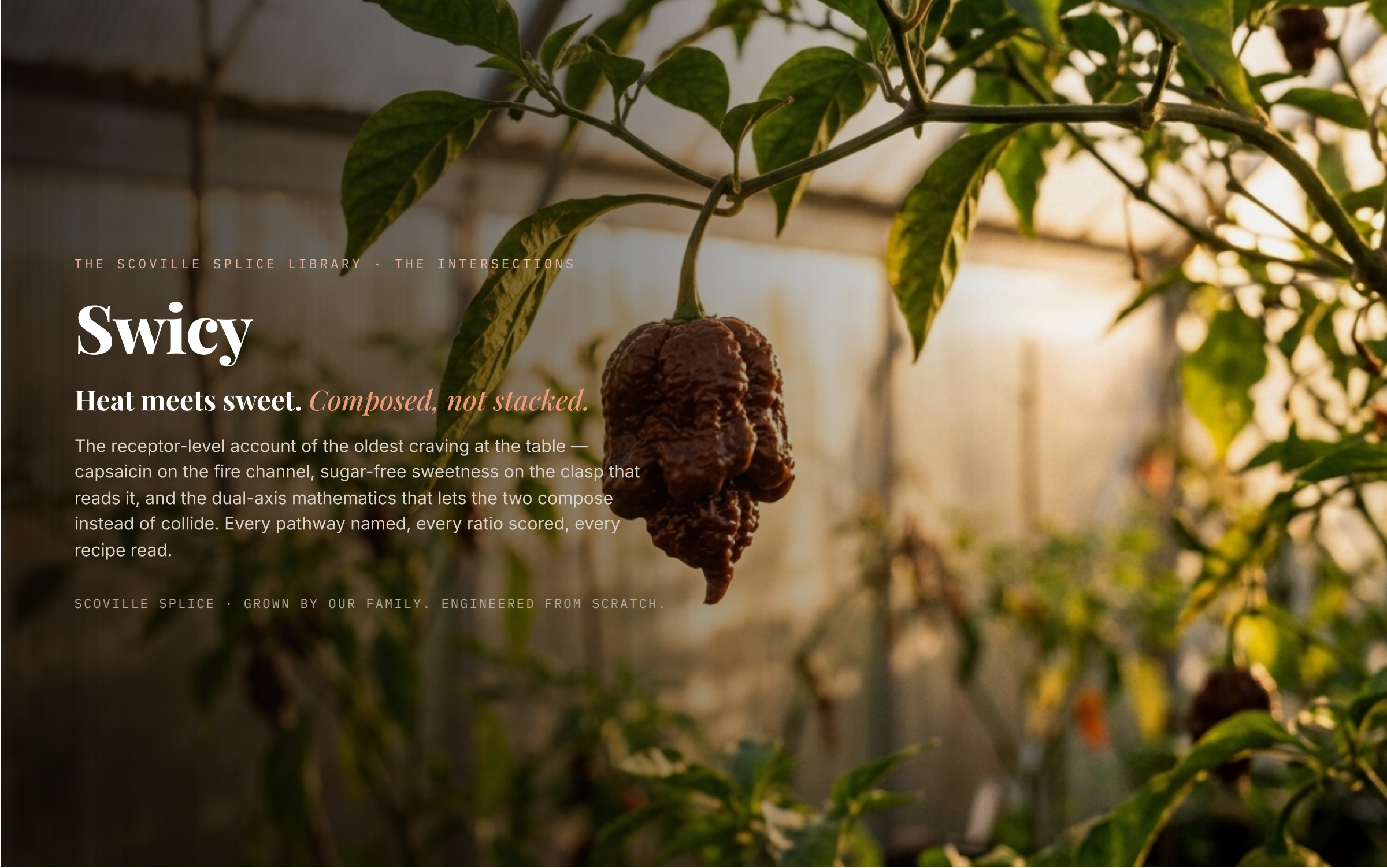

THE SCOVILLE SPLICE LIBRARY · THE INTERSECTIONS

Swicy

Heat meets sweet. *Composed, not stacked.*

The receptor-level account of the oldest craving at the table — capsaicin on the fire channel, sugar-free sweetness on the clasp that reads it, and the dual-axis mathematics that lets the two compose instead of collide. Every pathway named, every ratio scored, every recipe read.

SCOVILLE SPLICE · GROWN BY OUR FAMILY. ENGINEERED FROM SCRATCH.

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Opening essay · The oldest argument, settled

There is a flavor the internet named before the laboratory could. *Swicy* — sweet and spicy, said quickly, the way you'd say it with your mouth already full. Hot honey pulled in a thread across a cold slice of pizza. A square of dark chocolate with a chili that arrives a half-second late and then stays. Mango under chili salt from a street cart; a Korean table where the deep red of the gochujang is, unmistakably, also sweet. The craving is older than the word by several thousand years, and for most of that time it was the one thing about flavor that everyone agreed on and no one could explain — why a little warmth makes sweetness taste like more of itself, and why sweetness gives heat somewhere soft to land.

We are a family of scientists, and we grew up at a table where *why does this taste like this* was never a rhetorical question — someone would get up and go look. One pair of hands in this family does the computing; the whole family does the growing, the cooking, the arguing over whether a thing is finished. Swicy came to our bench the way most of our best obsessions have: an argument that would not resolve. Someone had drizzled a hot honey — a good one, floral, with a warmth that bloomed a beat after the sweetness — over a wedge of sharp cheese, and we could not agree on what made it work. Was it the heat lifting the sweet, or the sweet cushioning the heat? Three of us said three things. None of us could put a number on it. That, for us, has always been the beginning of the work.



The founders in the research greenhouse at first light — where most of our obsessions arrive before breakfast.

This is the twenty-sixth book in a library built on a single idea: that a flavor can be *measured* — not described, measured — against the half-activation of the receptor it speaks to. The Iyengar Flavor Index assigns every taste a number anchored to EC_{50}, the concentration at which a stimulus drives its receptor to half of full response. Invert that against a fixed reference, scale by a thousand, and loudness becomes a score. Eight axes. We have tuned forty-two plants to speak one or more of them on command, designed approximately 225 distinct constructs backing roughly 19,500 product SKUs, and made 1,000 of them available to order. These are computational designs; our cultivars and constructs represent computational predictions that have not been experimentally validated in a laboratory. We can read a chili and a strawberry and a jar of honey

on the same page now — and, more to the point of this book, we can read the *relationship* between two of those axes at once, which is the thing swicy has always actually been.

Because swicy is not one axis. It is two, speaking at the same instant, and they turned out to be two entirely different receptors. Heat is capsaicin finding **TRPV1**, the channel that also answers to open flame and to the warmth of a held breath. Sweetness is a duet: the **TAS1R2** and **TAS1R3** receptors clasp together, and only when both halves are moved does the brain hear *sweet*. They share no wiring. They are two separate lines run into the same dark room, and swicy is simply the instant both lines light — the tongue told two true things at once, each making the other easier to believe.

For most of history, that instant was a happy accident: a cook reaching for the honey and the chili in the same minute, tasting, adjusting, hoping the next batch landed the same. What no one could ever say was *how much*. How much warmth, how much sweetness, in what proportion, anchored to what — so that the dish tasted the way it was meant to in July and again in January, in a test kitchen and on a factory line. Swicy was a feeling we could chase and never specify. The Index does to that chase what a thermometer did to the word *hot*: it ends the guessing, not by denying the pleasure but by anchoring it. Two numbers, two receptors, one bite — and a ratio between them that you can finally write down.

And here is the thing the math reveals that the craving always knew: two axes do not simply add. Put more chili against more sugar and you do not get more swicy — you get loud, a shouting match in which neither side is understood. Receptors compete for a narrow attention; a naïve stack cancels itself into mud. What makes heat and sweet *compose* instead of collide is ratio, held exactly — and ratio is the one thing a tongue cannot measure and a model can. This book is that intersection, built one axis at a time and then composed back into one: the fire channel and the sweet clasp, the two biosynthetic pathways that feed them, the dual-axis flux mathematics that holds their proportion, and — at the end — a kitchen where all of it finally arrives on a spoon. Every page keeps the two numbers in view. Every recipe carries its scorecard. The oldest argument at the table was never really an argument. It was a partnership waiting for someone to write down the proportions.

A note we will hold through all eighteen chapters and never once break: the sweet half of swicy is, for us, the kind half, and we build it with care. We will talk about sweetness read from the shape of a signal rather than from a load of sugar, and about heat designed for the shape of its burn so you can taste all the way through it. We will talk about these as *intentions* — the way you'd talk about feeding someone you love well — and never once as a claim. There are no cures in this book, no detox, no health halo. There is fire, and sweetness, and the mathematics between them, and a jar on the counter that makes something swicy on demand.

Let us begin where swicy begins: with two receptors, and the single bite that lights them both.

Chapter 1 · TRPV1 — *the lock the fire fits.*

IFI-H · TRPV1 · the heat half

Begin with the fire, because it is the half of swicy everyone notices first and misreads most. We say a chili is *hot*, and the word is a lie the tongue tells faithfully. Nothing in a habanero is warm. The pod sitting on the cutting board is room temperature; the heat you feel when you bite it is not a measurement of its temperature but a hijacking of the machinery you use to measure temperature at all. Capsaicin does not warm the tissue. It opens a channel that reports warmth, and the brain, receiving the report, believes the fire is real — because to the channel, it is.

The channel is **TRPV1**, the transient receptor potential vanilloid type 1 — a non-selective cation channel threaded through the membrane of the free nerve endings of the trigeminal and sensory fibers that lace the tongue, the lips, the whole lining of the mouth. In its ordinary life TRPV1 is a thermometer with a threshold: it sits closed and quiet until the tissue around it climbs past roughly **43 °C**, at which point it opens, lets calcium and sodium pour across the membrane, and fires the nerve that your brain reads as *hot, and getting dangerous*. It is also gated by acid — by protons, the sourness of real tissue damage — so that TRPV1 is, in evolutionary terms, a small committee for reporting *things that are burning you*: heat, and acid, and, as it happens, a particular class of plant molecules that learned to speak the channel's language.



A designed chili, halved — the placental tissue running the inner wall is where the capsaicinoids are made and stored, the pale blistered ribs that carry the fire.

Capsaicin is that molecule, and it is almost suspiciously well-shaped for the job. It is a **vanilloid** — it carries the same vanillyl head group that vanilla does — attached to a long, oily, branched fatty tail. That architecture is the key cut for exactly this lock. The vanillyl head slots into a binding pocket on the inner face of the channel, between the S3 and S4 helices of the voltage-sensor-like domain, where a handful of residues — a tyrosine and a threonine the structural biologists have named and mutated and confirmed — grip the molecule and pull the gate open. Critically, capsaicin binds from *inside* the membrane: it is lipophilic, it dissolves into the fatty bilayer,

and it reaches the pocket from within. This is why water does nothing to put out a chili fire and why fat, or the casein in milk, does — the remedy has to go where the molecule went. What capsaicin does, once bound, is not add heat but *lower the threshold*: it drags TRPV1's set-point down from 43 °C to well below body temperature, so that the warmth of your own mouth, which the channel normally ignores, is suddenly read as a burn. The fire is your own body heat, finally being reported.

For the designer this mechanism is a gift, because it means heat is *tunable at the molecule*, not merely at the dose. The strength of the burn is the EC_{50} of the capsaicinoid against TRPV1 — the concentration at which it drives the channel to half of its full response — and different capsaicinoids have different EC_{50}s and, just as importantly, different *shapes* of burn: where it lands, how fast it blooms, how long it stays, how cleanly it leaves. Capsaicin itself is sharp and frontal; its near-twin dihydrocapsaicin is deeper and more persistent; the minor capsaicinoids each carry their own timing. The ratio among them — set, as we will see in Chapter 4, by the length and saturation of that oily tail — is the difference between a heat that stabs and a heat that glows. On the Index, IFI-H runs from the sunlit warmth of a shishito near **40** to the **4,200** of Phoenix, the only cultivar we have ever designed to register on all eight axes at once, behind a Scoville reading just shy of three million.

Hold one fact close, because the whole architecture of swicy rests on it: **TRPV1 is a line of its own.** It does not read sweetness; the sweet receptors do not read heat. The channel that reports the fire and the clasp that reports the sugar are wired to different nerves, transduced by different machinery, and routed to the brain as two independent facts. That independence is not a footnote — it is the entire reason swicy can be *designed* rather than merely stumbled into. It means heat and sweetness are two dials, not one slider: you can add warmth without touching the sweetness, lift the sweetness without dulling the burn. And it means the brain, receiving both signals at full strength and from separate lines, does something it can do with neither alone. We will spend a book on what that something is. It begins here, with the lock the fire fits — and in the next chapter, with the clasp that reads the honey.

Chapter 2 · The sweet clasp — *two proteins that must agree.*

IFI-S · TAS1R2·TAS1R3 · the sweet half

Now the other half, which could not be more different in temperament. Heat is a channel pried open by an oily molecule pretending to be fire. Sweetness is a handshake — and like a handshake, it requires two parties. There is no single "sweet receptor." There is **TAS1R2** and there is **TAS1R3**, two large proteins that sit in the membrane of a different set of taste cells, and only when they come together into a single clasped unit — a **heterodimer** — can the tongue report *sweet*. One protein alone hears almost nothing. The pair, joined, is the most generous and most promiscuous detector on the tongue.

Both halves belong to the **class C G-protein-coupled receptors**, a family whose signature is a huge extracellular structure called the **Venus flytrap domain** — two lobes hinged like a clam, named for the plant because they close around what they catch. TAS1R2 carries the flytrap that most sugars fall into: glucose, fructose, sucrose, and the small synthetic sweeteners such as sucralose and aspartame settle into the cleft between its lobes, the flytrap closes, and the motion is relayed down through a cysteine-rich linker to the seven-helix transmembrane bundle, where a G-protein named **gustducin** is waiting on the inner face. From there the signal runs a cascade that is worth naming because every sweet, bitter, and umami taste on the tongue shares its last steps: gustducin releases, **phospholipase C-β2 (PLCβ2)** fires, inositol trisphosphate (**IP_3**) floods the cell, calcium rises, and a channel called **TRPM5** opens to depolarize the taste cell and fire the nerve. The receptor that catches the sweetness is specific. The wire that carries it is shared. This is why the *quality* "sweet" lives entirely in the receptor and not in the nerve behind it — and why, if you can move the receptor, you can deliver sweetness by any molecule that fits, with no sugar required at all.



Sugarcane — sweetness as the plant itself makes it. The design question is never whether the clasp can be moved, but by what, and at what cost to the body that eats it.

