultural control. Meridian tropism and tonifying-versus-eliminating are two independent lines of research with different sample frames (187 and 366), and neither has been blind-reviewed; this paper does not treat the two lines as evidence for each other, and the meridian-tropism side is presented only as a preliminary observation from another line. The earlier idea of one parent encoding with two orthogonal axes is retained only as a testable discussion hypothesis at this stage, because the hot side lacks controls and the interaction is not estimable.

5. Limitations and outlook

First, the conclusions concern internal consistency and out-of-fold reproducibility within the textbook label system, constituting label-internal consistency rather than natural causation; the upstream habitat layer is outside the scope of this paper and is handled in a companion line of work. Second, family-grouped out-of-fold validation holds only within the plant frame, and fungi and fungal-like organisms are excluded for lack of family names. Third, the hot side has only one eliminating record among 30 and lacks controls, so that side is not testable and requires expansion with additional eliminating records before reassessment. Fourth, the confidence intervals of the differences between the single binary indicator and the full five flavors cross zero, and the upper bound of 0.081 exceeds the pre-set threshold of 0.06, so the carrier designation is not met and this cannot be stated as the other flavors being useless. Fifth, lycium root bark is placed in the deficiency-heat-clearing chapter in the textbook but assigned to tonifying deficiency in the master table, the only recorded discrepancy of this kind, to be rechecked after the classification scheme is unified; whether other deficiency-heat medicinals are likewise misaligned (such as black swallowwort root, starwort root, or picrorhiza) has been checked against the master table with no corresponding entries, but a full check is still required when the classification scheme is revised. Sixth, the six excluded classes totaling 61 records have a high sweet-containing proportion and zero tonifying records; this paper gives a functional reason for their exclusion and includes them in a sensitivity analysis (odds ratios still 12–16), but the functional positioning of this group remains open to discussion. Seventh, the four-nature scale contains asymmetric jumps; this paper rechecks with the symmetric scale (the comparable calibration), where the increment is 0.025, while the signed-rank calibration runs opposite to the baseline and serves only as an upper-bound reference (0.037), not as validation. The conclusions do not depend on the specific values of the baseline scale, but a single scale that handles both intensity and direction should still be fixed. Eighth, the master table contains record-level duplication (40 groups, 82 rows, plus 2 sharpleaf galangal fruit rows); this paper reports on the record convention and provides deduplication sensitivity analyses (odds ratios 15.34, 12.87, 11.68); the 427 figure is a count of records rather than independent species and must be noted as such when cited. Ninth, in the focused 172 frame the point estimate of the four-nature increment is small (0.037), but the upper bound of its confidence interval reaches 0.106, above the 0.06 magnitude reference; the no-significant-increment wording should therefore be read as an exploratory observation anchored in the wide frame. Independent blind review is the priority going forward, and after review the analysis will be rerun under the frozen specifications.

6. Conclusions

Within the plant-frame textbook label system, the sweet flavor has strong and directionally consistent discriminative power for tonifying versus eliminating on the cold and neutral directions, where controls are available (Fisher odds ratios 17.19 and 25.0); on the hot side, 29 of 30 records tonify deficiency and the single eliminating record is non-sweet, so there is only a single eliminating record, insufficient as a control, and the side is not testable, and neither the earlier hot-direction dominance nor the sweet-containing-by-direction interaction holds on that side. The four natures add no significant independent increment beyond the five flavors: in the 366 frame the combined model exceeds the five flavors alone by only 0.010, with increments of 0.010 and 0.025 under the comparable calibration (0.037 under the reversed-direction calibration, for reference only), none reaching the magnitude reference of 0.06; the standalone discriminative power of the four natures falls from 0.644 to 0.599 under the symmetric scale, and the direction-reversed calibration corrects to 0.557 measured as max(AUC, 1 - AUC). When the frame is widened to 391 and 427, the sweet-flavor odds ratios remain 13.081 and 11.948. The single binary sweet indicator differs from the full five flavors in out-of-fold performance by 0.016 (confidence interval crossing zero, upper bound above the threshold), so the sweet flavor should be described as a strong discriminator rather than an exclusive carrier. This structure provides a verifiable, label-internal empirical basis for defining usage levels through the continuous spectrum of property predilection in medicine–food homology settings, and it will be reconfirmed under the frozen specifications after blind review.

