

THE SCOVILLE SPLICE LIBRARY · THE KITCHEN

The Carnivore

Meat and live fire. *Grown by plant people.*

Meat and barbecue where the seasoning was designed on purpose — the heat laddered to a number, the savory grown back into the plant, the synergy between flesh and garden measured at the receptor. Every rub, every mop, every plate, scored.

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

Contents

01 Opening essay · The fire, and what we bring to it

02 Chapter 1 · The Savory Signal — the receptor the fire is reaching for.

03 Chapter 2 · The Inosinate the Fire Makes — why aged, seared flesh is a nucleotide factory.

04 Chapter 3 · One and One Make Eight — the synergy, and why the plant finishes the meat.

05 Chapter 4 · The Number on the Plate — loudness, not amount; and how to read a scorecard.

06 Chapter 5 · The Rub — the dry side, grown in our garden.

07 Chapter 6 · The Heat Ladder — choose your burn, by number.

08 Chapter 7 · Low & Slow — patience, measured; and the body of a long cook.

09 Chapter 8 · The Sear — a crust and a number.

10 Chapter 9 · Ribs, Wings & the Lacquer — sweet heat, built to hold.

11 Chapter 10 · The Bird & the Shoulder — the fungal floor, laid on poultry and pork.

12 Chapter 11 · The Mop & the Sauce Board — the restored tomato, made structural.

13 Chapter 12 · The Dark Rub — coffee and wine, turned down from the edge.

14 Chapter 13 · The Sharp Edge & the Cool Side — pungency and cool, as palate design.

15 Chapter 14 · Fermentation & Fire — where designed flavor meets live culture.

16 Chapter 15 · Precision — the same warmth in August and February.

17 Chapter 16 · Clean Label, Honestly — savory grown in the plant, not dosed on the plate.

18 Chapter 17 · The Whole Table — one fire, every tolerance.

19 A closing grace · the fire we keep

Opening essay · The fire, and what we bring to it

We do not eat meat. We never have. And we have spent our whole lives at tables where the people we love do — which is how a family of vegetarians came to write the barbecue book.

Here is the thing we learned standing at the edge of other people's fires: live flame is the oldest table there is, and nobody arrives at it empty-handed. The pitmaster brings patience. The butcher brings the cut. We bring the garden — the rub, the chile grown to a number, the tomato restored to its savory, the allium grown for its weight, the mustard that clears the sinuses, the mint that can cool a burn you built on purpose. That is our place at the fire, and we have come to love it without once wanting the plate for ourselves. This book is what we learned there: how a family that grows and measures flavor for a living can hand a griller a better set of tools than instinct and a shaker of salt, and how the oldest cooking on earth gets quietly, measurably better when the plants that season it are designed instead of merely picked.



The founders in the research greenhouse at dawn — where a family of vegetarians first asked what, exactly, they had to offer someone else's fire.

Stand close when fat first touches coals and you understand why this book exists. The smell that lifts off the grate is not one thing; it is the **Maillard reaction** unspooling into hundreds of molecules at once — pyrazines and furans and sulfur-bearing thiophenes, the browned-savory aroma of everything good that has ever come off a fire. And underneath that aroma runs a quieter signal the nose cannot read: free **glutamate** finding **mGluR1**, the receptor that tells the body *here is protein, here is nourishment, lean in.* For ten thousand years a cook could chase that signal only by feel — brown it harder, age it longer, salt it more — because the signal had no number and the ingredients had no dial. We can now grow the signal, measure it, and place it exactly. A tomato restored to **IFI-U 2,600** carries roughly three times the free glutamate that a century

of breeding-for-the-truck left in the supermarket fruit; cooked down into a mop and brushed over smoke, it makes the fire taste like more of itself.

But the deepest thing we have to offer a carnivore is not a louder tomato. It is a piece of arithmetic that turns out to be written into the meat itself. When an animal is slaughtered and the muscle's energy currency runs down, its ATP degrades along a fixed chemical staircase — ATP to ADP to AMP and then, crucially, to **IMP, inosine monophosphate**, the savory 5′-nucleotide. Aged flesh is an inosinate factory. And inosinate is precisely the molecule that, docking beside glutamate at the umami receptor, makes the receptor read the glutamate as several times louder than it could manage alone. Meat brings the nucleotide. The garden brings the glutamate. Put them on the same bite and the tongue does not add the two savory sources — *it multiplies them.* The whole of this book, the rubs and the mops and the long hours over coals, is in one sense a single applied equation: the synergy between what the fire makes of flesh and what we grew into a plant.

So every recipe here rests on a plant we tuned toward what it was meant to be, and every plate carries its **IFI scorecard**, so you can taste the intention and read it in the same breath. The heat is laddered to a number instead of a wish — anchored to the receptor so that "medium" means the same warmth in August in Montecito and in February in Memphis. The savory is grown in, not salted on. The sweet in a lacquer is amplified at the source so the sugar load stays low and the glaze still crisps. And the whole architecture is built so that one fire can feed a table of very different tolerances — the uncle who wants the top of the ladder beside the child who wants none of it — without anyone being dared and without anyone being left out. We have a single rule of hospitality that this entire book serves, and we will earn it chapter by chapter: **season to the floor, ladder from the table.**

Four tools carry this whole book, and it is worth naming them at the door, because everything that follows is one of the four held up to a fire. There is the **rub** — the dry side, almost entirely plants, where the garden's aromatics and its kokumi are pressed into the meat before a coal is lit. There is the **ladder** — heat laddered to a number, every rung a real cultivar held to a known loudness, so a burn can be chosen rather than risked. There is the **mop** — the wet side, the restored tomato and the koji and the mushroom, brushed on through the long hours to finish the meat's own savor with the glutamate it is missing. And there is the **cool** — the mint and the mustard and the sharp green things, the relief built in on purpose so a heavy plate never tires the mouth. Rub, ladder, mop, cool: the dry, the hot, the savory, the relief. Learn the receptor behind each and you are not following recipes anymore; you are composing a fire. The first four chapters give you the receptors; the rest give you the fire.

A word on the stance of this book, because a vegetarian writing about brisket invites the question. We are not here to persuade anyone toward or away from meat; we have watched the people we love eat it their whole lives and have never once felt the need to argue the plate in front of them. What we feel at a fire is simpler and

older: that feeding someone well is an act of love, and that doing it *precisely* — the heat where they want it, the savor grown in, the same every time — is love with its sleeves rolled up. The meat and seafood we write about we write about with exactly the reverence we bring to a tomato, because the tomato taught us the reverence first. Nothing here is written down to the carnivore or up at them. It is written beside them, from the one chair at the fire a plant family has always been able to pull up: the chair with the garden in its lap.

We are not here to convert the carnivore, and we are not here to apologize for the fire. We are plant people who revere what we grow, and we have come to revere the flame too — not as an assault on an animal but as the most ancient act of care a human being performs for another, which is to feed them, carefully, something they love. A quiet thread runs under every chapter, the same one that runs under every book in this library: that food should be grown to carry the most nourishment it can, that the body should be able to draw the most from it, and that designing flavor and designing nourishment are, in the plant, the same act. It is never a claim and never a sermon. It is only the reason we measure anything at all. Cooking for someone exactly what they love, made right every time, is its own kind of reverence — the same reverence we feel for the plant and for the fire. This is the book that explains how.



PART I OF V

The Science of a Seasoned Fire

mGluR1 · the inosinate the fire makes · the synergy · the number

Chapter 1 · The Savory Signal — *the receptor the fire is reaching for.*

IFI-U · mGluR1 · TAS1R1·TAS1R3

Everything that happens over a fire — the bark on a brisket, the crust on a steak, the long reduction of a mop — is, at bottom, a courtship of one receptor. It is worth knowing that receptor exactly, because once you can see what the tongue is actually doing when it reads *savory*, the whole craft of barbecue stops being folklore and becomes something you can aim.

The umami receptors belong to a protein family built around a structure chemists named, with unusual honesty for the field, the **Venus flytrap**. Picture a large hinged domain of two lobes with a cleft between them, floating on the outer membrane of a taste cell, sitting open and patient until the right molecule drifts into the cleft — and then the two lobes rotate shut around it like the trap of the carnivorous plant closing on its prey. That closure is the signal. For savor there are two such traps working the same prey, and our canon names them in order of their weight on the Index. The first is **mGluR1**, a metabotropic glutamate receptor — the same class the brain uses to read the glutamate it signals thoughts with — stationed on the tongue in a truncated, taste-specific form and tuned to answer glutamate above almost anything else. The second is **TAS1R1·TAS1R3**, a *heterodimer*: two different proteins, products of two different genes, clasped permanently together so the pair works as one receptor. That same TAS1R3 subunit, paired instead with TAS1R2, is the sweet receptor — a quiet structural fact that explains why savor and sweetness so often travel together, and why a long-cooked onion arrives sweet and savory at once. Both are **class C G-protein-coupled receptors**; both carry the flytrap domain at the tip, on a cysteine-rich stalk that passes the message down into a seven-helix transmembrane bundle.



A controlled-environment growth stage in the research chamber — where candidate lines are read for exactly the receptor signal this chapter describes, under fixed light and fixed hands, so a number means the same thing twice.