That the clasp can be moved without a grain of sugar is the most important sentence in the sweet half of this book, so let us make it concrete, because the receptor has not one door but several. Sugars

key the flytrap of TAS1R2. The intensely sweet *proteins* — brazzein, monellin, thaumatin — do not fit any sugar's pocket; they are far too large. Instead they appear to engage the receptor the way a wedge engages a closing clam, binding across the outer surface of the flytrap and the cysteine-rich domain and stabilizing the clasp in its "closed," firing conformation. The sweet-tasting *diterpene glycosides* of stevia and the *triterpene glycosides* of monk fruit find their own footholds. And the transmembrane bundle itself has a site — where cyclamate binds, and where the sweetness blocker lactisole shuts the whole thing off. One receptor, several keyholes, and a brain downstream that cannot tell which door was opened: it hears *sweet* and asks no further questions. On the Index, IFI-S climbs from the quiet sweetness of a ripe pea near **120** to engineered stevia above **3,000** — a bright, coreless sweetness carried by a molecule the body barely metabolizes.

This is the gift the sweet half gives swicy, and it is a specific, mechanical gift: **you can raise IFI-S without raising the sugar.** For most of culinary history the sweet side of a hot-and-sweet thing was also its sugar load — the honey, the syrup, the palm sugar that makes a chili sauce drinkable. Sweetness and calories were the same dial because the only way to move the receptor was to pour sucrose at it. Design the sweetness at the source — a steviol glycoside tuned in stevia, a mogroside from monk fruit, a brazzein-class protein, the native sugars of sugarcane amplified rather than added, the sweetness bred back into a tomato or a melon — and the receptor hears sweetness in full while the body reads almost nothing of the load that sweetness used to cost. The dial comes loose from the sugar. And a dial that is loose from the sugar is a dial you can turn freely to meet a rising heat, which is exactly the freedom the composition problem in Part IV will need.

We are careful with this half, and we will say why plainly, more than once, because it is the quiet center of why we build the way we do. A sweetness read from the *shape* of a signal rather than from a load of sugar is the gentlest way we know to keep a food joyful and still kind to the body that eats it. We make no claim of it. We simply build it that way, because it is how we would want to be fed. The fire gets the attention. The sweetness does the care.

Chapter 3 · The number for two — *EC50, IFI, and reading a ratio.*

the mathematics of two axes at once

We have used the word *measured* a dozen times. Let us earn it — and then do the thing this book exists to do, which is measure not one axis but two at once, and read the relationship between them. Everything in this library hangs from one formula, and it is worth writing out slowly, because once you have it, a swicy stops being a matter of opinion and becomes a matter of coordinates.

> **IFI(candidate) = 1,000 × EC_{50}(reference) ÷ EC_{50}(candidate).**

EC_{50} is the half-maximal effective concentration — the amount of a stimulus required to drive its receptor to half of its full response. It is the honest measure of *potency*, because it asks not "how much of this compound is present" but "how little of it does the receptor need to hear it." A molecule with a low EC_{50} is loud: the receptor answers a whisper of it. A molecule with a high EC_{50} is quiet: it takes a shout. The Index inverts the candidate's EC_{50} against a fixed reference's, so that loudness — potency — becomes the thing scored, and multiplies by a thousand to put ordinary flavors in a human range. Per axis, we normalize to a ceiling of **5,000**. A score of 1,000 means the candidate is exactly as loud as the reference. A score of 2,000 means it is twice as potent — the receptor reaches half-response at half the concentration.



Reading two axes at once begins at the bench — the microscope stage where a receptor's half-response is a number before it is ever a sensation.

The reason we anchor to EC_{50} and not to "how much" is the quiet rigor beneath the whole Index, and it matters doubly here because we are about to weigh two different receptors against each other. Receptors do not respond linearly to a stimulus; they respond sigmoidally, along a dose-response curve the pharmacologists write as the **Hill equation**:

> `response = R_max × [c]ⁿ ÷ (EC₅₀ⁿ + [c]ⁿ)`

where [c] is the stimulus concentration, *n* is the Hill coefficient that sets how steeply the response climbs, and EC_{50} is exactly the concentration at which the response reaches half of R_max. EC_{50} is the one point on that curve that does *not* depend on how much stimulus a given bite happens to carry; it is a property of the molecule-meets-receptor pairing itself. Anchoring to it means a score reports how *loudly a flavor speaks*, independent of the serving — which is the only reason a chili and a honey, read on two different receptors, can be placed on one comparable scale at all. The Hill coefficient is not a footnote for swicy, either: a steep *n* means a sensation that arrives suddenly and saturates fast, and TRPV1 heat tends to be steep — it blooms and commits — while sweetness climbs more gently across a wider concentration range. "The heat comes on fast and the sweetness eases in" is not a metaphor. It is two Hill slopes, and swicy is the experience of feeling them cross.

Run the formula once on each axis so the arithmetic is concrete. These are illustrative anchors, chosen to show the mechanism, not a measurement of any shipped SKU. Capsaicin is a *loud* molecule on TRPV1 — suppose our heat reference drives the channel to half-response at an EC_{50} of 1.0 micromolar, and a designed capsaicinoid reaches half-response at 0.5 micromolar: it needs half the concentration, so it is twice as loud.

> IFI-H = 1,000 × (1.0 µM ÷ 0.5 µM) = **2,000.**

Now sweetness, where the span of the molecules is enormous. Sucrose is a *soft* sweetener — it takes a great deal of it to half-saturate the clasp, an EC_{50} up in the tens of millimolar. A sweet protein such as thaumatin half-saturates the same receptor at nanomolar concentrations — a millionfold lower, a millionfold louder by mole. This is why a pinch of a sweet protein can out-sweeten a spoon of sugar, and why "sweetness" and "sugar" are not the same quantity at all. The Index reads the loudness, not the mass, which is exactly what lets us lift IFI-S while the sugar on the label falls.

Here is the move that makes this a book about *two* numbers rather than two separate books. Once heat and sweetness are each scored on the same EC_{50}-anchored scale, they share a currency — and a shared currency lets you read a *ratio*. We teach swicy as a ratio because that is how the tongue hears it: not IFI-H 300 and IFI-S 1,500 as two separate facts, but *sweet-forward, with a clean lift of warmth underneath.* The number is the spec; the ratio is the sensation. And the ratio is legible in a way the old label never was, because the old label could only say *hot* — it had no units for the sweet side of the balance and no way to anchor the two against each other. Three archetypes, which the whole of Part IV will build out, cover most of what a kitchen or a product line actually wants:

ARCHETYPE	IFI-H	IFI-S	H : S	READS AS
Bright · sweet-led	300	1,500	1 : 5	a lift of warmth under clear sweetness
Balanced · shoulder to shoulder	900	1,000	~1 : 1	both at once, belonging to neither
Brooding · heat-led	1,800	700	~2.5 : 1	a serious burn on a sweet cushion

Read that table as reading glasses, not rules. Slide the ratio and you slide the whole experience — the same two axes, recomposed. The gift of scoring both is that you can *aim*: say which archetype you want, read back whether you hit it, and adjust the one dial that missed instead of the whole dish. But a warning the next Part will spend itself on: these two numbers are not independent, and you cannot simply dial each to its maximum and expect the sum. Receptors compete; attention is finite; two full-volume shouts are heard as noise. Which is why the real mathematics of swicy is not addition but *composition* — and composition is what a flux-balance model is for. First, though, we owe each axis its own full account: the fire, designed, and then the sweet, without the sugar.



PART II OF VI

The Heat, Designed

IFI-H · TRPV1 · capsaicin · the phenylpropanoid branch · the ten we built

Chapter 4 · From phenylalanine to fire — *the pathway, named.*

IFI-H · the capsaicinoid route

To put heat into swicy with intention — a trace of clean, well-shaped warmth rather than a heavy hand of a muddy one — you have to know exactly where heat comes from, and the honest answer is a pathway of named enzymes and named intermediates that we can read end to end. Capsaicin is not conjured. It is assembled, step by committed step, from two feedstocks the plant already makes, joined at a single enzyme in a single tissue. This chapter walks that assembly, because the whole discipline of designed heat lives in it.

Capsaicin is an **acid amide** — two halves, bonded. One half is a *vanillylamine*, an aromatic head group; the other is a *branched-chain fatty acid*, an oily tail. The genius of the molecule, and the reason it fits TRPV1 so well, is that it carries a vanilloid aromatic ring on one end and a long lipophilic chain on the other: the ring finds the binding pocket, the chain dissolves into the membrane that delivers it there. Build those two halves separately, bolt them together, and you have fire.

The aromatic half comes from the **phenylpropanoid branch** — the trunk road of plant chemistry, running in every vascular plant on earth:

STEP	SUBSTRATE → PRODUCT	ENZYME
1	L-phenylalanine → cinnamic acid	PAL (phenylalanine ammonia-lyase)
2	cinnamic acid → *p*-coumaric acid	C4H (cinnamate 4-hydroxylase)
3	*p*-coumaric acid → *p*-coumaroyl-CoA	4CL (4-coumarate-CoA ligase)
4	*p*-coumaroyl-CoA → caffeoyl shikimate	HCT (hydroxycinnamoyl transferase)
5	→ ferulic acid → **vanillin** → **vanillylamine**	COMT, then **pAMT** (aminotransferase)

Read step 5's end twice. **pAMT** — the putative aminotransferase — converts vanillin to *vanillylamine*, the aromatic head group, and it is the first enzyme on the route that is more or less specific to the heat-making plants. Everything above it is universal; this is where the pepper begins to become a pepper.

The oily half comes from **branched-chain fatty acid synthesis**, seeded by the branched amino acids valine and leucine. **BCAT** (a branched-chain aminotransferase) and a dedicated **KAS** (ketoacyl-ACP synthase) elongate a branched starter into the 8-to-10-carbon, methyl-branched acyl chain that will become the tail — most often **8-methylnonanoic acid**, the chain behind capsaicin itself.

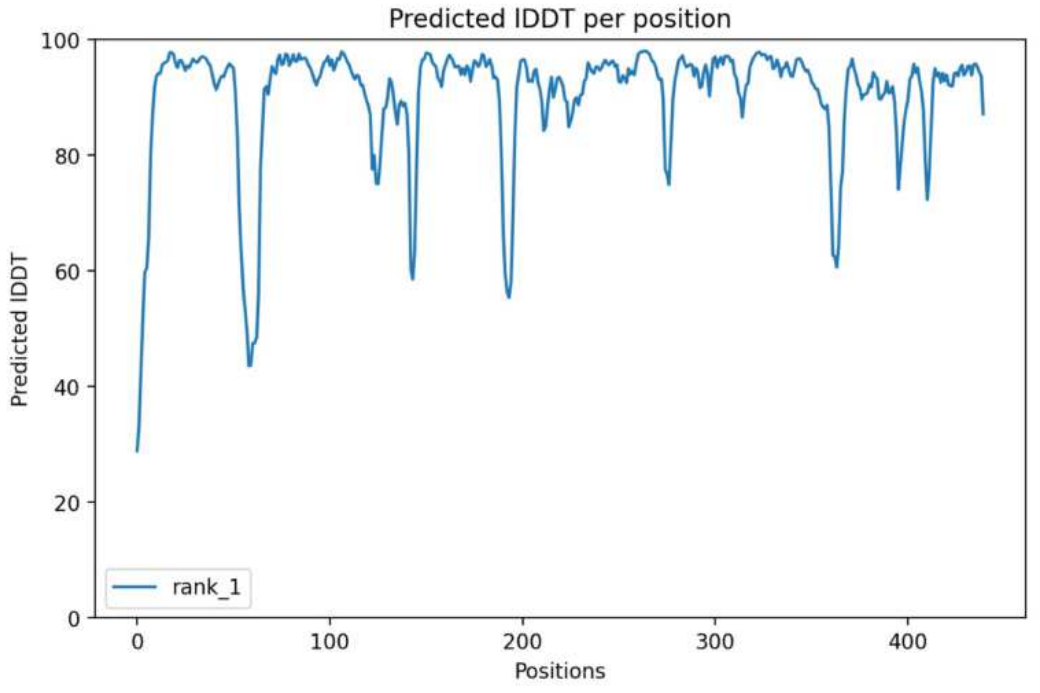


FIG. 4 — the terminal acyltransferase of the heat route, a platform fold model coloured by per-residue confidence (pLDDT); the active-site cleft, where the two halves of capsaicin are joined, resolves at high confidence.

And then the join. The two halves — vanillylamine and the branched acyl-CoA — are condensed into capsaicin by a single enzyme, the **capsaicin synthase** encoded at the **Pun1** locus (the acyltransferase AT3). This is the keystone. Pun1 is where the aromatic head meets the oily tail; a functional Pun1 is the difference between a hot pepper and a sweet one, and a pepper that loses Pun1 loses its heat entirely, which is precisely how sweet bell peppers arose in nature — a broken keystone. The reaction runs in a specialized tissue, the **placental epidermis**, the pale inner ribbing of the pod you saw in cross-section two chapters ago; the capsaicinoids are made there and secreted into blister-like vesicles on the placental surface, which is why the ribs and seeds carry most of a chili's fire.

One more fact, because it is the difference between a heat that stabs and a heat that glows, and swicy cares enormously about that difference. Pun1 does not make a single product; it makes a *family*, and which member it makes depends on the tail it is handed. An 8-methylnonanoyl tail yields **capsaicin** — sharp, frontal, fast. A straight-tail or saturated variant yields **dihydrocapsaicin** — deeper, rounder, more persistent. The minor capsaicinoids (nordihydrocapsaicin, homocapsaicin, and the rest) each carry their own timing and their own share of the burn. The *ratio* among them — set by the length and saturation of the acyl chain the fatty-acid machinery delivers — is the **shape** of the heat: where it lands in the mouth, how fast it blooms, how long it stays, how cleanly it leaves. To design heat for swicy is very often to design that ratio, because the point of the sweetness is to make the heat a pleasure, and a clean, well-shaped warmth is a pleasure where a muddy, lingering scorch is a chore. We do not only choose *how much* heat. We choose *what kind*.

That is the route, fully named: a universal aromatic branch, a branched-fatty-acid branch, a keystone acyltransferase, a specialized tissue. Every one of those is a place a model can reach in to tune — the amount of heat, and its shape. Chapter 6 is how. First, the ladder we tuned it against.

Chapter 5 · The heat ladder — *warmth with a shape.*

IFI-H · the ten flagships, and laddering down

Swicy rarely wants the top of the heat ladder, and it is worth saying plainly why: the point of the sweetness is to make the heat a pleasure, and pleasure lives lower on the rungs than most people think. The floor is the faint sunlit warmth of a shishito, an IFI-H near **40** — barely heat at all, more the memory of it. Almost all of swicy lives in the broad, generous band above that and well below the extreme: a warmth with shape, where you can taste *through* the burn to the fruit and the sugar underneath. A heat you cannot taste past is a heat that has crowded sweetness out of the room.