7. Data availability and conflicts of interest

Data and material availability: the unified master table v5.1 used in this paper is a self-built database (1,045 records); analysis scripts and accounting files (v04_check, sens_check, sens_frames, dedupe_check) can be provided on reasonable request. Materials related to the planned independent blind review (including the S6 answer table and the blind-label key) are controlled internal documents and are not provided with this paper. The research protocol is not pre-registered on a public platform, and its non-confidential portions can be provided on reasonable request.

Conflicts of interest and ethics: the author is an independent researcher with no funding and no employment, consulting, or equity relationship with any commercial organization. This paper uses published literature and a self-built label database; it does not involve human subjects or animal experiments and requires no ethics approval.

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Appendix A. Frozen methodological specifications

A1. Data: unified master table v5.1; Chinese Pharmacopoeia baseline, 2020 edition; functional actions standardized by keyword rules; four-nature intensity on fixed ordered scales, cold negative and hot positive.

A2. Sample frames: out-of-fold validation restricted to the plant frame; primary analysis n = 366, focused n = 172, side-stratified diagnosis n = 136, direction frame n = 328; included analyses n = 391 and n = 427.

A3. Sweet-flavor criterion: based on sweet presence in the full flavor profile; the neutral group is reported separately and is not removed.

A4. Separation handling: complete separation treated with Firth (Jeffreys prior) plus Fisher's exact test; non-separation indicators use 1,000 bootstraps with seed 42.

A5. Sensitivity: three four-nature scales (baseline in absolute values, symmetric, signed-rank); three sample frames (366, 391, 427). The 0.06 value is the threshold set by H8 for characterizing the sweet flavor; in this section it serves only as a magnitude reference and does not constitute an independent criterion for the four-nature increment. The four-nature increment (H10, exploratory addendum) is judged by whether the 95% CI of the difference in the 366 frame contains zero, with no separate threshold.

A6. Red lines on formulation: only label-internal co-occurrence, bias, out-of-fold AUC, and directional agreement proportions are stated, not natural causation; no disease or therapeutic-effect claims are used.

A7. Record-level duplication: the 570-medicinal source contains 40 groups of duplicates sharing name, botanical source, and functional category (42 rows in the plant frame) plus 2 sharpleaf galangal fruit rows; the primary analysis counts records, and after deduplication the 366 frame has n = 330 and odds ratio 15.337, with the conclusion direction unchanged.

Appendix B. Locked hypotheses H1–H9 and exploratory addendum H10 (summary of protocol v1.7)

H1–H5 concern the companion meridian-tropism study (outcome = meridian entry, not tonifying/eliminating) and are listed here for completeness; H6–H10 are the hypotheses that pertain to this study.

H1: Hepatic meridian entry is mainly carried by the medicinal part: after controlling for nature and flavor, the conditional increment of the part is independently discernible.

H2: The lung signal lies near the decision threshold and does not constitute an independent, robust signal.

H3: The five flavors add no increment to meridian entry once cold–hot nature is known (flavor-to-meridian decoupling).

H4: The spleen is the most aligned with cold–hot in descriptive direction, but the habitat link is not significant.

H5: The eight low-confidence part annotations are the sensitivity point of the hepatic signal.

H6: Operability of the prior that deficiency-heat-clearing medicinals have weaker four-nature intensity than fire-draining medicinals.

H7: Four-nature encoding of the cold–hot direction, assessed by out-of-fold AUC.

H8: Sweet flavor as the carrier of tonifying action within the textbook label system; reclassified in this paper as a strong discriminator.

H9: Interaction between sweet-containing status and cold–hot direction; recharacterized as no robust interaction evidence.

H10: The four natures add no significant independent increment beyond the five flavors for tonifying action (exploratory addendum; not among the first nine hypotheses). The full protocol v1.7 can be provided on reasonable request.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

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- Codepackage.zip