Watch the binding, because the entire axis lives in this one event. Free L-glutamate — from the meat's own proteins broken down by aging and heat, or from a tomato grown to pool it — drifts into the cleft of the flytrap domain. Its presence tips the energetic balance so

the closed conformation becomes the favored one; the lobes rotate shut; the rotation travels down the cysteine stalk into the transmembrane bundle, which shifts on the inner face of the membrane and grips the G-protein waiting inside. From there the signal is a cascade, and it is worth drawing in full, because its nonlinearity is exactly what a cook is exploiting without knowing it:

1. The activated receptor exchanges GDP for GTP on its coupled G-protein — in taste tissue, **α-gustducin** with the **Gβ3γ13** pair — releasing the βγ subunits to act.
2. Those subunits switch on **phospholipase C β2 (PLCβ2)**, which cleaves the membrane lipid PIP_2 into two messengers; the one that matters here is **inositol trisphosphate (IP_3)**.
3. IP_3 opens the **IP_3 receptor type 3 (IP_3R3)** on the endoplasmic reticulum, releasing a flood of stored **calcium** into the cell.
4. The rising calcium opens **TRPM5**, a calcium-activated cation channel, which depolarizes the cell — tips its voltage past the firing threshold.
5. Depolarization opens the large-pore **CALHM1/CALHM3** channel, through which the cell releases **ATP** as its neurotransmitter onto the gustatory nerve beneath it. The nerve carries one word to the brain: *savory, here.*

Five relays, and at nearly every one the signal is amplified — one receptor switches many G-proteins, one enzyme makes many messengers, a trickle of bound glutamate becomes a shout of ATP at the nerve. This is why savor does not climb in a straight line with the amount of glutamate present, and why the *quantity* of a savory compound tells you much less than you would hope about how savory a thing will taste. The receptor and its cascade are steeply nonlinear across their working range. Double the glutamate near the receptor's half-activation point and you can far more than double the firing at the nerve, because you are climbing the steep middle of a sigmoid curve. The Index measures that response — the loudness at the nerve, not the count in the jar — which is the first thing to understand about why a designed tomato can read nearly tenfold louder than a commodity one while carrying only about three times the glutamate.

Two behaviors of the living receptor matter at the grill. The first is **adaptation**: hold a single steady savory note on the tongue and the signal fades, the cascade desensitizing, which is why the first bite of a rich thing reads deepest and why a plate built on one loud note tires the mouth. A savor composed of a note *and* a body — umami *and* kokumi, the floor and the room around it — resists that fade, which is the whole reason the brisket chapter insists on building both. The second is **threshold**: the bare detection threshold for glutamate alone sits around a hundredth of a gram per hundred millilitres, but put a 5′-nucleotide beside it and that threshold plunges, sometimes by an order of magnitude. Savor you could not have detected becomes savor you cannot miss.

It is worth placing these receptors in their family, because the family explains some of savor's oddest behaviors — and one fact in it is a gift to a book about meat. Class C GPCRs are the *dimeric* receptors,

working in pairs of flytrap-bearing subunits, unlike the single-chain receptors that read heat or smell. The umami pair shares its TAS1R3 subunit with the sweet pair, which is the structural reason savory and sweetness co-occur so naturally — a long-braised onion arriving sweet and savory at once is a single receptor architecture speaking two of its words. And mGluR1, the receptor our canon anchors IFI-U to, is the oldest and most conserved glutamate sensor in the whole animal lineage, a stable reference across the kingdom and the reason the Index pins savor to it specifically rather than to the more variable heterodimer. A sidelong proof that this is *the* axis of meat: the domestic cat, an obligate carnivore, has lost a working sweet receptor entirely — its TAS1R2 is a pseudogene, which is why cats are famously indifferent to sugar — while its umami machinery stayed intact and vigorous, because for a pure meat-eater the protein signal is the one that must never fail. The lineage that evolved to hunt kept the savory receptor and let the sweet one rot. When we design a plant to speak umami to a human who loves meat, we are speaking the one taste-language a carnivore's biology treats as non-negotiable — which is why a vegetarian family turns out to have something a griller genuinely needs.

That last fact is the hinge of the whole book, and it is structural. The flytrap domain of TAS1R1 has, near the *opening* of its cleft — up at the lip, by the hinge — a second, separate binding site. It is not where glutamate goes. It is where the **5′-ribonucleotides** go: inosinate from seared and aged flesh, guanylate from a dried mushroom. When a nucleotide docks into that lip site, it acts as a molecular doorstop in reverse — it stabilizes the *closed* trap, making it harder for the lobes to spring back open once glutamate has been caught. The glutamate is held longer; the receptor reads it louder; the EC_{50} falls. One site catches the prey. A second site, just beside it, holds the trap shut. A carnivore's great advantage is that the meat arrives at the table already carrying the molecule for that second site — and the next two chapters are, between them, how that molecule gets there and the arithmetic of what it does.

Chapter 2 · The Inosinate the Fire Makes — *why aged, seared flesh is a nucleotide factory.*

IMP · the post-mortem staircase · dry-aging · the Maillard crust

Here is the fact that made us, a family of vegetarians, fall for this project in the first place: a good steak is already doing half of our work for us, chemically, before any seasoning touches it. The meat brings to the table the one savory molecule the garden makes least of — the 5′-nucleotide that holds the receptor's trap shut — and it makes that molecule through a staircase of chemistry as fixed and knowable as any pathway we engineer into a plant.

The staircase begins at death. Living muscle runs on **ATP**, adenosine triphosphate, the cell's energy currency. When the animal is slaughtered and the muscle can no longer regenerate it, the ATP runs down through a fixed sequence of dephosphorylations and deaminations: ATP → ADP → AMP → **IMP** → inosine → **hypoxanthine**. The middle of that staircase, IMP — inosine monophosphate, inosinate — is the savory one, and it accumulates in the first hours and days after slaughter as the enzyme AMP deaminase strips the amino group from AMP. This is a measurable, textbook progression; meat scientists even track its endpoint, the **K-value**, the ratio of the breakdown products inosine and hypoxanthine to the total nucleotide pool, as a freshness index. A low K-value means the IMP is still high and the flesh still savory; a high K-value means the staircase has run down to hypoxanthine, which carries no savor and, past a point, a stale bitterness. Freshness, aging, and savor are the same chemistry read at different steps. Here is the staircase laid out, with what each step is to the tongue — a ladder the meat descends on its own, and the reason there is a window in which flesh is at its most savory:

STEP	MOLECULE	TO THE TONGUE
ATP	adenosine triphosphate	energy currency; no savor
ADP → AMP	adenosine di-/mono-phosphate	transient intermediates
IMP	**inosinate**	**the savory peak — the 5′-nucleotide that holds the receptor's trap shut**
inosine	deribosylated IMP	fading savor; faintly sweet
hypoxanthine	the end of the line	bitter, stale; the signal of age

The window is the point of it. A pitmaster who buys well-aged beef and a Japanese chef who insists tuna rest exactly so long before serving are both timing the same staircase — holding the flesh at or near its IMP peak, before the slide to hypoxanthine begins. The garden cannot move that window, but it can make the most of wherever on it the meat happens to sit, because the glutamate it brings multiplies whatever inosinate the step has left.



The sequencer bench where a candidate line's composite savory extract is read against the receptor — the same discipline of measuring *loudness, not amount* that a meat scientist applies to the IMP staircase.

Now consider what **dry-aging** does, because it is the clearest proof that a pitmaster and a plant engineer are after the same thing by different roads. Hang a primal in cold, moving, humidity-controlled air for weeks and two processes run at once. The muscle's own enzymes — **calpains** and **cathepsins** — go on cleaving proteins long after death, liberating free amino acids, **glutamate chief among them**, from the long chains where they were locked. At the same time, moisture leaves the meat, concentrating everything that remains: the glutamate the enzymes have freed, the IMP from the post-mortem staircase, the sugars and peptides. A four-week dry-aged ribeye can carry several times the free glutamate of a fresh one, alongside its inherited inosinate. Dry-aging, read at the receptor, is a slow deliberate climb up the umami axis — the butcher's version of the restoration we engineer into the tomato, reached through time and dry air instead of through the plant's own GAD and GDH1 enzymes. Same destination. Different wall of the same problem.

The climb is steep and worth seeing as a ladder, because it is the carnivore's own version of the great emptying's reverse — glutamate *built back* by time rather than bred away by logistics. The figures below are representative of the free-glutamate rise a well-run dry-age produces; the exact numbers depend on the cut, the animal, and the room, but the shape is fixed:

DRY-AGE	FREE GLUTAMATE (RELATIVE)	CHARACTER
Fresh, day 1	baseline	clean, mild, "beefy" but shallow
14 days	~1.5×	rounder, the first real depth
28 days	~2–3×	nutty, concentrated, the classic steak-house age
45 days+	~3–4×	blue-cheese funk at the edge, savor approaching its ceiling

Notice that the butcher reaches, through weeks of cold dry air, roughly the same *kind* of gain the tomato grower lost to the truck — a two-to-fourfold change in free glutamate. The difference is only the direction of the arrow and the wall it climbs. And the dry-aged surface, seared, meets the garden's glutamate already carrying a crowd of its own: this is why a dry-aged ribeye brushed with a

restored-tomato finish is nearly obscene with savor, two deep glutamate pools stacked on a bed of inosinate, three sources where a supermarket steak with ketchup has barely one.