So what are the superhots *for*, in a book about sweet-and-spicy? Architecture, and reach. Our ten flagship cultivars — a proof-of-concept series in *Capsicum chinense* — climb a laddered scale we built gene by gene, each rung a designed step above the last, and even when a swicy product never touches their altitude, it is often built from a few drops of their precision. A measured trace of a top-rung chili carries clean, well-shaped heat into a jar of honey far more reliably than a heavy hand of a muddier pepper does. The ladder is the reference you ladder *down* from.

CULTIVAR	SKU	PREDICTED SHU	IFI-H	AXES
Ember	SS-0087	866K	1,570	2/8
Cinder	SS-0088	1.05M	2,290	3/8
Kindle	SS-0089	1.25M	2,000	3/8
Flare	SS-0090	1.48M	—	4/8
Blaze	SS-0091	1.72M	2,630	4/8
Wildfire	SS-0092	1.96M	2,930	5/8
Scorch	SS-0093	2.21M	3,220	5/8
Firestorm	SS-0094	2.47M	3,490	6/8
Solara	SS-0095	2.72M	3,980	6/8
Phoenix	SS-0096	2.95M	4,200	**8/8**



Solara, SS-0095 — the ninth rung, 2.72 million Scoville, six of eight axes expressed. A swicy maker never pours this; they borrow a few clean drops of its precision.

Notice the rightmost column, because it is the quiet thesis of the whole ladder and the reason swicy can be grown rather than merely mixed. As the heat climbs, the number of axes a cultivar expresses climbs with it — not by accident, but because the same careful flux routing that lets us specify extreme heat lets us grow *company* for it on the other pathways. A swicy designer reads that column as a promise: heat at the top of this ladder does not have to arrive alone. It can arrive already holding sweetness by the hand. That promise is kept completely only once, at the summit, where Phoenix wears all eight axes at a batch tolerance of seven percent — the full-spectrum anchor we close the book on in Chapter 18.

Two bands of this ladder do almost all the work of swicy, and they are the low ones. Call **Band 0** the warmth, IFI-H roughly 40 to 250 — a heat you can live inside, that reads as hospitality rather than challenge, the register of a good hot honey. Call **Band 1** the glow, roughly 250 to 600 — where the meal wakes up, a real and happy sting that still leaves the sweetness fully audible. Above that, from Band 2 onward, swicy gets harder to hold, because the heat begins to demand the whole stage and the sweetness has to fight for its place; it can be done, and the brooding chili-chocolate of Chapter 14 does it, but it is a composition problem, not a pour. The ladder's top exists so the bottom can be precise. We built a pepper that frightens you kindly so that a strawberry could learn to merely flirt.

A note on how we hold heat, here as everywhere in the library: it is a pleasure and not an assault. Even sourced from the top of the ladder, we design for the *shape* of the burn — where it lands, how it blooms, how cleanly it leaves — because a heat you can taste through is a heat that feeds the meal instead of ending it. That is the whole reason to ladder down from precision rather than up from a muddle: precision is kind.

Chapter 6 · Designing the burn — *ESM2, flux balance, CRISPR.*

the method, and why it makes heat gentle enough for sweetness

Here is the part people find hard to believe, so we will be concrete about every step: we design the heat *in silico*, before a single seed exists, and the plant we grow is a readout of a calculation we already trust. This is the method that founded the company — it built the ten-rung ladder of the last chapter — and five of its seven modules transfer unchanged to any genome we can sequence, which is why the same method will build the sweet half and, eventually, the single-fruit swicy of Chapter 11. For heat, the pipeline has four movements.

First, the structure. An enzyme is a shape, and you cannot reason about an edit without it. For the keystone of the heat route — the Pun1/AT3 acyltransferase that joins the two halves of capsaicin — we build a high-confidence structural model with a folding network and score every residue by local confidence (**pLDDT**) and by the predicted aligned error between domains (**PAE**). We want to know, before we touch anything, which parts are rigid scaffold, which are the flexible active-site loops, and where the substrate and the acyl-CoA actually sit. We design into the high-confidence active-site cleft and leave the floppy termini alone.

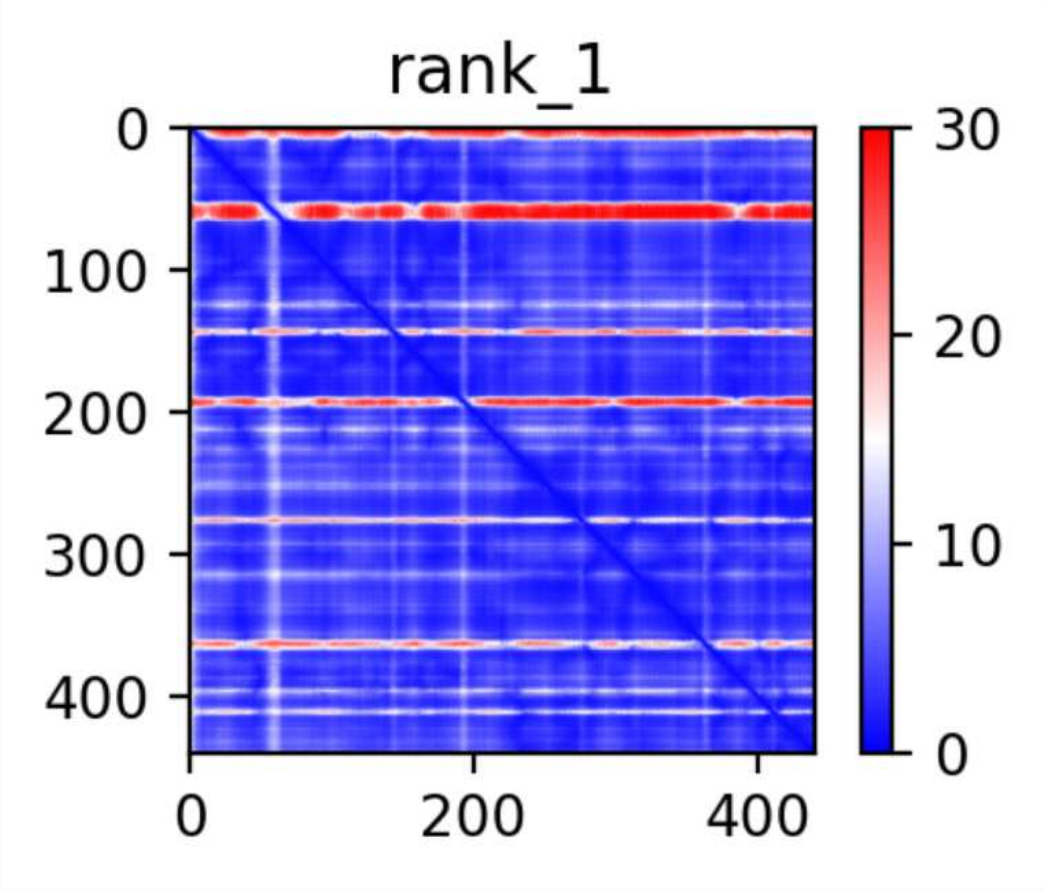


FIG. 6 — the predicted aligned error map (PAE) for the Pun1/AT3 fold: low error between the catalytic domains means the model is confident about their relative geometry, which is exactly the geometry an edit must respect.

Second, the language model. We score every possible single-residue substitution in the enzyme with a protein language model — an **ESM2-class** network of 650 million parameters, trained by

masked language modeling on the grammar of hundreds of millions of natural proteins. The model has never been told what Pun1 *does*; it has only learned what proteins *are*, and from that it estimates, for every position and every amino acid, how surprising — how destabilizing, how unnatural — a substitution would be. The **log-likelihood ratio** it assigns a variant turns out to be a remarkable zero-shot predictor of that mutation's effect, with no experimental training data at all. We fold that evolutionary-grammar score together with an explicit **ΔΔG** of fold stability computed from the structure: the grammar catches the mutations that break *function*, the ΔΔG catches the ones that break the *fold*, and their product ranks the whole landscape by the thing we actually want.

That ranking surfaced two variants in Pun1 — the double variant S39L+L345G — that no breeding program ever found, because breeding selects a phenotype and hopes the genotype followed, while we read the genotype first. In our model, the double variant is designed to lift peak output to approximately **2.95 million SHU** at a designed batch-to-batch coefficient of variation of **≤ 7%**, against 42% in conventionally bred material. A third substitution, C175S, was identified during structural modelling as a potential disulfide-misfold prevention site (ΔΔG −0.9 kcal/mol) but was not included in the final shipped construct:

VARIANT	EFFECT	ΔΔG (KCAL/MOL)
S39L	binding affinity ↑ (N-terminal)	−2.1
L345G	steric relief, active-site cleft	−1.8
C175S *(structural annotation — not in shipped construct)*	disulfide-misfold prevention	−0.9

Third, the flux check. A better enzyme is useless if it is not the step that controls the outcome, which is the job of a genome-scale **flux-balance analysis**. We write the plant's metabolism as a stoichiometric matrix **S** — a row per metabolite, a column per reaction — and impose the single steady-state constraint **S · v = 0** on the flux vector **v**, bounded by each enzyme's capacity. That leaves a whole convex space of feasible flux distributions, which we search by linear programming, and then ask the question that matters: if I push *this* enzyme, how far does the capsaicinoid pool move, and what else moves with it? The founding result of the company came from exactly this model — our flux analysis predicts control sits upstream in the phenylpropanoid pathway, at 4CL and HCT, not at the terminal Pun1/AT3 step. Pun1 is the final capsaicin synthase; it labels the product but does not govern the rate. Knowing where control sits tells us precisely where to push. For swicy the flux check earns a second, subtler keep: it lets us route a *little* extra flux cleanly, to place a low, well-shaped heat without the metabolic spillover that makes muddy, lingering burns.

Fourth, the write. The surviving edits are written with CRISPR and the plant is grown against the computational specification — the capsaicinoid budget and the capsaicin-to-dihydrocapsaicin ratio computed to deliver the designed shape of heat; and the whole eight-axis profile specified by the Index. The statistic that anchors the whole product is the designed CV. A swicy founder who orders a chili at IFI-H 320 for a hot honey needs IFI-H 320 to be the designed specification in February and in August, in this harvest and the next — because a flavor that drifts from jar to jar is not a brand, it is a rumor. Reproducibility is why designed heat is the right heat for sweetness: it is not only gentle and well-shaped, it is *the same* gentle, well-shaped warmth by design, every time, which is the only kind you can safely set against a sweetness and promise a customer.



PART III OF VI

The Sweet, Without the Sugar

IFI-S · TAS1R2·TAS1R3 · glycosides · sweet proteins · sweetness at the source

Chapter 7 · The sweet repertoire — *sugars, glycosides, proteins.*

IFI-S · the molecules that move the clasp

The fire has one feedstock and one keystone. Sweetness has a *repertoire* — a whole cast of molecules, wildly different in size and chemistry, that all fit the same clasp and all read, to the brain, as the one word *sweet*. Understanding swicy's sweet half means knowing the cast, because each member brings a different accent, a different EC_{50}, a different relationship to the sugar load, and a different cost to build. Swicy loves this variety: it means the sweet side of the balance can be chosen, not merely poured.

Start with the sugars, because they are the standard the rest are measured against. **Sucrose** is the reference sweetness of the human table — glucose and fructose joined — and it is, in receptor terms, a *soft* agonist of the TAS1R2 flytrap: pleasant, clean, familiar, but requiring a great deal of itself to half-saturate the clasp (an EC_{50} up in the tens of millimolar). That softness is why sugar is sweetness you can eat by the spoon, and also why sugar is sweetness that arrives with a heavy metabolic load — potency and calories, in sugar, are the same quantity. Fructose is louder and rounder; glucose quieter. Every honey and syrup swicy has ever used is some ratio of these three, carried with the aromatics of whatever plant made them.



Monk fruit, halved — mogroside V, a cucurbitane triterpene glycoside, delivers a sweetness hundreds of times louder than sucrose from a molecule the body barely takes up.

Now the loud ones, where potency and calories finally come apart. The **steviol glycosides** of *Stevia rebaudiana* — stevioside, rebaudioside A, and the prize, rebaudioside M — are **ent-kaurene diterpenes** dressed in sugar groups, and they key the clasp at a potency hundreds of times that of sucrose by weight while passing through the body largely unmetabolized. The **mogrosides** of monk fruit — mogroside V chief among them — are **cucurbitane triterpene glycosides** that do the same from a different scaffold. And then the extraordinary ones: the **sweet proteins**. Brazzein (54 amino acids, from a West African fruit, and remarkably heat-stable), monellin

(from the serendipity berry), and thaumatin (207 amino acids, the sweetest known thing by weight, thousands of times sucrose) do not fit any sugar pocket — they are far too large — but engage the receptor as a wedge across its outer surface, holding the flytrap in its firing conformation. A few milligrams read as a spoonful.

Here is the same repertoire as a scale of loudness and as the real engineering targets we have built against, with construct counts from the Index:

SWEET SOURCE	KEY MOLECULE(S)	ROUGH LOUDNESS VS. SUCROSE	OUR PLATFORM WORK
Sucrose (reference)	glucose–fructose	1×	the anchor
Sugarcane	native sucrose, amplified	~1× (more per plant)	Sugarcane · 200 constructs
Stevia	rebaudioside M / A	~200–350×	Stevia · 910 constructs
Monk fruit	mogroside V	~150–250×	Monk Fruit · 80 constructs
Brazzein	brazzein protein	~500–2,000×	sweet-protein route
Thaumatin	thaumatin protein	~2,000–3,000×	sweet-protein route

The practical lesson of the table for swicy is that the sweet half of the balance is not one knob but a *palette*, and the choice of molecule is a choice of character. Stevia reaches highest and cleanest — IFI-S above **3,000** — a bright, coreless sweetness with almost no body; it is the sweetness that meets a heat without adding a gram of load. Monk fruit rounds it, warmer and fruitier. Sugarcane carries the familiar sweetness of the thing itself, amplified at the source rather than added, with the plant's own soft character intact. And the sweet proteins bring a sweetness that *lingers* — their binding is slow to clear — which can be a gift or a flaw depending on the ratio you are after. A bright hot honey wants a sweetness that arrives and resolves; a brooding chili-chocolate can use a sweetness that stays and cushions. The repertoire lets you match the sweet molecule's timing to the heat's Hill slope, so the two cross in the mouth exactly when you meant them to.

One honest complication, because the voice of this library requires it: some of the loud sweeteners carry a *tail*. Crude stevioside, in particular, is famous for a bitter and licorice-like aftertaste — a real off-target, caused when the molecule also keys a couple of the bitter TAS2R receptors (notably TAS2R4 and TAS2R14) a beat after the sweetness. That tail is not sweetness; it is a second axis arriving uninvited, and it is exactly the kind of problem the platform exists to solve. The next chapter is how we erase it — and how we move sweetness from a thing you add to a thing the plant already carries.