Then comes the fire, and the fire does something the aging cannot. The **Maillard reaction** — the browning that is not caramelization, though the two often run together — is a cascade that begins when a reducing sugar's carbonyl group condenses with a free amino group from an amino acid or protein. Through a thicket of intermediates (the Amadori rearrangement, Strecker degradation, and on into melanoidin polymers) it generates, in a seared crust, hundreds of new molecules: the nutty pyrazines, the meaty sulfur compounds, the roasted furans and thiophenes that *are* the smell of a grill. Two things about Maillard matter for savor specifically. First, it consumes some free amino acids as reactants — so an over-charred surface can actually spend the glutamate it might have shown as savor, which is one reason a crust past a certain darkness tips from savory to merely bitter. Second, and more useful, the reaction's products interact with the surviving glutamate and inosinate to make the browned surface read as *more* than the sum of its aromas: deep, savory, complete. A great crust is Maillard aroma sitting on top of a concentrated pool of glutamate and IMP — the nose's signal and the tongue's signal, stacked.

So the carnivore arrives at the seasoning stage holding two of the three things savor is built from. Lay them out plainly:

SAVORY SOURCE	PRINCIPAL COMPOUND	WHERE IT COMES FROM
Fresh muscle	IMP (inosinate)	the post-mortem ATP staircase, peaking in the first days
Dry-aged flesh	free glutamate + IMP	calpain/cathepsin proteolysis, concentrated by moisture loss
The seared crust	Maillard products + concentrated Glu/IMP	reducing sugars + amino groups, under high dry heat
What the garden adds	**free glutamate (and GMP)**	**a restored tomato, koji, a dried shiitake — grown to pool it**

Read that table and the thesis of the book is already visible in the bottom row. The meat is magnificent at inosinate and, aged, generous with glutamate. What it cannot do is reach the glutamate *concentrations* of a plant built for nothing else — and it cannot supply **guanylate (GMP)**, the most potent of the savory nucleotides, which is the private gift of fungi. The garden's job at this fire is not to compete with the meat on its own ground. It is to bring the glutamate that pairs with the meat's inosinate, and the guanylate the meat has none of, so that the receptor's lip site and its cleft are both occupied at once and the trap is held shut hard. That pairing has an equation, and the equation is the next chapter — the single most important page a griller who cooks with our plants will ever read, because it says exactly why a spoonful of restored-tomato mop makes a whole brisket taste deeper than the mop has any right to.

Chapter 3 · One and One Make Eight — *the synergy, and why the plant finishes the meat.*

the EUC equation · IMP × Glu · the 1:1 optimum

Savor's strangest and most useful property is that its two ingredient-classes multiply rather than add. We met the structure of it at the end of Chapter 1 — glutamate caught in the flytrap's cleft, a 5′-nucleotide docked at the lip, holding the trap shut — and we met its sources in Chapter 2: the meat makes the nucleotide, the plant makes the glutamate. Here we give that pairing its arithmetic, because the arithmetic is the design lever, and for a carnivore it is the whole argument for ever letting a plant near the plate.

Glutamate sets the baseline. On its own it establishes a certain EC_{50} at the receptor — a certain loudness. Now introduce a nucleotide. The three that matter are **IMP (inosinate)**, the savory nucleotide of seared and aged flesh; **GMP (guanylate)**, the nucleotide of dried mushrooms and the most potent of the three; and **AMP (adenylate)**, the weakest. Each slips into the lip site beside the glutamate and pins the trap shut, and the glutamate's EC_{50} falls — severalfold, in the mixtures real food delivers. The *same* glutamate now drives the receptor to half-response at a fraction of the concentration. On the tongue it is the difference between a broth and a revelation. On the Index it is a score that multiplies instead of sums.



A dried shiitake in cross-section — the flesh that carries guanylate, umami's great multiplier, locked in RNA until drying and heat set it free. The fungal gift the meat cannot make for itself.

The synergy was quantified in the 1960s and 70s, and the result is one of the most beautiful equations in all of flavor science — the umami analog of the IFI formula itself. It computes the **equivalent umami concentration (EUC)**: the amount of pure MSG, in grams per hundred grams, that would taste as savory as a given mixture of umami amino acids and nucleotides.

$$\mathrm{EUC} = \Sigma(a_i \cdot b_i) + 1218 \cdot (\Sigma\, a_i \cdot b_i) \cdot (\Sigma\, a_j \cdot b_j)$$

The terms unpack plainly. The a_i are the concentrations (g/100 g) of each umami amino acid; the b_i their umami strengths relative to glutamate. The a_j are the concentrations of each umami nucleotide; the b_j their strengths relative to inosinate. The first term is simple addition — the savor the amino acids give with no synergy. The second term is the synergy, and its shape is the whole story: it is the *product* of the amino-acid sum and the nucleotide sum, times a large empirical constant, **1218**. When either sum is zero — no glutamate, or no nucleotide — the second term vanishes and you are left with mere addition. When both are present, the product dominates, often by tens. That is the mathematics of *one and one make eight.*

COMPOUND	CLASS	RELATIVE COEFFICIENT
L-glutamate (Glu)	amino acid	1.00 *(reference)*
L-aspartate (Asp)	amino acid	0.077
IMP · inosinate	5′-nucleotide	1.00 *(reference)*
GMP · guanylate	5′-nucleotide	2.30
AMP · adenylate	5′-nucleotide	0.18

Now work the example that is this book in miniature: a seared steak, savory on its own, and a spoonful of restored-tomato mop brushed across it. Say the meat's surface, aged and seared, delivers inosinate at 0.025 g/100 g and a little free glutamate of its own, 0.040. On its own the steak's EUC is close to its glutamate figure — the inosinate has almost no glutamate to multiply, so the product term is small: 0.040 + 1218 × (0.040 × 0.025) = 0.040 + 1.218 = **≈ 1.26 g/100 g** MSG-equivalent. Respectable. Now add the mop: a restored tomato reduced down, bringing glutamate up to 0.180 g/100 g across the bite, the inosinate from the meat unchanged at 0.025. Recompute: 0.180 + 1218 × (0.180 × 0.025) = 0.180 + 5.48 = **≈ 5.66 g/100 g.** The glutamate roughly quadrupled; the *savor* — the EUC — more than quadrupled on top of a base that was already high, because the meat's inosinate was sitting there the whole time with almost nothing to multiply, and the plant handed it the partner it was missing. The tomato did not merely add its own savor. It unlocked the savor the meat was already carrying.

This is why we say the plant *finishes* the meat rather than competes with it. The carnivore starts the dish with a loud nucleotide and a modest glutamate; the designed garden supplies the glutamate that makes the nucleotide pay. And the direction runs both ways across the whole book: a mushroom rub lays guanylate — coefficient **2.30**, more than twice as potent as the meat's own inosinate — onto a surface already glutamate-rich from aging, and the product term climbs again. The synergy has an optimum worth knowing: for a fixed total of glutamate-plus-nucleotide, perceived savor peaks near a **1:1 ratio by weight** and falls away toward either pure endpoint, because a product is largest when its two factors are equal. In practice this means the first additions of the missing partner buy the most, and there is a point past which more does little — the lip site is already occupied, the trap already shut. A griller holding a

nucleotide-rich steak gets the steepest return from the *first* brush of a glutamate-rich plant, which is exactly why a thin mop outperforms a thick one and why depth is built in layers, not in one heavy stroke.

Work the synergy a second way, because the most powerful pairing in this book runs in the other direction — the garden bringing the *nucleotide* this time, not the glutamate. A brisket surface, long-cooked and dry-aged, is rich in free glutamate (say 0.150 g/100 g) but its inosinate has largely run down the staircase of Chapter 2 toward inosine; the savor is real but one-sided, a glutamate pool with a weak partner. Rub it with ground dried shiitake and you lay **guanylate** — coefficient **2.30**, more than twice as potent as the meat's own inosinate ever was — onto that waiting glutamate: say 0.012 g/100 g of GMP, so the nucleotide sum is 0.012 × 2.30 = 0.0276. The EUC climbs from the glutamate-alone figure of about 0.15 to 0.150 + 1218 × (0.150 × 0.0276) = 0.150 + 5.04 = **≈ 5.19 g/100 g.** A thirty-fold leap in perceived savor from a dusting of mushroom, because the receptor was starving for the partner the mushroom carries. The lesson repeats in both directions: find which site of the receptor the meat has left empty — the glutamate cleft or the nucleotide lip — and bring the plant that fills it.

Here is the principle in a single table, read as *which partner does the meat need*:

MEAT BRINGS	LOW IN	PAIR WITH	THE PLANT SUPPLIES
Fresh seared steak	glutamate	restored tomato, koji	glutamate for the cleft
Dry-aged, long-cooked beef	inosinate (run down)	dried shiitake, mushroom	guanylate for the lip
Poultry (modest both)	glutamate *and* nucleotide	koji brine + shiitake	both at once
Pork, well-marbled	nucleotide	tomato mop, soy	glutamate for the cleft

A carnivore who learns to diagnose the empty site — rather than simply reaching for "more flavor" — is cooking the equation, and the equation is the most efficient savor there is.