Chapter 8 · Sweetness at the source — *restoring, amplifying, cleaning.*

IFI-S · the design of the sweet half

The deepest move in the sweet half of swicy is not to add sweetness but to *build it into the plant* — to raise IFI-S at the source, where it comes loose from the sugar load and from the off-flavors that dog the added sweeteners. Three design problems live here, and the platform has worked all three: cleaning the tail off a glycoside, amplifying a plant's native sweetness, and restoring a sweetness that modern agriculture bred out. Each is the same method from Chapter 6 aimed at a different enzyme.

Take the **tail** first, because it is the sweet half's version of "attenuation, not amputation." Crude stevioside's bitter-licorice aftertaste is a glycosylation problem: the steviol backbone is decorated with sugar groups by a series of **UGT glycosyltransferases** — UGT85C2, UGT74G1, UGT76G1, UGT91D2 — and *which* glycoside you end up with depends on which UGTs act and in what order. Stevioside, the tailed one, carries fewer glucose units; **rebaudioside M**, the clean one, is more fully glycosylated, and that extra decoration is exactly what stops it keying the bitter receptors. So the design is not to remove sweetness but to *route the glycosylation* toward Reb M — to push flux through the UGTs that build the clean molecule and away from the ones that leave the tail. We score the result on two axes at once: IFI-S up, and the bitter tail, read on the TAS2R-anchored scale, down. A sweetness with no second axis sneaking in behind it is the only sweetness you can safely hand a heat, because swicy has no room for an uninvited bitterness muddying the cross.



Tomato, restored — sweetness bred out for shelf life and shipping, grown back in through the plant's own sugar machinery. The fruit that tastes the way it is supposed to.

Now **amplification** and **restoration**, which are two faces of one idea: move the plant's own sugar economy. A fruit's sweetness is set by its **Brix** — its dissolved-sugar fraction — and by the balance of enzymes that make, store, and break down those sugars as it ripens: **sucrose synthase** and the **invertases** that interconvert sucrose and its hexoses, the transporters that load sugar into the fruit, the acids that frame how sweet the sugar reads. Modern tomato is the

cautionary tale and the proof at once. Decades of breeding for yield, uniform ripening, and shelf life quietly selected against the alleles that made a tomato *sweet and aromatic* — the trade that gives you a fruit that ships beautifully and tastes of almost nothing. The platform's tomato work, two thousand and forty constructs deep, is in large part a restoration: reading the sugar and acid and volatile machinery, finding where the sweetness was lost, and routing flux back toward it — IFI-U and IFI-S grown back into a fruit that had been engineered, by blind selection, to forget them. Sugarcane is the amplification case: a plant that is already a sucrose factory, pushed to carry more of its own native sweetness per stalk rather than handed a foreign molecule.

Why does swicy care so much about where the sweetness comes from? Because of the single mechanical fact at the center of the whole sweet half: **a sweetness designed at the source is a dial that is loose from the sugar.** When the sweet side of a hot-and-sweet product is honey or syrup, lifting IFI-S to meet a rising heat means pouring in more sugar — and the ratio you want becomes a ratio you cannot afford, nutritionally or on the label. Design the sweetness into a clean glycoside, a sweet protein, an amplified cane, a restored fruit, and the dial turns freely: you can raise the sweetness to meet any heat you like, hold the archetype you aimed for, and shed most of the load. The composition problem of the next Part — finding the exact proportion of heat to sweet that *composes* — is only solvable in practice because this chapter makes the sweet dial free to move. A ratio you cannot adjust cleanly is a ratio you cannot design to.

And this is the chapter where the quiet through-line of the whole library comes closest to the surface, so we will say it once, plainly, and then let it hum: a sweetness read from the shape of a signal rather than from a load of sugar lets a food stay joyful without asking the body to pay twice for the joy. We make no claim about that. We build it that way because it is how we would want to be fed — and because the sweet half of swicy was always, underneath the thrill, the kind half. The fire is the dare. The sweetness, built with care, is the part that takes care of you while you take the dare.



PART IV OF VI

Composing the Two

IFI-M · the dual-axis space · ratio, not sum · the single-fruit frontier

Chapter 9 · Composed, not stacked — *why two axes fight.*

IFI-M · the dual-axis design space

The temptation, every time, is to think swicy is addition: take a sweet thing, add a hot thing, and the hot-plus-sweet will be the sum. It almost never is. Two axes drawn up carelessly interfere — the sugar coats the burn and flattens it, or the heat spikes first and the sweetness arrives late and unwelcome, a guest to a party that already peaked. The sensation you were chasing is there in the ingredients and gone from the mouth. This is the oldest frustration of the swicy cook, and it is not a failure of nerve. It is a failure of ratio.

The reason is competition, and it is real at the level of perception, not just metaphor. Attention on the tongue is finite; the brain triages the signals it receives, and a flavor that arrives as two full-volume shouts gets heard as noise rather than as a chord. Recall from Chapter 3 that heat and sweetness have different Hill slopes — the burn steep and fast, the sweetness gentler and wider — so a naïve stack does not even collide *evenly*: the heat tends to arrive first and loudest, step on the sweetness while it is still climbing, and leave the sweet half perpetually a beat behind, apologizing. What reads as *composed* is not two maxima but a proportion: one axis leading, the other answering, the lead and the answer held in a ratio the palate experiences as a single, three-dimensional thing. Finding that ratio by hand means batch after batch of taste-and-adjust, and even then it drifts, because honey is not the same in two jars and a chili is not the same in two seasons.



A library, not a pile — each well a different ratio of the same two axes, mapped rather than guessed. The dual-axis space is a survey of the proportions that hold.

This is the work the **flux-balance model** does, and it is why the heat-and-sweet library is a *map* rather than a heap of experiments. Each axis is anchored by the Index — IFI = 1,000 × EC_{50}(reference) ÷ EC_{50}(candidate) — so heat and sweetness are measured in the same currency and can be weighed against each other exactly. The model then searches the metabolic space of the plant for the proportion that lands, routing flux toward one pathway and trimming another so

the ratio holds *in the cell*, batch to batch, within a coefficient of variation of seven percent or less. The dual-axis library that comes out of this is what we call **M2** — the two-axis design class, **8,400** constructs deep — and the heat-and-sweet corridor is its busiest road. Beyond it lies **M3**, the triple-axis class at **2,800** constructs, where a third axis (a cooling TRPM8 note, a savory kokumi body) joins the composition and the interference problem gets correspondingly harder.

It is worth being precise about what "composition" means on the Index, because it is the mathematical heart of the whole intersections shelf. Axes do not simply sum, and they do not simply average; they *compose*, and the composite can land above or below either axis alone depending on whether the two are coherent. A well-designed dual-axis construct — heat and sweetness whose timings and intensities were tuned to cross cleanly — reaches a composite the platform anchors at **8,400**, well above either single axis's ceiling of 5,000, because the two signals reinforce rather than mask. An *incoherent* pairing, two axes that fight for the same attention, interferes destructively and falls back toward the triple-axis floor near **2,800** — more axes present, less flavor delivered. This is the quantitative statement of the oldest swicy truth: more is not more. The composite is a function of the *relationship*, and the model optimizes the relationship, not the amounts.

> Stacking asks *how much of each?* Composition asks *in what proportion?* The first question has no good answer. The second is the only one worth engineering.

So the dual-axis library is not a pile of hot-and-sweet attempts. It is a survey of the ratios that compose — the proportions at which heat and sweetness reinforce instead of cancel — and the next chapter is how to read your position on that map and aim for the one you want.

Chapter 10 · The swicy ratio — *bright, balanced, brooding.*

reading and aiming the two numbers

Once heat and sweetness share a currency, swicy becomes legible in a way it never was on a label that only said *hot*. You read it as two numbers and, more usefully, as the relationship between them — which axis leads, and by how far. We introduced the three archetypes in Chapter 3; here we give them their full account, because naming your archetype is the first and most consequential decision in any swicy, from a weeknight drizzle to a product line.



One cultivar, read across its axes — the same two-number discipline that reads a dish reads a plant. Position on the map is a choice, not an accident.

Bright is sweet-led, the heat a lift at the finish — a ratio around 1 : 5, IFI-H to IFI-S. This is the register of hot honey and sweet chili, where the warmth is a wink rather than a dare; the sweetness carries the dish and the heat arrives at the back of the throat to make you go back for the next bite and feel it bloom again. Bright is the most forgiving swicy and the right place to start, because the wide, gentle Hill slope of the sweetness gives the steep little heat a soft bed to land on. It is also where the designed sweet dial earns its keep most obviously: a bright swicy lives or dies on a clean, load-free sweetness that can be set high without turning the thing to syrup.

Balanced is the two axes shoulder to shoulder, roughly 1 : 1 — a glaze or a sauce that reads equally of both and belongs to neither. It is the hardest ratio to hold, precisely because of the interference of the last chapter: at equal strength the steep heat wants to step on the climbing sweetness, and holding them level means tuning their *timing*, not just their amounts. This is where fermentation, which we come to in Chapter 15, quietly does the compositional work for you — a gochujang holds the balance because the ferment has already braided the heat and the sweet into a single slow-arriving thing. Balanced is the most versatile archetype when you land it and the most likely to turn to mud when you don't.

Brooding is heat-led, the sweetness a cushion the burn lands on — around 2.5 : 1 or steeper. This is chili-chocolate, a dark and serious sauce, swicy for people who came for the fire and stayed for the depth. Brooding is where swicy touches the other axes most: as the heat leads, bitterness and astringency and kokumi tend to join the composition (a dark chocolate is already four axes before the chili arrives), and the sweetness's job changes from leading to *catching* — a soft place for a heat that means it. A brooding swicy is almost always secretly a triple- or quadruple-axis problem wearing a two-axis name, which is why Chapter 14 is the most technical of the kitchen.

ARCHETYPE	IFI-H : IFI-S	HEAT BAND	SWEET SOURCE THAT SUITS IT	WATCH FOR
Bright	~1 : 5	Band 0 (40–250)	clean stevia / amplified cane — resolves fast	over-sweetening to syrup
Balanced	~1 : 1	Band 1 (250–600)	monk fruit / ferment sweetness — rounds	timing; the heat stepping early
Brooding	~2.5 : 1+	Band 1–2 (400–1,100)	sweet protein / sugar that lingers	the other axes crowding in

These are not rules; they are reading glasses. Slide the ratio and you slide the whole experience — the same two axes, recomposed. The gift of scoring both is that you can aim: say which archetype you want, read back whether you hit it, and adjust the one dial that missed instead of reworking the whole dish. Every recipe in Part V names its archetype in the readout, so you can taste the proportion and check your work against it. Learn to read these two numbers and you will never again be at the mercy of a recipe that worked once and never again — you will know *why* it worked, which is the only thing that lets you make it work twice.

Chapter 11 · The strawberry that bites back — *Sweet Heat, engineered.*

the single-fruit frontier · IFI-H × IFI-S in one cell

Everything so far has composed swicy on the plate — a hot thing set against a sweet thing, held in ratio. The frontier is to compose it in the *cell*: a single fruit that carries heat and sweetness together, grown rather than assembled. The strawberry is where we are proving it, and the reason it is possible at all is the thesis that founded this company — that the machinery of heat is not a pepper's private property.

Recall the route from Chapter 4. The **phenylpropanoid branch** — PAL → C4H → 4CL → HCT → COMT — runs in every vascular plant, the strawberry included; it is the trunk road, already there, already carrying flux. What a pepper adds, at the very end, is a short spur of terminal enzymes — **pAMT** to make the vanillylamine head, **BCAT** and **KAS** to build the branched acyl tail, and **Pun1/CS** to bolt the two together. Give a strawberry that spur, carefully and in the right tissue, and you have handed a sweet fruit the last few steps it was always only a handful of genes away from. It does not stop being a strawberry. It learns to end on warmth. This is cross-family engineering — heat leaving the nightshades entirely — and it is the hardest and most thrilling work in the swicy book, because the fruit already brings the sweetness and the aroma; we are only adding the fire, from inside.



A strawberry in cross-section — the sweet, aromatic flesh that would carry a grown-in heat from within rather than a dusted-on heat from without.

We call the line **Sweet Heat**, and it belongs to the Cross-Family tier of the Beyond-Peppers roadmap — seven to ten genes, a horizon of three to four years, the tier where the method leaves the nightshades for good. We think of it as a ladder of nerve, each rung a little bolder than the last:

RUNG	NAME	WHAT IT TASTES LIKE	ARCHETYPE IT GROWS
1	**Warm Kiss**	barely more than a flush; sweetness with a warm edge	`deep bright`
2	**Sugar Burn**	a real and happy sting inside the sweetness	`bright, bolder`
3	**Candied Fang**	sharp enough to make you laugh; heat clearly present	`toward balanced`
4	**Devil's Dessert**	the dare at the top; heat leading, fruit cushioning	`brooding, in a berry`

Sweet Heat is not alone on the tier. A **Solar** melon and a **Forbidden** apple carry the same idea into different sugars — a cooling, watery sweetness learning a low heat; a crisp, acid-bright sweetness learning a sharp one — and a *Contradiction* cucumber and an *Espionage* lettuce push the cross-family method further still. These are the fruits swicy was always reaching toward: not a sweet thing beside a hot thing, but one bite that is both, with the heat arriving from the inside of the sweetness instead of from a dusting on top.

The difference is not academic. A heat grown into the fruit shares the fruit's own timing and tissue; it reads as *part of* the sweetness rather than an argument with it — the cleanest composition there is, because the two axes were never assembled, they were grown together from the start.

We are honest about where this stands: Sweet Heat is frontier, not shelf. A fruiting plant keeps its own calendar, cross-family flux balance is genuinely hard, and we hold the single-fruit swicy to the same CV ≤ 7% and the same eight-axis honesty as everything else before it ships. But the design is written, the method is proven on the ten-rung heat ladder and on forty-two restored and amplified hosts, and the only thing between the calculation and the berry is the patience a plant demands. In the meantime, the kitchen composes swicy the way cooks always have — a sweet thing and a hot thing, held in ratio — only now with both numbers in view and a clean, free sweet dial to turn. That kitchen is the next Part, and we have kept you from it long enough.



PART V OF VI

The Swicy Kitchen

bright · balanced · brooding · the sweet-hot cuisines · a pantry to keep

Chapter 12 · Bright swicy — *the gateway, sweet-led.*

Band 0 heat · a lift of warmth under clear sweetness

If swicy has a front door, it is a jar of hot honey, and there is a reason it converted the world so fast. Honey is sweetness that already smells like somewhere — clover, orange blossom, the particular field it came from — and chili is warmth looking for exactly that kind of company. The two meet in the *bright* register: sweetness clearly in the lead, heat a lift at the back of the throat that makes you go back for the next bite to feel it arrive again. It is the most forgiving swicy there is, which is why it is where everyone should start, cook and formulator alike. Three bright recipes follow; each names its archetype and shows its ratio, so you can taste the proportion and read it in the same breath.