A word for the formulators reading over the cook's shoulder: industry buys this synergy by the kilogram as **disodium 5′-ribonucleotides**, usually a 1:1 blend of inosinate and guanylate known in the trade as **I+G**, dosed into a formula to multiply whatever glutamate it already holds. Our source-side approach reaches the same multiplication by a different road — we grow the nucleotides into the shiitake and the yeast and let the glutamate pool in the tomato, so the multiplier arrives inside a plant, with everything else that plant carries, and labels as food rather than as an additive. The carnivore has a third road, older than both: the animal makes the inosinate for free, in the hours after slaughter, and the fire concentrates it. All three roads end at the same equation. This book cooks the third one and finishes it with the first.

Chapter 4 · The Number on the Plate — *loudness, not amount; and how to read a scorecard.*

IFI(c) = 1,000 × EC_{50}(ref) ÷ EC_{50}(c) · per-axis maximum 5,000

We have said *loudness, not amount* three times now; this chapter is where it becomes a number you can read off a plate. Every recipe in this book ends in a block of eight letters and eight values — the IFI scorecard — and the whole system rests on one formula simple enough to hold in your head.

EC_{50} is the concentration at which a stimulus drives its receptor to half of full response. A compound — or a whole extract — that reaches half-response at a low concentration is *loud*; one that needs a flood to get there is *quiet.* Invert the candidate's EC_{50} against a fixed reference, scale by a thousand, and loudness becomes a score you can print and reproduce:

> **IFI(c) = 1,000 × EC_{50}(ref) ÷ EC_{50}(c)**

The reference on each axis is anchored so the native wild-type receptor's half-activation reads **1,000**. A candidate twice as loud reads 2,000; one that needs twice the concentration reads 500. Every axis normalizes to a per-axis maximum of **5,000**, the ceiling a scorecard radar is drawn against, so a savory reading, a heat reading, and a sweetness reading all sit legibly on one eight-spoke figure. Eight axes, eight receptors, one currency:

CODE	AXIS	RECEPTOR	WHAT IT READS AT THE FIRE
IFI-H	Heat	TRPV1	capsaicin; the laddered burn
IFI-S	Sweetness	TAS1R2·TAS1R3	the lacquer, the glaze
IFI-U	Umami	mGluR1 / TAS1R1·R3	the savory floor; the mop
IFI-B	Zero-Bitter	TAS2R38	coffee and cocoa rubs, turned down
IFI-K	Kokumi	CaSR	the body of a long cook; the bark
IFI-C	Cool-Burn	TRPM8	the mint against the fire
IFI-P	Pungency	TRPA1	the rub's lift; the sharp sauce
IFI-A	Astringency	salivary PRPs	the red-wine mop's grip

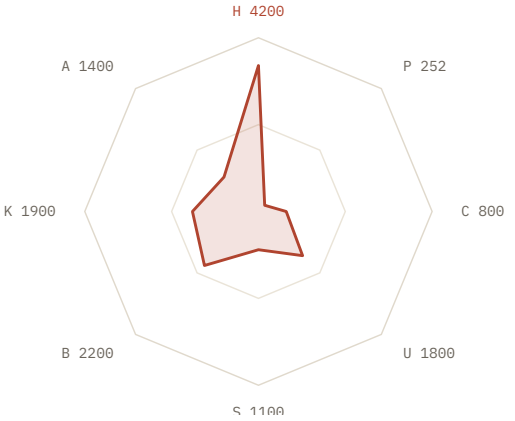
The thing to hold onto is that the number captures the *compounded* loudness you actually perceive — the steep receptor curve, the nucleotide synergy riding along, the whole nonlinear truth — rather than the flat count a mass spectrometer returns. We measure the EC_{50} of a food's *composite extract* against the receptor on a calibrated cell-based assay, cross-checked against a trained human panel, so the synergy of Chapter 3 is already *inside* every IFI-U we print. A scorecard is not a theory with a correction bolted on; it is the measured loudness of everything a bite brings to the tongue at once.



Phoenix — SS-0096 — the only cultivar we have ever designed to register on all eight axes at once, and the single clearest lesson in how to read a scorecard: heat towers, but it never stands alone.

It helps to read one full profile before you meet a hundred of them. This is **Phoenix**, SS-0096, the full-spectrum flagship — a pepper designed gene by gene, with our model predicting approximately 2.95 million SHU, and the first designed to target all eight axes at once:

IFI PROFILE



IFI-H	4,200
IFI-P	252
IFI-C	800
IFI-U	1,800
IFI-S	1,100
IFI-B	2,200
IFI-K	1,900
IFI-A	1,400

Run your eye down it. Heat at 4,200 is the headline, and we will spend a whole chapter on how it was reached. But look at the savor grown in beneath it — **IFI-U 1,800**, in a *pepper* — and the kokumi body at 1,900, and the bitterness held low at 2,200 so the fruit's darkness never scolds, and the faint cool note set against the fire at 800. That is the deepest lesson the scorecard teaches, and it is the lesson of this entire book applied to a single fruit: heat is never eaten alone, savor is the floor the other seven stand on, and a thing designed to thrill one receptor had better bring company for the rest.

A carnivore reading a plate the way they would read Phoenix — not *how hot* but *how composed* — is a carnivore who will never cook a one-note dish again.

Put one number through the formula so it stops being abstract. Say the heat reference — the native receptor's half-activation — sits at an EC_{50} of some concentration we will call *R*. A mild grilling chile reaches half-activation of TRPV1 at about 25× that concentration, so its IFI-H is 1,000 × (R ÷ 25R) = 40: a sunlit warmth. A designed superhot like Blaze reaches half-activation at a fraction of the reference — about R ÷ 2.63 — so its IFI-H is 1,000 × (R ÷ (R ÷ 2.63)) = 2,630: the rung that ends conversations. The arithmetic is deliberately plain, a ratio and a thousand, because the sophistication lives not in the formula but in the measurement of EC_{50} itself, where the receptor's steep nonlinearity is captured. The number is simple so the honesty can be complicated in the right place — the assay, cross-checked against a trained human panel, where a cultivar earns its figure before it is ever printed on a recipe.

It is worth knowing the scale behind the scorecards, because it is why a cook can trust them. The library these numbers are read from spans some **225 distinct construct designs** across **42 validated host organisms** — about **1,000 live and purchasable today**, backing **19,500 product SKUs** mapped against the **8 sensory axes** — every one scored the same way, on the same 0–5,000 scale, held to a batch-to-batch variation design target of **≤7%** and documented across three patents and twenty-one peer-reviewed papers. A number on a plate in this book is not a flourish. It is the visible tip of a computed design library.

One more habit of reading, because it is the one that stops a cook from over-dosing. The axes are not additive across a plate; each is its own receptor with its own saturating curve. Stacking four glutamate sources on a burger does not give you four times the umami — it climbs the single IFI-U curve toward its ceiling, with the steepest gains from the first sources and diminishing returns past the middle. The same is true of heat, of sweet, of every axis. Read a scorecard as eight separate dials, each with a floor and a ceiling, and you will reach for the ingredient that moves the dial still low rather than piling onto the one already loud. That is composition, and composition — not intensity — is the thing the Index was built to let you practice.



PART II OF V

The Dry Side

the rub · the aromatics · the heat ladder, to a number

Chapter 5 · The Rub — *the dry side, grown in our garden.*

IFI-P · TRPA1 · the aromatics · kokumi from the allium

Before the fire, the rub. It is the layer closest to the meat and the first thing the heat will change, and it is almost entirely plants — which is why the dry side is where a plant family has the most to say and the most to grow.

A rub works, first, on the sharp channel. Thyme, oregano, cinnamon, fresh ginger, garlic, mustard: their bright, front-of-mouth lift is **TRPA1**, the pungency receptor, a channel distinct from the heat receptor and far quicker. Where capsaicin on TRPV1 builds and lingers, pungency on TRPA1 flashes and clears. The molecules that fire it are a rogues' gallery of reactive electrophiles — **allicin** and the diallyl sulfides from garlic, **allyl isothiocyanate** from mustard seed, **cinnamaldehyde** from cinnamon, **gingerols** and their cooked cousins the shogaols from ginger, the thymol and carvacrol of thyme and oregano. They work by covalently nudging cysteine residues on the channel, a sharp chemical tap rather than the slow thermal fooling of capsaicin, and the tongue reads them as a top note that wakes a piece of meat up before any burn arrives. We grow these aromatics for that channel on purpose — a thyme tuned toward **IFI-P 120**, a black mustard whose seed carries pungency high, a cinnamon whose sweetness and sharpness arrive in the right order.



Designed garlic in cross-section — grown for two channels at once: allicin for the pungent lift on TRPA1, and γ-glutamyl peptides for the kokumi body on CaSR. The reason a good rub tastes complete and not merely hot.

But the rub does a second, quieter thing, and it is the one that separates a good rub from a great one: it lays down **kokumi**. We will give kokumi its full chapter at the brisket (Chapter 7), but you meet it first here, in the garlic and the onion and the pinch of nutritional yeast. Kokumi has no taste of its own; it is **γ-glutamyl peptides** — glutathione, γ-Glu-Val-Gly and their kin — activating **CaSR**, the calcium-sensing receptor, lending a seasoning continuity and roundness and the sense that it fills the whole mouth and stays. It is why a rub built on real alliums tastes *complete* rather than merely sharp, and why it can lean on far less salt to be felt. Garlic in our

library carries both channels at once — **560 constructs**, tuned for pungency *and* kokumi — which is why it is the backbone of nearly every dry blend we make.