Our Hot Honey

Makes one jar · 20 minutes plus an overnight · the thing we keep on the counter

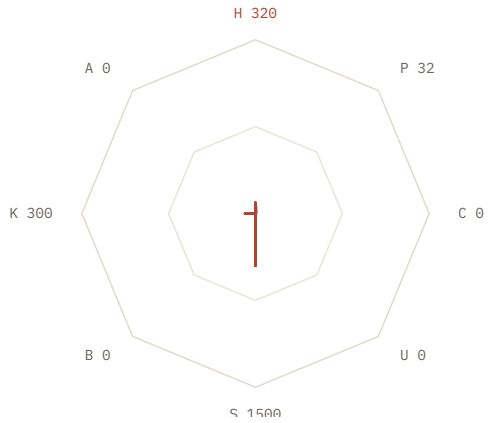
The whole craft is restraint. You want the honey to stay honey, carrying a warmth that blooms *after* the sweetness, not before it. We use a gentle designed chili — IFI-H around **300**, clean-shaped heat with no bitterness to muddy the gold — and we steep rather than boil, because heat drives the aromatics off the honey and we want them kept.

250 g		good honey (a floral one — orange blossom is our house pick)
2	tsp	mild designed chili flake (IFI-H ~300), or to taste
1	pinch	flaky salt
1	tsp	cider vinegar

1. Warm the honey gently in a small pot until it just loosens and flows — no hotter than a bath you'd sit in. Do not let it simmer.
2. Stir in the chili flake and the salt. Pull it off the heat the moment it is combined.
3. Let it steep, off the heat, until it cools — then cover and leave it overnight. The warmth settles into the honey slowly and evenly, the opposite of what boiling would do.
4. Stir in the vinegar in the morning — a quiet brightness that makes the heat read cleaner. Strain if you want it smooth; leave the flake in if you want it to keep building. It keeps for months.

Why it works — Honey carries IFI-S near 1,500 on its own, so the sweetness needs no help; the work is placing a small, well-shaped heat *behind* it. Steeping instead of boiling keeps the chili's capsaicin — which is heat-stable — while sparing the honey's volatile aromatics, which are not. The vinegar does not add an axis; it sharpens the edge where the two you have already meet. Textbook bright: the honey leads by a length.

IFI PROFILE



IFI-H	320
IFI-P	32
IFI-C	0
IFI-U	0
IFI-S	1,500
IFI-B	0
IFI-K	300
IFI-A	0

*Archetype: **bright** (sweet-led), ~1 : 5. Drizzle on anything that can take a wink of fire — a cold slice, a wheel of soft cheese, roasted carrots, the rim of a glass.*

Sweet Chili Dipping Sauce

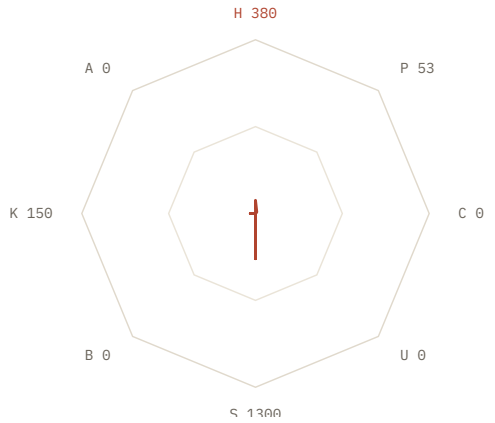
Makes a small jar · 25 minutes · the clear red one, done clean

120	ml	water
80	g	designed sweetener (or light palm sugar)
60	ml	rice vinegar
2	tsp	mild designed chili flake (IFI-H ~350)
2	cloves	garlic, grated · 1 tsp grated ginger
1	tsp	cornstarch slurried in 1 tbsp water · pinch salt

1. Bring the water, sweetener, and vinegar to a gentle simmer until the sweetener dissolves clear.
2. Add the chili, garlic, ginger, and salt; simmer four minutes so the aromatics bloom.
3. Stir in the slurry and cook one minute more, until it turns glossy and just coats a spoon. Cool — it thickens as it sits.

Why it works — This is bright swicy with the sweet dial lifted *off* the sugar: a designed sweetener carries IFI-S high while shedding most of the load a classic sweet-chili pours in, so the sauce stays bright and clinging without being cloying. The garlic and ginger add a flicker of TRPA1 pungency at the front — a quick sharpness that clears the way for the slow sweetness behind.

IFI PROFILE



IFI-H	380
IFI-P	53
IFI-C	0
IFI-U	0
IFI-S	1,300
IFI-B	0
IFI-K	150
IFI-A	0

*Archetype: **bright**, ~1 : 3.5. Spring rolls, crisp tofu, grilled anything, a spoon.*

Mango, Chili, Lime

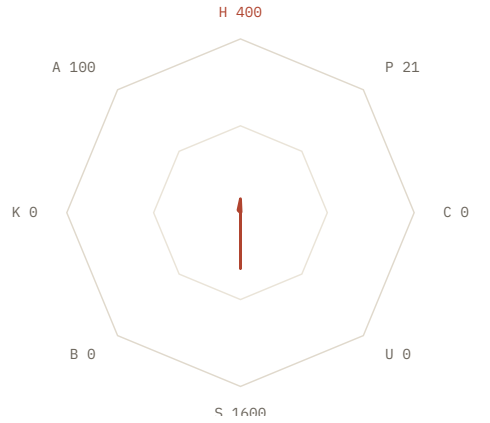
Serves 4 · 10 minutes · the street-cart idea, scored

```
2  ripe    mangoes, in thick batons
1  tsp     mild designed chili flake (IFI-H ~400)
            flaky salt · juice of 1 lime · a little lime zest
```

1. Lay the mango on a plate in a single generous layer.
2. Scatter the chili, a good pinch of salt, and the zest across the top.
3. Squeeze the lime over just before serving, so the fruit stays bright and firm.

Why it works — The mango brings a loud, aromatic sweetness (IFI-S high, and *fragrant*, which is the version swicy loves most); the chili sets a low warmth against it; the lime's acid lifts both and keeps the sweetness from going flat. Almost nothing to it, and almost impossible to get wrong — the clearest proof that bright swicy is a ratio, not a recipe.

IFI PROFILE



IFI-H	400
IFI-P	21
IFI-C	0
IFI-U	0
IFI-S	1,600
IFI-B	0
IFI-K	0
IFI-A	100

*Archetype: **bright**, ~1 : 4. Pineapple, green mango, watermelon, jicama — any sweet, firm fruit takes the same treatment.*

Chapter 13 · Balanced swicy — *shoulder to shoulder.*

Band 1 heat · both at once, belonging to neither

Balanced is the hardest archetype and the most useful when you land it — the two axes level, a glaze or a sauce that reads equally of heat and sweet and belongs to neither. The difficulty, as Chapter 10 warned, is timing: at equal strength the steep heat wants to arrive first and step on the climbing sweetness. The fix in a live kitchen is almost always to recruit a *third* thing that slows the heat's arrival and braids the two together — fat, ferment, or a long reduction. These recipes each do that, and one of them hands the problem to a ferment entirely.



Eggplant — the vegetarian's favorite canvas for a balanced glaze, its creamy flesh carrying a sauce without competing with it.

Gochujang-Glazed Eggplant

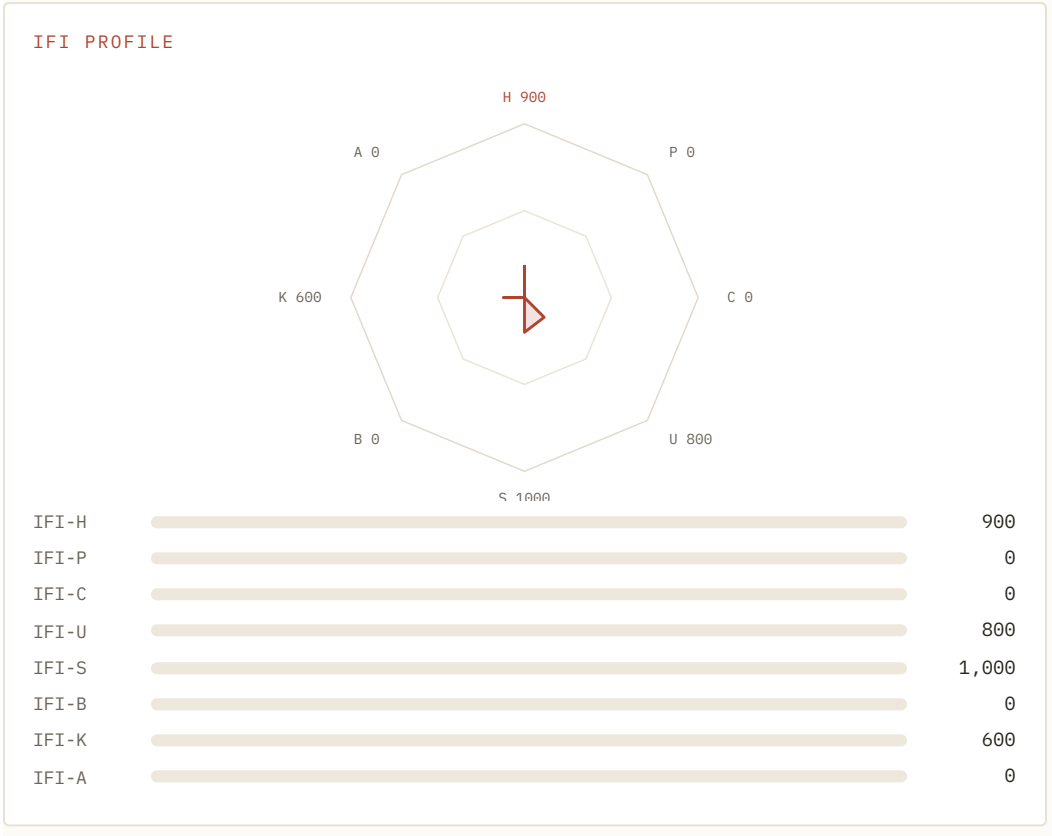
Serves 4 · 30 minutes · the balanced archetype, on a plate

2	large	eggplants, in thick half-moons
2	tbsp	gochujang
1	tbsp	honey or designed sweetener
1	tbsp	soy sauce · 1 tsp rice vinegar · 1 clove garlic, grated
		neutral oil · sesame · scallion

1. Salt the eggplant and let it sit ten minutes; pat dry. This is the step that makes it silky instead of spongy.
2. Sear the pieces in a hot, oiled pan until deeply gold on both faces, then lower the heat and let the insides go creamy.
3. Whisk the gochujang, honey, soy, vinegar, and garlic into a loose glaze. Spoon it over the eggplant and let it bubble and cling two minutes.
4. Finish with sesame and scallion. It should read equally of sweet and heat, the ferment humming under both.

Why it works — Gochujang is already a multi-axis object: heat from the chili, sweetness from the grain, and a fermented umami-and-kokumi depth a fresh sauce can't fake. The ferment holds the heat and sweet shoulder to shoulder *for* you — it has already braided

them into one slow-arriving thing — which is why the balanced archetype, so hard to hold by hand, comes naturally to the sweet-hot ferments.



*Archetype: **balanced**, ~1 : 1, with umami and kokumi along for the ride. Over rice, in a bowl, folded into greens.*

Pineapple-Habanero Glaze

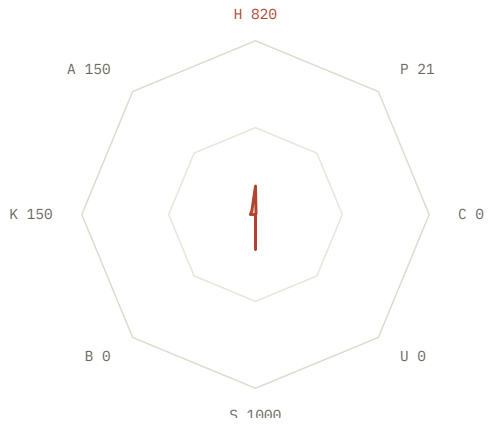
Makes one jar · 25 minutes · balanced, with the heat a half-step up

```
200 g      pineapple, puréed · 60 g designed sweetener
1          designed habanero-type chili, seeded and minced (or IFI-H ~800 flake, ½ tsp)
60 ml      cider vinegar · 1 tsp grated ginger · pinch salt
```

1. Simmer the pineapple, sweetener, and vinegar fifteen minutes, until reduced and jammy.
2. Add the chili, ginger, and salt; simmer five minutes more.
3. Blend smooth if you like, or leave it rustic. It should taste equally of fruit and fire.

Why it works — Pineapple's acid and loud sweetness can carry a bolder heat than honey can, which lets the ratio sit near even. The reduction is doing the timing work here: cooking the fruit down thickens the glaze so it clings, which slows the heat's delivery and lets the two cross evenly on the palate instead of the heat racing ahead. A *designed* habanero-type brings the fruit-forward heat of its species without the muddy, lingering scorch of an uneven pod.

IFI PROFILE



IFI-H	820
IFI-P	21
IFI-C	0
IFI-U	0
IFI-S	1,000
IFI-B	0
IFI-K	150
IFI-A	150

*Archetype: **balanced**, ~1 : 1.2. Brush on roasted squash, grilled halloumi, or — written with equal respect — on fish or chicken toward the end of the cook.*

Swicy-Glazed Salmon

Serves 4 · 20 minutes · the same balance, on seafood

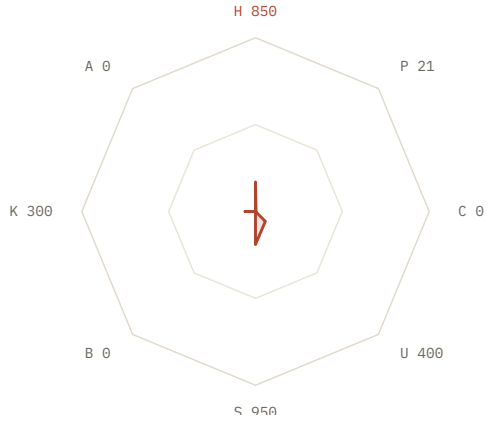
We cook plant-first in this family, and we cook fish with the same care we give a vegetable — no apology either way. Salmon's richness is a natural cushion for a balanced swicy; the fat slows the heat and lengthens the sweet.

```
4          salmon fillets, skin on
3  tbsp    sweet chili sauce (Chapter 12) or pineapple-habanero glaze
1  tbsp    soy sauce · 1 tsp grated ginger · 1 tsp lime juice
            neutral oil · scallion · sesame
```

1. Pat the fillets dry; season. Sear skin-side down in a hot, oiled pan until the skin is crisp and the fish is three-quarters cooked up the side.
2. Whisk the glaze with the soy, ginger, and lime. Turn the fish, spoon the glaze over, and let it bubble and lacquer one to two minutes.
3. Finish with scallion and sesame. The glaze should read equally sweet and hot against the rich fish.

Why it works — Fat is the third element that makes balance easy here: the richness of the salmon slows the heat's steep arrival and carries the sweetness long, so the two sit level without any trick of timing. The lime keeps it from going heavy. Equal parts of two axes, held by the fish itself.

IFI PROFILE



IFI-H		850
IFI-P		21
IFI-C		0
IFI-U		400
IFI-S		950
IFI-B		0
IFI-K		300
IFI-A		0

*Archetype: **balanced**, ~1 : 1.1. Firm tofu or king oyster mushrooms take the identical glaze and the identical readout — the balance belongs to the sauce, not the protein.*

Chapter 14 · Brooding swicy — *heat through the dark.*

Band 1–2 heat · a serious burn on a sweet cushion

Brooding is the *heat-led* end of swicy, and it is the one that teaches you the most, because at this ratio swicy stops being a two-axis problem and reveals itself as the multi-axis problem it secretly was. Chili-chocolate is the canonical case: a good dark bar is already four axes at once — sweetness, yes, but also the bitterness of the cacao, the tannic grip of astringency, and the deep kokumi roundness that makes chocolate feel like it fills the whole mouth. Drop heat into that and you are composing not two axes but five, which is exactly why it feels so complete when it lands and so harsh when it misses.



Cacao — the brooding partner. A dark bar is four axes before the chili arrives; swicy at this end is really a five-axis composition wearing a two-axis name.

The trap is that heat and bitterness reinforce each other's sharp edges — add chili to a punishing dark chocolate and you get two assaults, not a composition. The designed fix is subtraction, and it is the subject of this book's companion volume, *Zero-Bitter*: cacao's bitterness answers to the **TAS2R** receptors, and the platform attenuates it — twenty to sixty-five percent — by rerouting the methylxanthine and polyphenol load at the enzymes, without touching what makes cacao taste like cacao. Pull the bitterness down, and suddenly there is room for the heat to be a pleasure and for the sweetness to be heard. The astringency we leave: a little tannic grip is the backbone the whole thing hangs on.

Dark Chocolate, Chili, Flaky Salt

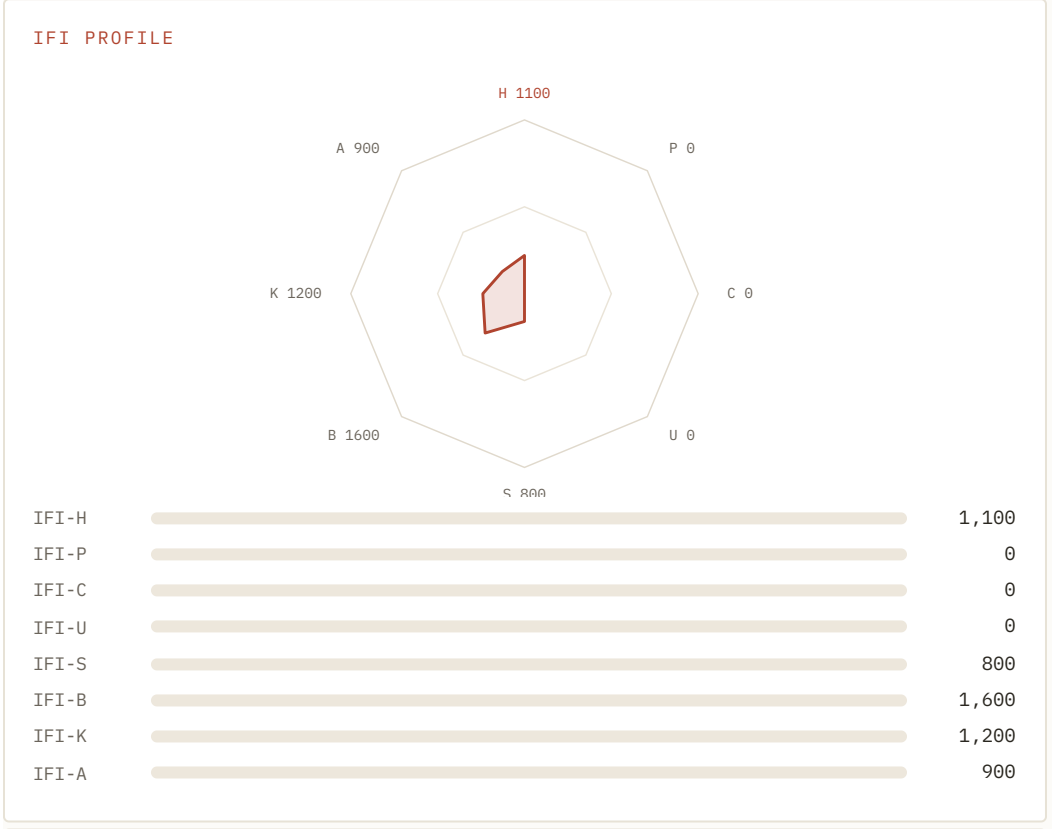
Makes a small slab · 30 minutes plus setting · the one we break off in the evening

```
200 g      dark chocolate, 70% (a low-bitter one if you have it)
0.5 tsp    mild designed chili flake (IFI-H ~300)
1  pinch   smoked flaky salt
1  tbsp    cacao nibs, for grip and sound
```

1. Melt two-thirds of the chocolate slowly over a bare whisper of heat. Off the heat, stir in the rest until smooth and slightly cooled — a rough temper, enough for a clean snap.
2. Stir in half the chili. Pour the chocolate thin onto parchment.

3. Scatter the nibs, the rest of the chili, and the salt across the surface while it is still wet.
4. Let it set at cool room temperature — not the fridge, which dulls the snap and the aromatics both. Break it into shards.

Why it works — With the cacao's bitterness turned down at the source, the heat lands on sweetness and body instead of on an existing sharpness, so it reads as warmth blooming through the dark rather than a second sting. The astringency, left in, gives structure; the kokumi gives length. The salt is the pin that holds it together.



*Archetype: **brooding** (heat-led), ~1.4 : 1 over the sweet — but read how many axes are in play. This is nearly the whole Index, folded into a square.*

Chili-Chocolate Pots de Crème

Serves 6 · 20 minutes plus chilling · brooding, made tender

200 g	dark chocolate (70%, low-bitter), chopped
300 ml	cream · 100 ml whole milk
2	egg yolks · 1 tbsp designed sweetener
0.5 tsp	mild designed chili flake (IFI-H ~350) · pinch salt

1. Warm the cream, milk, chili, and salt to a bare simmer; pull off and steep ten minutes, then strain.
2. Whisk the yolks and sweetener; temper in the warm cream; return to low heat and stir until it coats a spoon.
3. Pour over the chopped chocolate, wait a minute, whisk smooth. Pour into cups and chill four hours.

Why it works — Custard is a kindness to brooding swicy: the fat and the cool temperature stretch the heat out long and slow, so a Band 1 chili reads as a deep, late warmth rather than a sting. The sweetness, lifted off sugar by the designed sweetener, cushions without cloying; the attenuated bitterness keeps the dark serious but not punishing.

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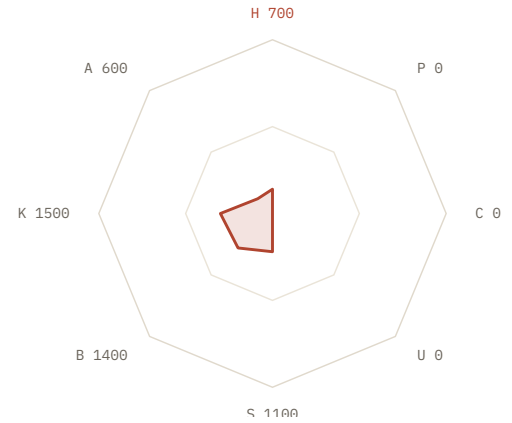

IFI-H		700
IFI-P		0
IFI-C		0
IFI-U		0
IFI-S		1,100
IFI-B		1,400
IFI-K		1,500
IFI-A		600

*Archetype: **brooding**, but softened toward balanced by the dairy — the heat leads, the body catches. A scrape of orange zest is welcome.*

A Brooding Table Sauce

Makes one jar · 40 minutes · heat-led, deep, for pouring over serious food

4	dried mild-dark chilies (ancho-type), stemmed and seeded
1	designed hot chili, to taste (IFI-H ~1,200), for the lead
200 ml	tomato purée · 60 g designed sweetener · 30 g dark chocolate
2 cloves	garlic · 1 tsp cumin · 1 tsp smoked paprika · 60 ml cider vinegar · salt

1. Toast the dried chilies in a dry pan until fragrant, then soak in hot water fifteen minutes.
2. Blend the soaked chilies with the tomato, garlic, spices, and vinegar until smooth.
3. Simmer twenty minutes with the sweetener; stir in the chocolate and the designed hot chili at the end; season. It should lead with heat and finish deep and faintly sweet.

Why it works — This is swicy at its most *brooding*: heat clearly in front, with bitterness (chili skins, cacao), astringency, and umami (tomato) crowding in behind, and the sweetness held low as a cushion. The chocolate is not for sweetness — it is for kokumi and length, the body that keeps a hot sauce from being merely sharp. A trace of a high, clean designed chili sets the heat's *shape*; the dried chilies set its *color*.

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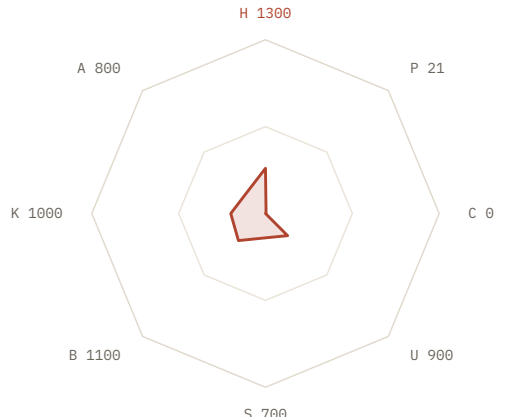


IFI-H		1,300
IFI-P		21
IFI-C		0
IFI-U		900
IFI-S		700
IFI-B		1,100
IFI-K		1,000
IFI-A		800

*Archetype: **brooding**, ~2 : 1 over the sweet. Over roasted sweet potato, charred cauliflower, braised beans — or, with equal respect, over slow-cooked meat.*

Chapter 15 · Swicy around the world — *the sweet-hot cuisines.*

balance as architecture · what the ferments already knew

The rest of the world has been composing swicy, formally and for centuries, in the great sweet-hot cuisines — and they did it by treating balance as the dish's whole architecture, long before anyone could name a receptor. A Thai sauce is sweet, hot, sour, and salt held in a tension so exact that pulling any one strand slackens the others. A Korean table runs on gochujang, where fermentation has folded sweetness and heat and deep savor into a single red paste. A Sichuan chili crisp sets heat against a numbing cool and a whisper of sugar. A Mexican tamarind-chili candy leads with sour and sweet and finishes on fire. These kitchens solved by palate and patience what the Index now lets us solve by specification: the proportion that holds.



Ginger — the bright TRPA1 lift that opens so many sweet-hot cuisines, a sharp front note that clears the way for the slow sweetness behind.

What our tools add is not a better instinct — those cooks' instincts are the standard we measure against — but repeatability and a cleaner sweetness. A sweet-heat glaze usually leans on a heavy pour of sugar to carry it; design the sweetness at the source and the glaze keeps its balance while shedding most of that load, and the ferment's umami is free to come forward instead of being buried under syrup. There is a real mechanism under why the ferments hold balance so well, and it is worth naming: fermentation does not just add flavor, it *changes the timing*. Microbes break proteins into glutamates (umami, mGluR1) and build γ-glutamyl peptides (kokumi,

CaSR), and those slow, broad, modulating axes act like a brake on the steep heat — they give the capsaicin a long, savory bed to land on, so the sweet and the hot arrive together instead of the heat racing ahead. The ferment is a timing device. That is why the balanced archetype, nearly impossible to hold with fresh sugar and fresh chili, comes naturally to a paste that has been breaking itself down for months.

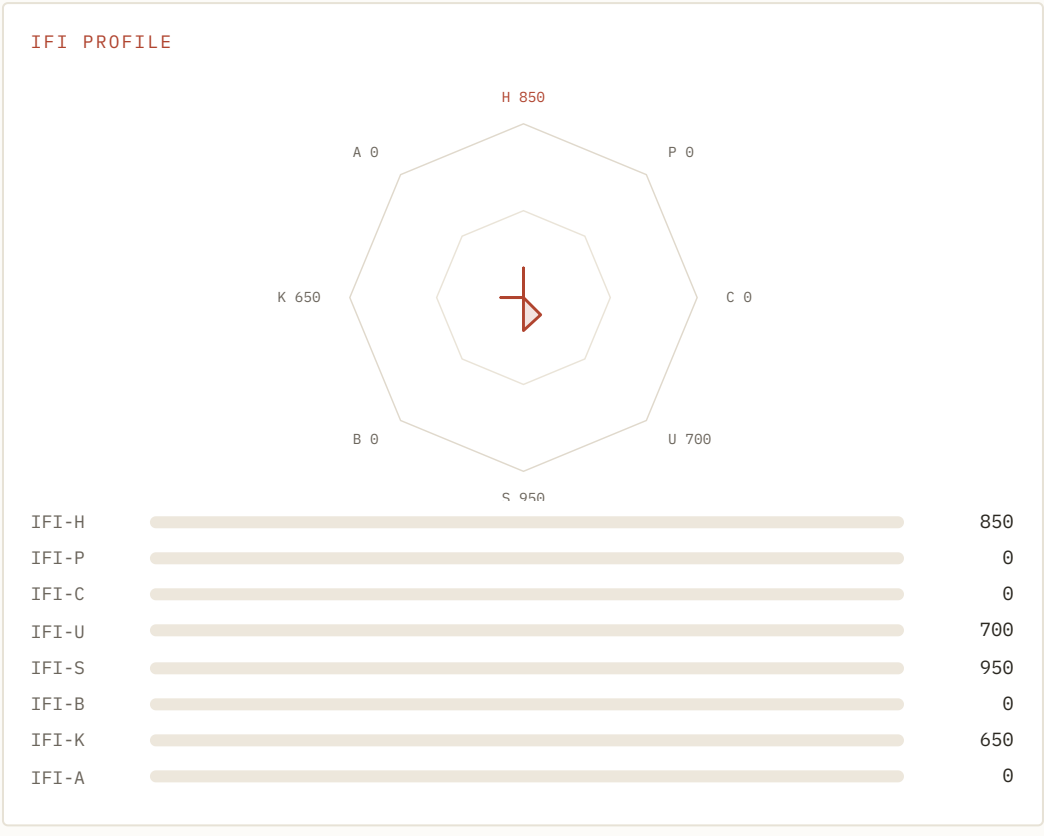
Gochujang Butter-Glazed Cauliflower

Serves 4 · 35 minutes · the Korean balance, plant-first

```
1  large   cauliflower, in thick wedges
2  tbsp    gochujang · 1 tbsp honey or designed sweetener
1  tbsp    soy · 1 tbsp butter · 1 clove garlic, grated · 1 tsp rice
vinegar
            sesame · scallion
```

1. Roast the cauliflower wedges at high heat until deeply browned and tender at the stem, about twenty-five minutes.
2. Melt the butter with the gochujang, honey, soy, garlic, and vinegar into a glossy glaze.
3. Toss the roasted wedges in the warm glaze; return to the oven five minutes to lacquer. Finish with sesame and scallion.