Every aromatic on the dry side is a real organism in the library, grown toward the channel the rub needs. Here is the pantry of the dry side, with what each plant is tuned for and the depth of the library behind it:

AROMATIC	CONSTRUCTS	GROWN FOR	THE MOLECULE
Garlic	560	pungency + kokumi	allicin; γ-glutamyl peptides
Black mustard	2,790	pungency	allyl isothiocyanate
Thyme	120	pungency	thymol
Ginger	120	pungency	gingerols, shogaols
Onion	40	kokumi	γ-glutamyl peptides
Oregano	40	pungency	carvacrol
Cinnamon	40	pungency	cinnamaldehyde
White mustard	200	pungency	p-hydroxybenzyl isothiocyanate
Yeast	240	umami + kokumi	glutamate; γ-glutamyl peptides

Read that table and the dry side's whole logic is visible: it is a pungency library (TRPA1) wrapped around a kokumi core (CaSR), with yeast smuggling in a little umami floor. Not one gram of it is there for heat; the heat is the chile's job, laddered separately, so that the rub's character and the plate's warmth can be set independently. That separation — aromatic voice on one dial, burn on another — is the quiet luxury the designed pantry gives a griller.

The House Rub

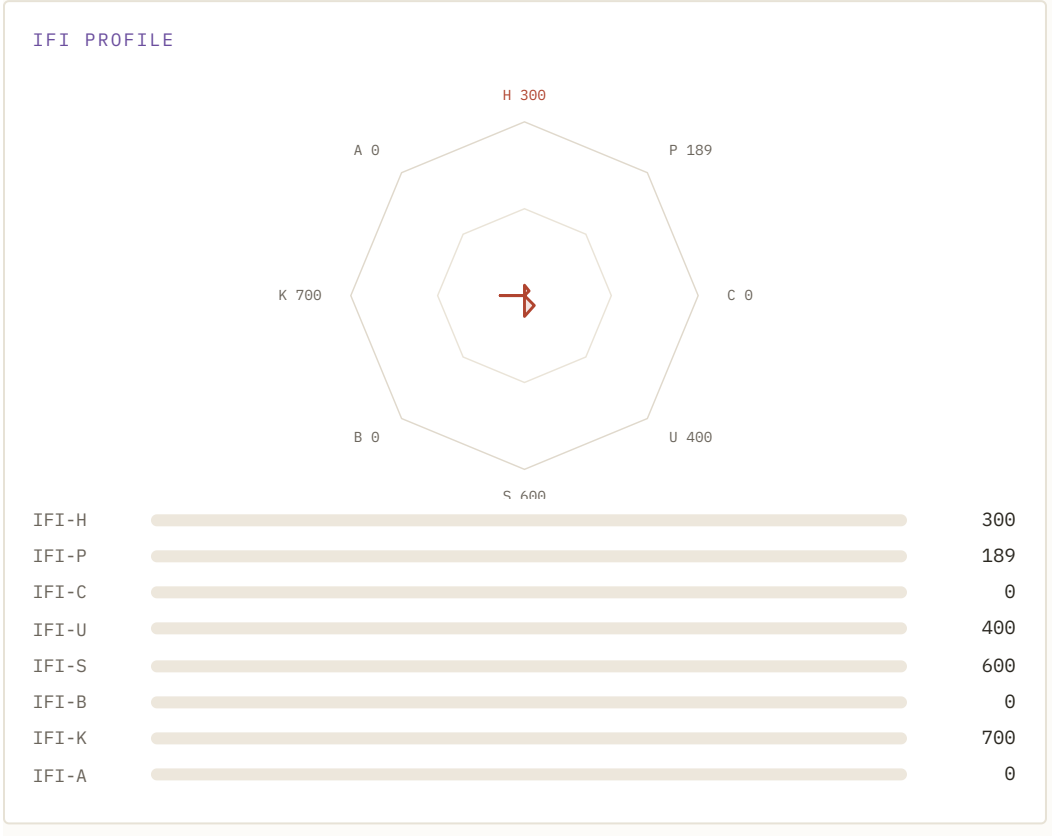
Makes about 1 cup · the backbone of this whole book

The one we reach for first, balanced to sit under almost anything that meets fire. Toast the whole spices if you have them; the aromatics bloom louder for it.

```
Makes ~1 cup · 10 minutes
4 tbsp smoked paprika
2 tbsp light brown sugar
1 tbsp kosher salt
1 tbsp designed garlic, granulated (IFI-P + IFI-K)
2 tsp designed onion, granulated
2 tsp ground thyme
2 tsp ground oregano
1 tsp ground cinnamon
1 tsp ground ginger
1 tsp coarse black pepper
chile, ground, to your rung on the ladder (Chapter 6)
```

1. Stir everything but the chile together until the color is even and no clumps of sugar remain.
2. Add the chile last and in stages, tasting the raw rub on a fingertip between additions, until the warmth sits where you want it. This is the one variable you own; everything above it is the frame.
3. Keep in a sealed jar away from light. It is best within a month, while the pungent aromatics still have their edge — TRPA1 agonists are volatile and reactive, and a rub is at its loudest young.

Why it works — The garlic and onion run two channels at once: allicin on TRPA1 for the lift, γ-glutamyl peptides on CaSR for the body. The smoked paprika and the brown sugar set up the fire's Maillard browning; the salt is modest on purpose, because seasoning grown for depth does not need sodium to be felt. Every molecule here is doing receptor work you can name.



The Pungent Herb Rub

Makes about ¾ cup · for poultry, pork, and anything that wants lift over smoke

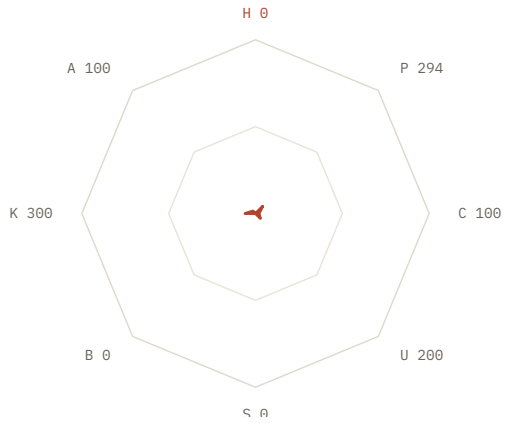
Where the House Rub leans dark and sweet, this one leans green and sharp — built to cut through fat rather than deepen it, the TRPA1 aromatics pushed to the front.

```
Makes ~¾ cup · 10 minutes
3 tbsp ground thyme (designed thyme, IFI-P 120)
2 tbsp ground oregano
1 tbsp designed garlic, granulated
1 tbsp ground coriander
2 tsp fennel seed, cracked
2 tsp kosher salt
1 tsp ground white mustard (designed white mustard, IFI-P)
1 tsp lemon zest, dried
```

1. Crack the fennel and coriander coarsely so they bloom rather than powder.
2. Stir all together; store airtight. Use within three weeks for the brightest pungency.
3. Apply heavier than you think on poultry skin — the herbs want to char lightly, which rounds the raw-green edge into something toasted.

Why it works — Thyme and oregano carry thymol and carvacrol; the white mustard adds a faint volatile sharpness; together they stack TRPA1 without touching TRPV1, so the rub reads *bright* rather than *hot.* On fatty skin, pungency is a knife — it clears the richness and resets the palate for the next bite.

IFI PROFILE



IFI-H	0
IFI-P	294
IFI-C	100
IFI-U	200
IFI-S	0
IFI-B	0
IFI-K	300
IFI-A	100

The Kokumi Dry-Brine

Makes enough for one large cut · overnight · the invisible head start

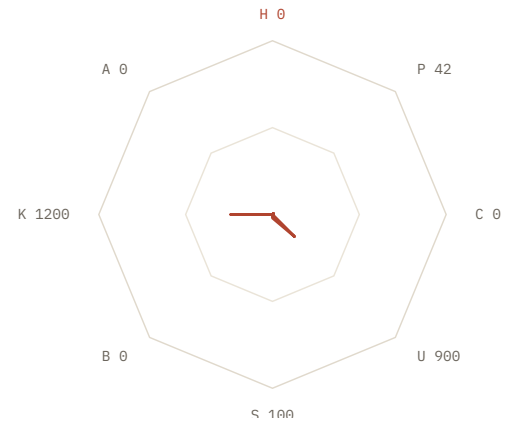
Not quite a rub — a dry-brine, salt and kokumi worked into the surface the night before, where it draws moisture out and then back in, seasoning deep and laying a body a long cook will reward.

```
For one brisket, pork shoulder, or whole bird
3 tbsp kosher salt
1 tbsp designed garlic, granulated
1 tbsp nutritional yeast, from designed yeast (IFI-U + IFI-K)
1 tsp coarse black pepper
1 tsp light brown sugar
```

1. Mix and apply to every surface the night before, heavier on the thick parts. Leave uncovered in the cold.
2. The salt draws moisture to the surface, dissolves, and is reabsorbed carrying the kokumi peptides with it — seasoning the cut from within rather than coating it.
3. Cook as the recipe directs. The surface will dry to a better bark for having started here.