Why it works — Roasting builds a browned, almost meaty depth in the cauliflower that stands up to the ferment; the butter carries the heat and lengthens it; the gochujang holds the heat and sweet level by itself. Written vegetarian-first — and the identical glaze lacquers chicken wings with equal respect, the ferment doing the same balancing work on either.



*Archetype: **balanced**, ~1 : 1.1. A whole roasted cauliflower, glazed this way and carved at the table, is a centerpiece.*

Thai-Style Sweet-Hot-Sour Glazed Tofu

Serves 4 · 25 minutes · four strands in tension

400 g	firm tofu, pressed and cubed · cornstarch to dust	
3 tbsp	designed sweetener · 3 tbsp tamarind paste · 2 tbsp soy	
2 tsp	mild designed chili flake (IFI-H ~500) · 2 cloves garlic · neutral oil	
	thai basil · lime	

1. Dust the tofu in cornstarch and pan-fry until crisp on all sides; set aside.
2. Simmer the sweetener, tamarind, soy, chili, and garlic into a loose caramel.
3. Toss the crisp tofu through to coat; finish with torn basil and a squeeze of lime.

Why it works — Thai balance is a four-way tension, and the IFI reads three of them: sweet (loud, and lifted off sugar), heat (a Band 1 glow), and the sour of the tamarind framing both. Hold any two and the dish is good; hold all three against the salt and it sings. The sweetener does the job sugar usually does here — carrying the caramel — without the load.

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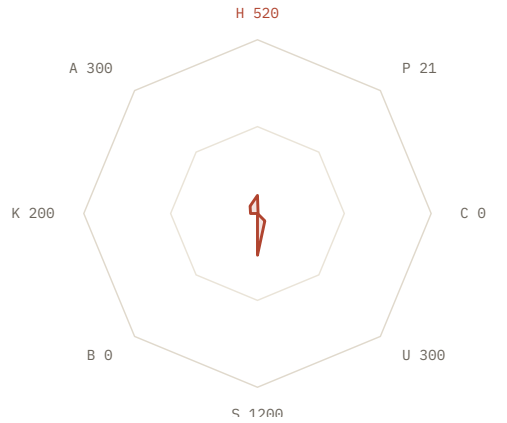


IFI-H	520
IFI-P	21
IFI-C	0
IFI-U	300
IFI-S	1,200
IFI-B	0
IFI-K	200
IFI-A	300

*Archetype: **bright-to-balanced**, ~1 : 2.3, with a loud sour frame. Over rice or rice noodles; the crisp tofu is the point.*

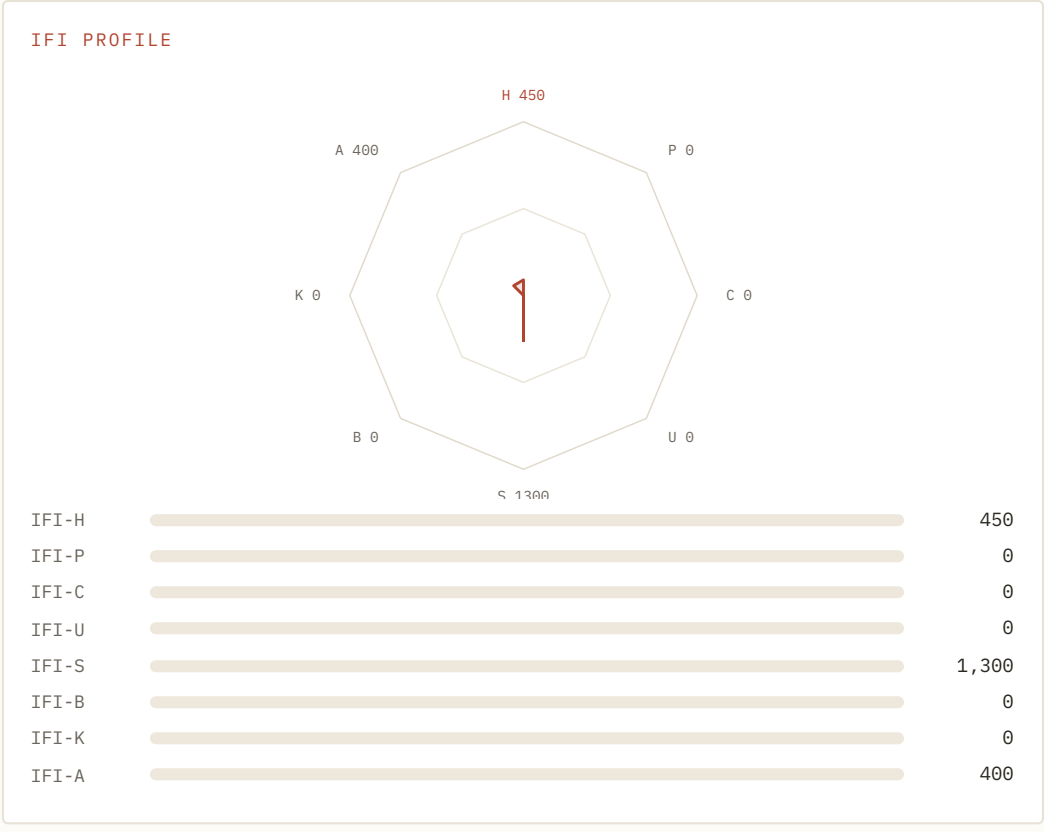
Tamarind-Chili Fruit, Chamoy-Style

Serves 6 · 15 minutes · sour-sweet leading, fire behind

60 g	tamarind paste · 40 g designed sweetener · juice of 2 limes
2 tsp	mild designed chili powder (IFI-H ~450) · 1 tsp flaky salt
800 g	firm fruit (mango, pineapple, jicama, cucumber), in spears

1. Whisk the tamarind, sweetener, lime, half the chili, and half the salt into a loose, pourable sauce.
2. Arrange the fruit; pour the sauce over; dust with the remaining chili and salt.
3. Eat at once, while the fruit is cold and firm and the sauce is bright.

Why it works — The Mexican sweet-sour-chili tradition leads with tamarind's sour-sweet and lets the heat arrive last, a slow warmth under a bright, mouth-watering sauce. It is bright swicy with a loud astringent-sour frame — the clearest proof that swicy is rarely *only* two axes; the sour and the salt are what make the sweet and hot legible.



*Archetype: **bright**, ~1 : 3, sour-framed. The sauce keeps a week; the fruit is best cut to order.*

Chapter 16 · A swicy pantry — *the jars within reach.*

condiments · the building blocks of composition

Swicy's native form is the condiment — the jar within reach that makes something swicy on demand — and a good swicy pantry turns the whole book from a set of recipes into a reflex. Make these once and dinner becomes a matter of reaching, not cooking. Each is a composition you can read and adjust: learn the ratio, and you can shift any of them bright or brooding by moving one dial.



Garlic — the quiet backbone of the pantry, a flicker of TRPA1 pungency that frames heat and sweet without competing with either.

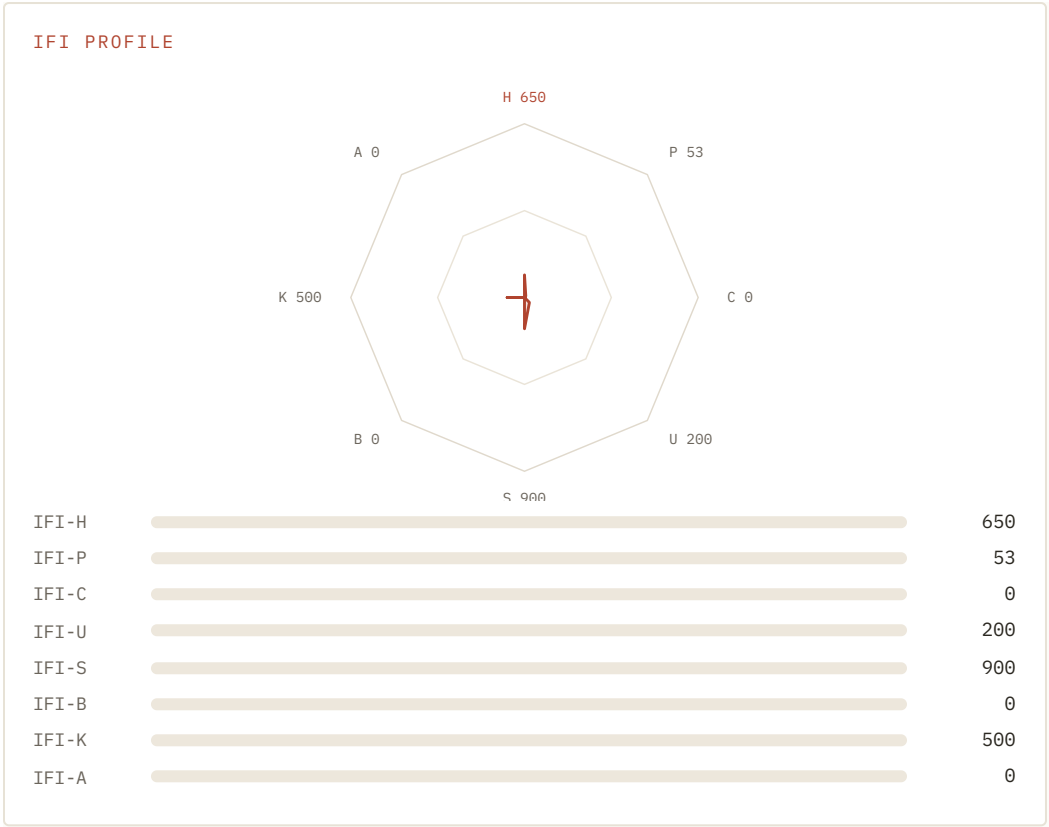
Sweet-Heat Chili Crisp

Makes one jar · 25 minutes · the one that disappears fastest

120 ml		neutral oil
3	tbsp	mild designed chili flake (IFI-H ~300)
2	tbsp	designed sweetener or light honey
2	cloves	garlic, sliced thin
1	tbsp	soy sauce · 1 tsp toasted sesame · pinch salt

1. Fry the garlic slices gently in the oil until pale gold, then lift them out before they darken — bitterness is the one axis you do not want here.
2. Take the oil off the heat and let it cool a full minute. Pour it, still warm, over the chili flake in a heatproof bowl; it should sizzle softly, not scorch.
3. Stir in the sweetener, soy, sesame, salt, and the reserved garlic. Cool and jar.

Why it works — Pouring the oil *warm* rather than screaming-hot keeps the chili's capsaicin while sparing its sugars and the garlic's aromatics from scorching — the same steep-don't-boil logic as the hot honey, which is how you keep heat clean. A balanced-leaning crisp that reads of both at once.



*Archetype: **balanced**-leaning, ~1 : 1.4. Over rice, eggs, noodles, roasted anything, cold tofu.*

Quick Candied Chili

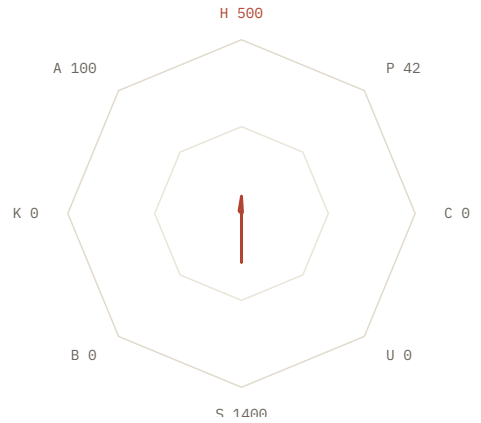
Makes a small jar · 20 minutes · sweetness and heat, fused

150 g	fresh mild red chilies, sliced in rings
100 g	designed sweetener or sugar
60 ml	cider vinegar · 60 ml water · pinch salt

1. Bring the sweetener, vinegar, water, and salt to a simmer until the liquid turns to a loose, glossy syrup.
2. Add the chili rings and cook five minutes, until they soften and go translucent at the edges.
3. Lift the rings into a jar; reduce the syrup another minute and pour it over. It keeps for weeks and sweetens as it sits.

Why it works — Candying fuses the two axes into one object: the chili takes on the syrup's sweetness while giving the syrup its heat, so there is no "sweet part" and "hot part" left to argue — they have cooked into a single thing. The vinegar keeps it from cloying. Bright, and the syrup is as useful as the rings.

IFI PROFILE



IFI-H	500
IFI-P	42
IFI-C	0
IFI-U	0
IFI-S	1,400
IFI-B	0
IFI-K	0
IFI-A	100

*Archetype: **bright**, ~1 : 2.8. On a cheese board, a sandwich, the edge of a bowl of greens; the syrup over soft cheese.*

Swicy Finishing Salt

Makes one jar · 5 minutes · the fastest swicy there is

```
60 g       flaky salt
2  tbsp    designed sweetener (fine) · 1 tbsp mild designed chili powder
(IFI-H ~450)
1  tsp     citric acid or fine lime zest, dried
```

1. Crush everything together lightly so the flakes stay distinct.
2. Store airtight. It clumps if it meets moisture, so keep it dry and it keeps for months.

Why it works — A dry swicy you can finish anything with: the salt carries, the sweetener and chili set a bright low ratio, the citric acid brightens. The whole composition in a pinch, with no cooking at all — proof that the archetypes are about proportion, which a rub holds as well as a sauce.