Why it works — The designed yeast carries both axes of this book's quiet workhorses: glutamate for umami and γ-glutamyl peptides for kokumi, both in one cell. Worked into the meat a day ahead, it gives CaSR something to read through the whole cook, which is why a dry-brined cut tastes *rounder* all the way to the center and not only in the bark.

IFI PROFILE



IFI-H	0
IFI-P	42
IFI-C	0
IFI-U	900
IFI-S	100
IFI-B	0
IFI-K	1,200
IFI-A	0

The Dalmatian — salt, pepper, and one idea

Makes ½ cup · the Texas minimalist, with a quiet amendment

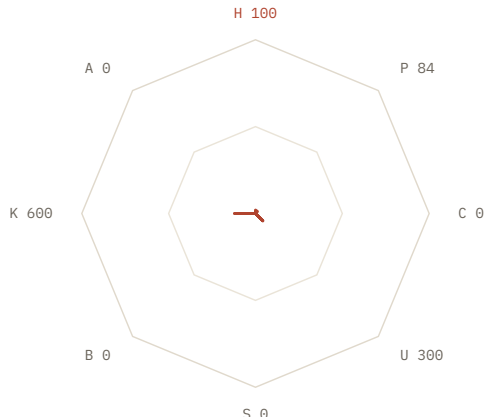
Central Texas taught the world that a great brisket needs only coarse salt and coarse black pepper — the "dalmatian" rub, black-and-white. We honor that restraint and make one quiet amendment: a whisper of designed garlic, enough to wake CaSR without ever announcing itself. The discipline of the dalmatian is that nothing hides; so every grain has to earn its place.

```
Makes ~½ cup · 5 minutes
¼ cup coarse kosher salt
¼ cup coarse-ground black pepper (16-mesh if you can find it)
2 tsp designed garlic, granulated
```

1. Mix and apply in a single even coat, heavier on the fat cap. No sugar, no paprika, nothing to brown but the meat's own surface.
2. Let the salt begin its work at least an hour ahead — longer is better — so it penetrates rather than merely coats.
3. Cook low and slow (Chapter 7). The pepper's piperine will bloom over the long hours into a warm, resinous crust.

Why it works — Black pepper's bite is **piperine**, which works partly on TRPV1 (a faint, warm cousin of the chile's heat) and partly as an aromatic; coarse-ground, it blooms slowly through a twelve-hour cook rather than scorching early. The salt does the penetrating; the designed garlic lays a nearly invisible kokumi floor so the "plain" brisket tastes rounder than its three ingredients should allow. Restraint, with one receptor quietly engaged.

IFI PROFILE



IFI-H		100
IFI-P		84
IFI-C		0
IFI-U		300
IFI-S		0
IFI-B		0
IFI-K		600
IFI-A		0

A note that threads the dry side together: **cut and timing are dose.** A whole toasted spice releases slowly; a fine powder blooms all at once; an aromatic applied the night before mellows and marries, while one dusted on at the fire stays loud and raw. The TRPA1 agonists in particular are fragile — volatile, reactive, quick to fade — so a rub is a young thing, loudest in its first weeks, and the garden's contribution to it is at its brightest closest to the harvest. We grow these plants to carry their pungency high precisely because so much of it is spent between the field and the fire. Season generously, grind fresh, and let the fire finish what the garden started.

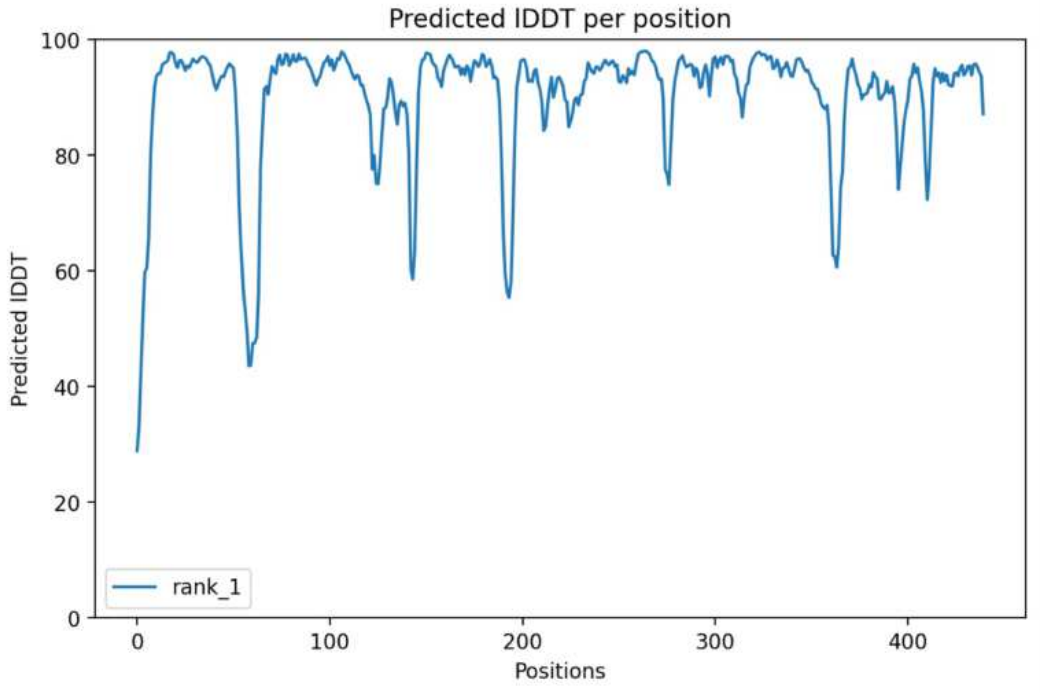
Chapter 6 · The Heat Ladder — *choose your burn, by number.*

IFI-H · TRPV1 · capsaicin · SHU vs the receptor · CV ≤7%

"Medium" is a wish. A number is an instruction. The whole reason we measure heat is so the warmth on a Tuesday is the warmth you remember from the summer, because it is anchored to the receptor and not to a memory — the same rung tasting the same in Montecito in August and in Memphis in February.

Capsaicin finds **TRPV1**, a non-selective cation channel on the trigeminal nerve endings of the tongue — the same receptor gated by temperatures above 43 °C and by acid. The molecule does not warm the tissue; it lowers the channel's thermal threshold, so the body reports a fire that is not there. Nothing is harmed. The capsaicinoid itself is built in the pepper's placenta where vanillylamine condenses with an 8-methyl branched-chain fatty acid at the **Pun1/AT3 acyltransferase**; the length and saturation of that acyl chain set the balance between capsaicin and its cousin dihydrocapsaicin, and with it the *shape* of the burn — where it lands, how it blooms, how cleanly it leaves.

The griller does not need the whole biosynthetic route by heart, but a glance at it explains why heat could be engineered at all. Capsaicin is the marriage of two branches. The vanillylamine half descends from phenylalanine down the **phenylpropanoid pathway — PAL → C4H → 4CL → HCT → COMT** — the same branch that runs in every vascular plant, which is the deep reason the heat method transfers beyond peppers. The fatty-acid half is built and shortened by **BCAT and KAS** from branched-chain amino acids. The two are joined, at the last step, by **Pun1/CS**, the acyltransferase, with **pAMT** supplying the vanillylamine. Only four of those enzymes are pepper-specific; the long upstream spine is universal. This is why we can specify heat precisely: the pathway is known enzyme by enzyme, the key steps have been modelled, and the acyltransferase is a protein we can read, model, and edit.



The Pun1/AT3 acyltransferase, modeled and colored by pLDDT confidence — the terminal enzyme of the capsaicin pathway, and the protein whose two designed substitutions carry the top of the ladder.

It is worth being clear about why we do not simply use the old Scoville number. **SHU** — Scoville Heat Units — is a dilution figure: how many times a pepper's extract must be diluted before a panel can no longer detect the heat. It measures *amount* in the jar. **IFI-H** measures *loudness* at the receptor, by the same EC_{50} inversion as every other axis, which is why it tracks the sensation you actually feel — including the shape and the timing a raw SHU count is blind to. The two correlate but they are not the same measurement, and the difference is exactly why a designed heat can be built to feel clean and well-placed rather than merely large.



Phoenix in cross-section — the placental tissue where capsaicin is built, and the fruit that sits at the top of the ladder below at IFI-H 4,200.

Here is the ladder we cook from, every rung a real cultivar with a real number — the ten flagship superhots, *C. chinense*, the series designed to show how heat can be specified gene by gene:

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
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**

The top of that ladder did not exist in nature; we designed it. The highest rungs were reached by editing the Pun1 pathway itself, using a method we detail in the science books but owe the griller a glimpse of here, because it is why the heat behaves. A **650-million-parameter protein language model (ESM2)** scored every possible single-residue substitution in Pun1 by predicted effect on catalytic efficiency times fold stability; a genome-scale **flux-balance model** predicts that rate control sits upstream in the phenylpropanoid pathway — at 4CL and HCT — not at the terminal Pun1 step. Pun1 is the final capsaicin synthase; it labels the product but does not govern the rate. Two substitutions, never before combined, emerged and were written in with CRISPR:

EDIT	EFFECT	ΔΔG (KCAL/MOL)
S39L	binding affinity ↑ (N-terminus)	−2.1
L345G	steric relief at the active-site cleft	−1.8
C175S	*structural annotation from modelling; not in the shipped construct*	*−0.9*

The double variant S39L+L345G is designed to target approximately **2.94 million SHU** in our model, at a batch-to-batch coefficient of variation design target of **≤7%**, against 42% in wild-type. That last number is the one a cook should love most, and we will return to it in Chapter 15: it means the rung is the rung, every harvest, so a recipe metered to a number is honest. A heat you can trust is a heat you can build a table around.