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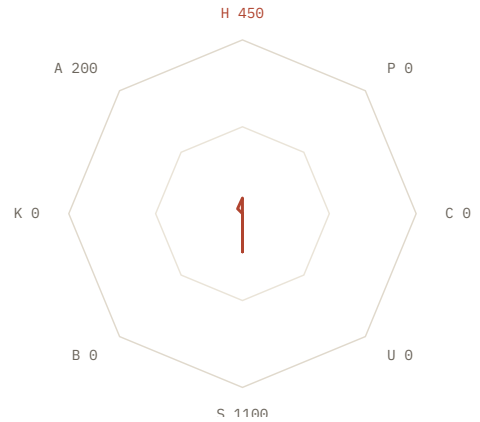
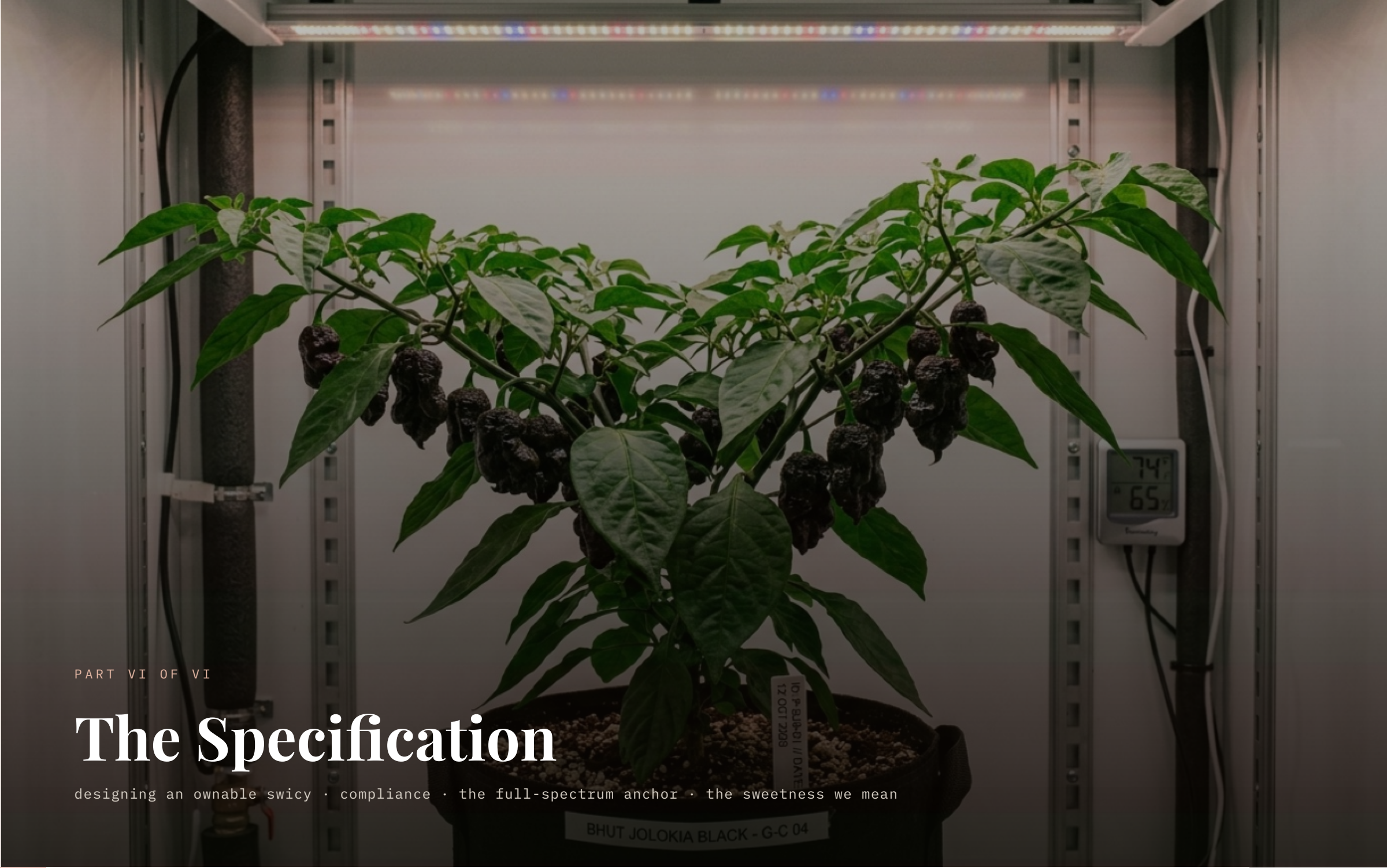


IFI-H	450
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,100
IFI-B	0
IFI-K	0
IFI-A	200

*Archetype: **bright**, ~1 : 2.4. On mango, grilled corn, popcorn, a margarita rim, roasted squash.*



PART VI OF VI

The Specification

designing an ownable swicy · compliance · the full-spectrum anchor · the sweetness we mean

Chapter 17 · Designing an ownable swicy — *the dial in your hand.*

the spec · reproducibility · the compliance of two axes

For the cook, swicy is dinner. For a brand, it is a specification — and this chapter is for the founder with a jar and an idea. The good news is that everything the book has shown turns the vaguest brief in the category, *make it sweet and spicy*, into something you can write down, build, and reproduce. The hot-sauce and CPG makers who come to the platform almost always arrive with a flavor they can taste in their heads and cannot put a number on. The whole point of the Index is to let them hand us the number instead of the metaphor.

Start with the ratio, not the ingredients. Decide the archetype first — *bright*, *balanced*, or *brooding* — because it decides everything downstream. A bright sauce and a brooding one can share a label and be entirely different products; naming the archetype is naming the customer. Then put numbers to it: a target IFI-H and a target IFI-S, read off the Index rather than off a competitor's guesswork. Now you have a spec a kitchen and a factory can both read, and a thing you can test a batch against instead of arguing about.

Then choose where each axis comes from, and this is where the platform earns its place. Source the heat from the ladder — a trace of a high, clean cultivar for well-shaped warmth, rather than a heavy hand of a muddy one — and source the sweetness at the plant, so your IFI-S is not chained to a sugar load you will have to defend on a nutrition panel. Composing the two is the flux-balance problem of Chapter 9, solved the same way: let the model find the proportion that holds, rather than chasing it batch by batch.



The sequencer bench — where an ownable flavor stops being a taste someone remembers and becomes a specification a factory can hit twice.

The thing that separates a product from a lucky kitchen is consistency. Flavor that drifts from jar to jar is not a brand; it is a rumor. Every construct we ship holds its profile to a coefficient of variation of **seven percent or less**, which means the swicy a customer loved in the first jar is the swicy waiting in the twelfth. Across a catalog of roughly **19,500** product SKUs backed by approximately **225** distinct construct designs — **1,000** live and

purchasable today, with **3** patents filed and **21** peer-reviewed papers released openly on Zenodo under CC BY 4.0 — that reproducibility is the quiet thing the whole catalog is actually selling. It is the difference between a flavor you found and a flavor you own.

A word on **compliance**, because a two-axis product touches two sets of rules and a careful founder plans for both. On the heat side, labeling is mostly about disclosure and about keeping the extreme tier honest — heat is an attribute, declared plainly, and a product laddered down from a precise cultivar is far easier to keep consistent (and to stand behind) than one built from variable raw pods. On the sweet side, the designed sweeteners live in a well-trodden regulatory lane: steviol glycosides and monk-fruit mogrosides are recognized sweeteners in many jurisdictions and are labeled as such; the sweet proteins are *proteins*, which means they belong on an allergen-aware label like any other. Two housekeeping disciplines matter across both axes. First, **lock a single master number system** before anything publishes — the heat band, the sweet level, the batch CV — and let every spec sheet and every label pull from that one source, because across a product line, drift is the one thing that reads as sloppy. Second, and non-negotiably: **nourishment is an attribute and an intention, never a claim.** We will say a swicy can carry its sweetness with less sugar load; we will never say it does anything *to* you. No cures, no detox, no health halo. The platform makes that discipline easy, because "less sugar for the same sweetness" is a measured fact about the molecule — an IFI-S held high while the sugar falls — and a measured fact needs no claim to stand behind it. The number is the honesty.

The whole of this book, read as a brief, is this: swicy is two dials, each now free and each now scored, composed by a model into a ratio you can name and a factory can hit. A founder who learns to write the spec — archetype, two numbers, two clean sources, one tolerance — owns a flavor instead of chasing one. That is the dial, finally, in your hand.

Chapter 18 · Phoenix, all eight at once — *the full-spectrum anchor.*

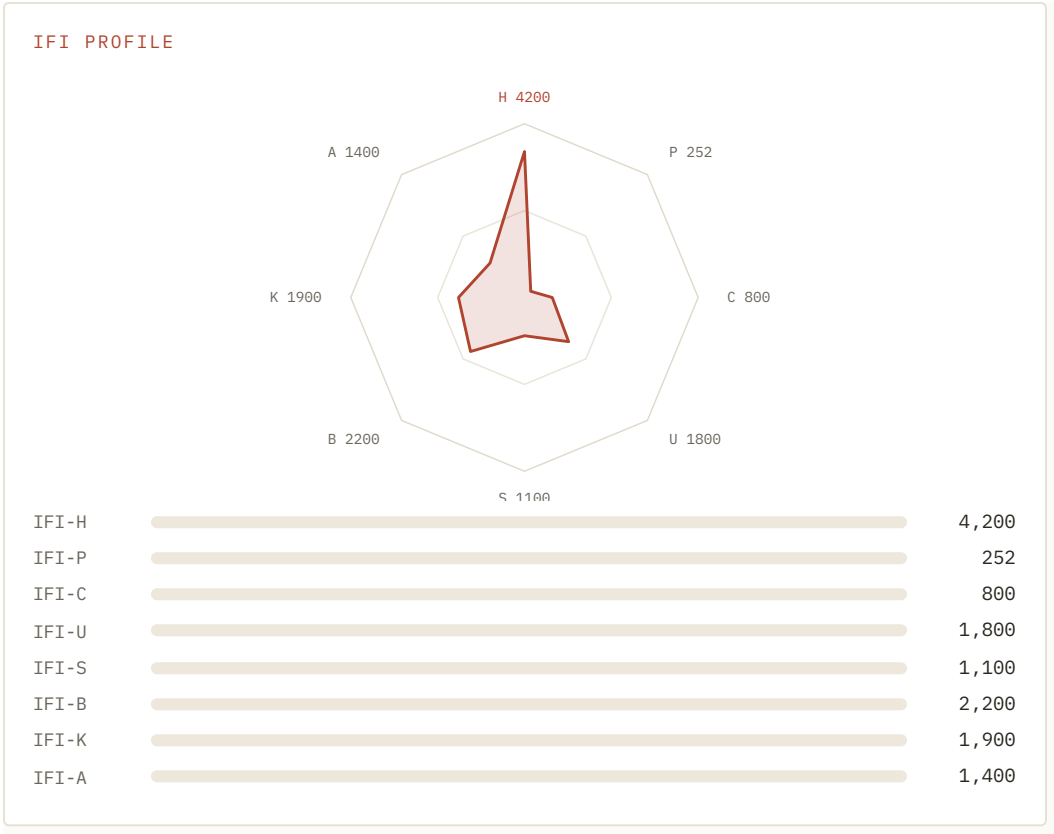
IFI-F · swicy as one chord in eight

Everything in this book has treated heat and sweetness as two dials, set against each other on a plate or grown together into a single fruit. Phoenix is where the whole Index arrives in one cultivar at once — the only one we have ever designed to register on all eight axes — and it is the right place to close, because it shows what swicy becomes when it stops being a pairing and becomes one relationship inside something larger.



Phoenix, SS-0096 — the summit of the ladder, the first and only 8/8 cultivar, and the proof that heat and sweetness can be grown together inside a single cell.

Read the profile. The heat is the headline, IFI-H **4,200**, the highest we have ever specified — our model predicts a Scoville equivalent of approximately 2.95 million. But run your eye across the rest and the swicy is right there inside it: sweetness at **1,100**, grown in alongside the fire rather than poured on after. The heat and the sweet are not the whole story here — they are two voices in an eight-part chord, which is exactly the point. A full-spectrum cultivar does not abandon swicy; it holds it as one relationship among many, all of them kept in proportion by the same flux model that balances a hot honey.



The heat that made the chord possible came from two AI-designed variants in the Pun1 gene — the double variant **S39L** (−2.1) and **L345G** (−1.8) — found with a protein language model, ranked by predicted efficacy and fold stability, and designed for expression with CRISPR. (A third structural annotation, C175S, was identified during modelling but was not included in the final shipped construct.) The mutations made the heat; the flux-balance model made the other seven axes *coherent* around it, which is the harder trick and the one this whole book has been about. Eight axes at once is not eight separate maxima — recall from Chapter 9 that stacked maxima interfere and collapse. It is eight axes held in a single composed relationship, a chord rather than a shout, which is why Phoenix registers as a complete thing rather than a painful one.

PHOENIX · SS-0096			
IFI-H · Heat	4,200	IFI-S · Sweet	1,100
IFI-P · Pungency	252	IFI-B · Zero-Bitter	2,200
IFI-C · Cool-Burn	800	IFI-K · Kokumi	1,900
IFI-U · Umami	1,800	IFI-A · Astringency	1,400

You would never drizzle Phoenix on toast. It is an extreme by design, the summit the ladder is measured from — but it is also the proof the rest of the book depends on. If heat and sweetness can be grown together, in proportion, inside a single cell alongside six other axes and held to a seven-percent batch tolerance, then a *bright* hot honey or a *balanced* glaze is not a lucky accident of cooking. It is a point on a map we have already surveyed to its far edge. Swicy, read all the way down, is not a trend and not a trick. It is a two-note phrase from an eight-note language we can now write in full.

Closing essay · the sweetness we actually mean

We have spent a book on heat and sweetness, and we want to end on the sweetness, because it is the half that says what we are really after. Swicy is thrilling — the warmth, the bright edge, the dare of it — but the thrill is not the whole reason the pairing has lasted ten thousand years. The reason is kindness. Heat without sweetness can be a test; sweetness gives it somewhere soft to land, turns an assault into a pleasure, makes a fierce thing generous. The best swicy is not the hottest. It is the one that takes care of you while it thrills you.



The greenhouse at dusk — the plants we grow toward the fullest flavor and the fullest nourishment they can carry, which we have never believed were two different projects.

That is why we are so careful with the sweet half. A sweetness read from the shape of a signal rather than from a load of sugar lets a food stay joyful without asking the body to pay twice for the joy — and a heat designed for the shape of its burn is a heat you can taste all the way through, down to the fruit it was grown beside. We make no claim about any of this. We only build it the way we would want to be fed: on purpose, toward pleasure, and toward the body at the same time, because we have never once believed those were two different things. The whole library runs on that conviction, and swicy is where it is easiest to taste — the fire that gives you the thrill, the sweetness, built with care, that gives you the kindness, and the two arriving together because we wrote down the proportion.

Compose it, don't stack it. Read the ratio. Keep the thrill and keep the gentleness, and let the two true signals arrive together the way they were always meant to — one warm, one sweet, each making the other easier to love. That was the oldest argument at the table, and it was never an argument at all. It was a partnership, waiting all this time for someone to measure it. Now someone has, and the jar is on the counter, and dinner is a matter of reaching.