A note on how we hold heat, because it governs the whole book: heat, to us, is a pleasure and not an assault. Even at 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 you, not one that only tests you. The recipes below are built so the chile is a dial, not a dare.

Six bands organize the whole range, and knowing them lets you read a recipe's heat the way you read its salt — as a choice with a known effect, not a gamble:

IFI-H	BAND	THE SENSATION	AT THE GRILL
0–100	Warmth	sunlit, barely there	a child's plate; aromatics without burn
100–400	Glow	a warmth you reach for again	the default table heat
400–900	Burn	the meal wakes up	where most barbecue lives
900–1,600	Fire	loud, climbing, the bite's headline	the serious table
1,600–2,600	Inferno	the edge of comfort	the chilihead's chosen rung
2,600+	The Reckoning	the ladder's top, metered by the pinch	offered, never forced

The point of the bands is the same as the point of the whole Index: to turn a word everyone argues about — *medium* — into a thing two cooks a thousand miles apart can agree on. When a recipe in this book says IFI-H 700, it means the Burn band, the meal waking up, and it means exactly that in every kitchen that follows it.

Table Heat — a finishing chile oil at the rung you name

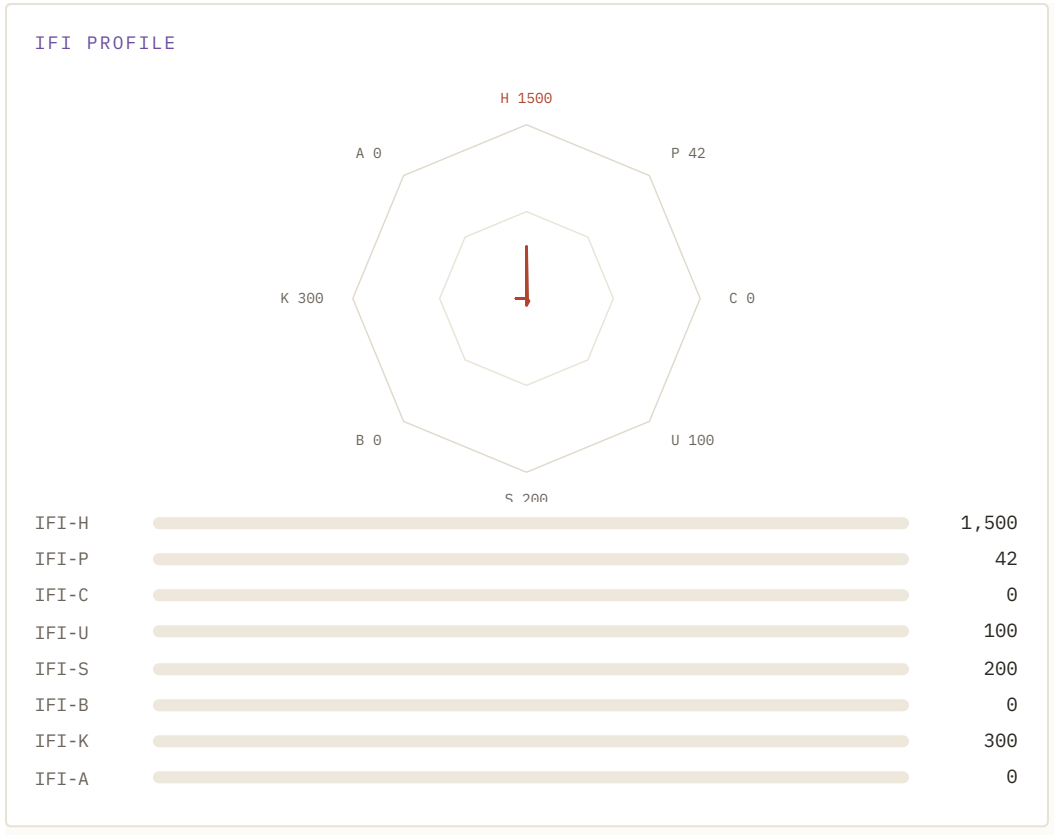
Makes 1 cup · the dial for the whole table

Keep this beside the platter and you never have to cook to a committee. The meat comes off the fire seasoned to the mildest palate present; everyone else dials up from here.

```
Makes 1 cup · 20 minutes
1 cup neutral oil
4 cloves designed garlic, smashed
2 strips orange peel
chile, ground, to a measured IFI-H (see step 2)
flaky salt
```

1. Warm the oil, garlic, and orange peel gently — a bare shimmer, never a fry — until the garlic is gold and the kitchen smells sweet. Fish out the solids.
2. Off the heat, stir in the ground chile. For a crowd-pleasing finish, dial to **IFI-H 600**. For a serious table, **1,500**. For the rung that ends conversations, meter in **Blaze (IFI-H 2,630)** a pinch at a time, tasting on bread between additions.
3. Salt, cool, and bottle. Spoon over anything that came off the grate. It keeps a month in the cold.

Why it works — Infusing into warm oil, below a fry, extracts the capsaicinoids (which are fat-soluble) without scorching the garlic's aromatics. The orange peel's own terpenes ride along to round the burn's edge. The point of a laddered oil is dignity: nobody at the table is dared, and nobody is left out.



The Laddered Dry Chile Blend

Makes ½ cup · a single blend, built to a target number

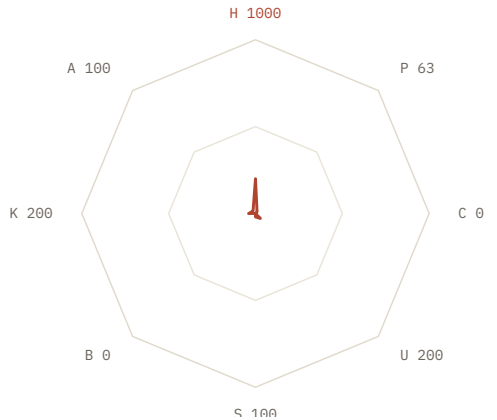
Rather than reach for whatever chile is in the cabinet, build the heat the way we build a cultivar: to a target. This blend mixes rungs of the ladder with milder aromatic chiles so the *character* stays broad while the *number* lands where you set it.

```
Makes ~½ cup · 10 minutes
3 tbsp mild ancho-type chile, ground (fruit and color, little heat)
1 tbsp guajillo-type chile, ground (bright, berry, low heat)
1–3 tsp designed superhot, ground (the ladder — your dial)
1 tsp smoked paprika
½ tsp designed garlic, granulated
```

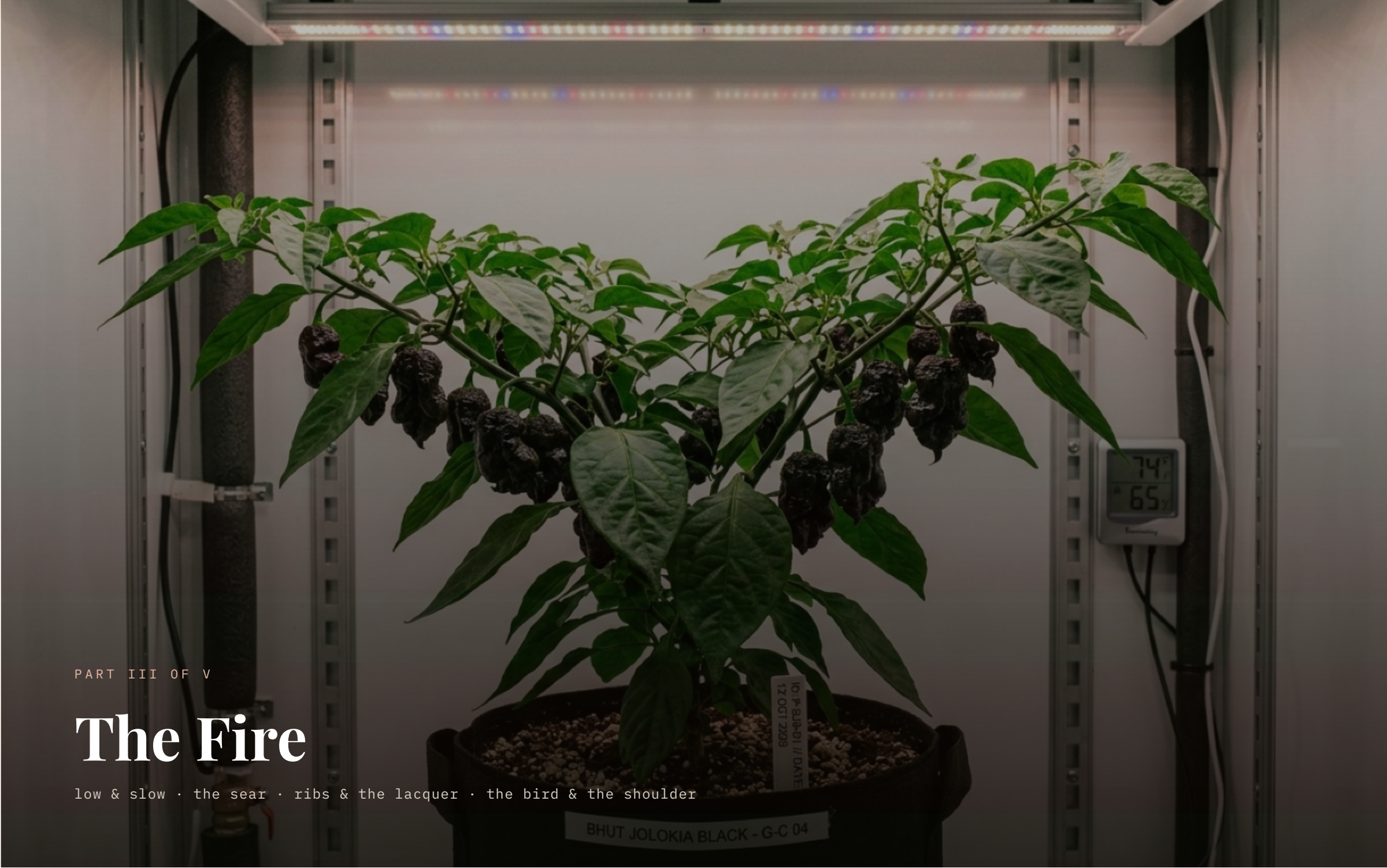
1. Start with the ancho and guajillo for body, color, and fruit — this is the chile's *voice*, nearly heatless.
2. Add the designed superhot to set the *volume*: 1 tsp of Blaze brings the blend near IFI-H 500; 2 tsp near 1,000; 3 tsp past 1,500. Because the superhot runs at CV ≤7%, the teaspoon is a reliable unit.
3. Finish with paprika and garlic. Store airtight, dark, and use within a month.

Why it works — The milder chiles carry capsorubin and capsanthin (the deep reds) and a fruity aromatic profile with almost no capsaicin; the designed superhot carries nearly pure, well-shaped heat at a known loudness. Separating *voice* from *volume* is the whole trick of cooking with a ladder: you set the character once and dial the heat to the room.

IFI PROFILE



IFI-H	1,000
IFI-P	63
IFI-C	0
IFI-U	200
IFI-S	100
IFI-B	0
IFI-K	200
IFI-A	100



PART III OF V

The Fire

low & slow · the sear · ribs & the lacquer · the bird & the shoulder

Chapter 7 · Low & Slow — *patience, measured; and the body of a long cook.*

IFI-K · CaSR · γ-glutamyl peptides · collagen → gelatin

Some things the fire can only teach by taking all day. A brisket held at 107 °C for twelve hours is not cooking so much as a slow dismantling — collagen loosening into gelatin, fat rendering down into the muscle, the surface drying and darkening into bark. What you are chasing through all those hours has a name on our Index, and it is not heat. It is **kokumi**.

Kokumi has no flavor of its own. It is mouthfeel made molecular: **γ-glutamyl peptides** — glutathione (γ-Glu-Cys-Gly), γ-Glu-Val-Gly, and their relatives — activating **CaSR**, the calcium-sensing receptor, a class C GPCR like the umami receptors but tuned to read calcium and these particular peptides rather than glutamate. CaSR does not report sweet or salty or hot. It reports *fullness* — continuity, roundness, the sense that a flavor fills the whole mouth and persists. It is why aged and long-cooked things taste *complete*, and why a thin broth and a deep one can carry identical glutamate yet feel worlds apart. The depth a pitmaster spends a decade learning to coax from time alone is, read at the receptor, a slow accumulation of these peptides — and we can grow them into garlic and yeast at the source, so the richness can be seasoned in before the fire is even lit.

The peptides themselves are a small, specific family, and naming them makes kokumi feel less like magic and more like the designable thing it is:

PEPTIDE	STRUCTURE	WHERE IT LIVES	NOTE
Glutathione	γ-Glu-Cys-Gly	garlic, yeast, meat	the canonical kokumi peptide
γ-Glu-Val-Gly	tripeptide	ferments; designed yeast	among the most potent known
γ-Glu-Cys	dipeptide	alliums	a glutathione precursor, itself active
γ-Glu-Val	dipeptide	aged and fermented foods	rounds and lengthens
γ-Glu-Met	dipeptide	alliums, legumes	savory continuity

What unites them is the **γ-linkage** — a bond from glutamate's *side-chain* carboxyl rather than its usual backbone, which is why these peptides resist the ordinary proteases that would otherwise clip them, and why they survive a long cook to reach the receptor intact. CaSR reads that γ-glutamyl signature as *body.* We tune garlic (560 constructs) and yeast (240) to carry more of these peptides than a wild plant would, which is the molecular whole of "seasoning richness in."

The long cook builds kokumi two ways at once. Time and gentle heat drive slow proteolysis and peptide formation in the meat itself, the same enzymatic liberation that dry-aging began (Chapter 2), now accelerated by warmth. And the **collagen** in a tough cut — a brisket, a shoulder, a short rib — unwinds from its triple helix and hydrolyzes into **gelatin**, which coats the mouth and carries every other flavor longer, extending the kokumi sensation physically as well as chemically. This is why the cuts that demand the most patience reward it with the most body: they are the ones richest in connective tissue, and connective tissue is a kokumi engine that only time can start.



Designed onion in cross-section — grown for kokumi, the γ-glutamyl peptides that give a long cook its body. Cooked slow and sweet, it fills the gaps between the savory peaks.

Low-and-Slow Brisket, Kokumi Bark

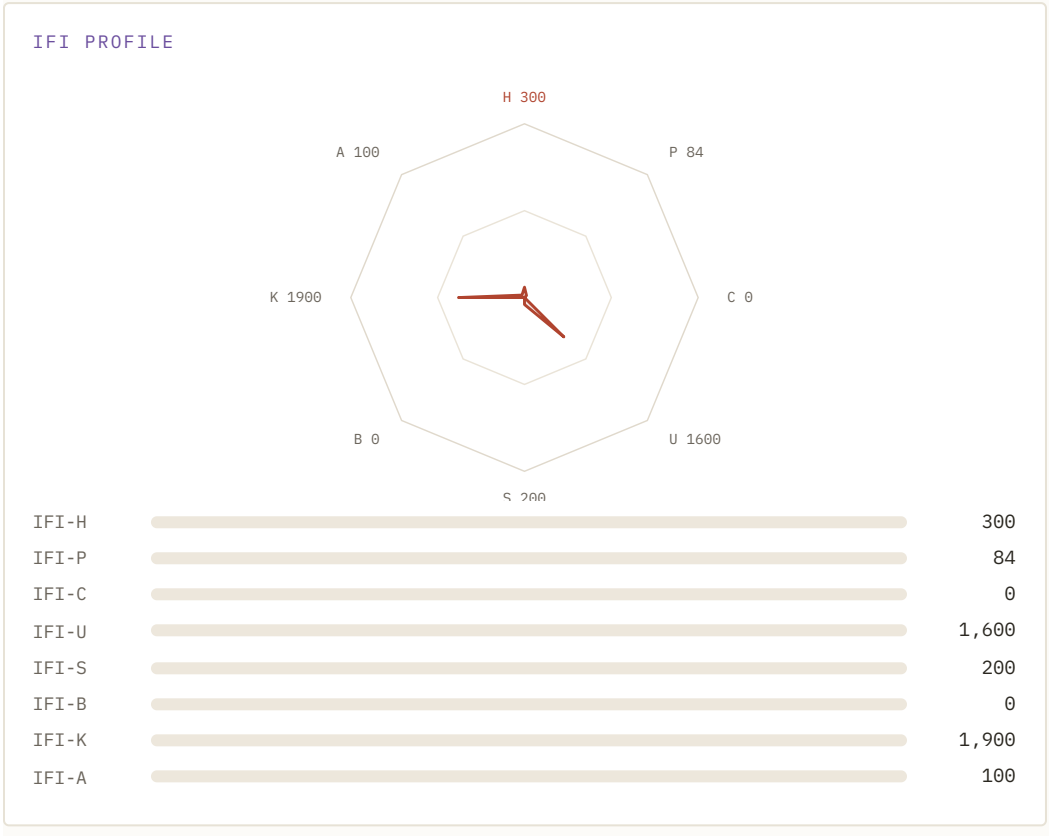
Serves 10–12 · 12 hours · the one that asks for your whole day

```
Serves 10–12 · 12 hours + overnight dry-brine
1 whole packer brisket (5–6 kg)
Kokumi Dry-Brine (Chapter 5), the night before
½ cup House Rub (Chapter 5)
2 tbsp designed garlic, granulated
1 tbsp nutritional yeast, from designed yeast
Koji-Tomato Mop (Chapter 11), for the back half
```

1. The night before, trim the fat cap to a finger's width and apply the Kokumi Dry-Brine to every surface. Leave uncovered in the cold; the bark begins here.
2. In the morning, mix the House Rub with the extra garlic and yeast — a second kokumi layer — and press it into every surface. Smoke fat-side up at a steady 107 °C. Do not open the lid for the first six hours; you are building, not checking.
3. When the bark is set and dark — around 74 °C internal — begin mopping (Chapter 11) every half hour. Push through the stall; it always passes. The stall is evaporative cooling as surface moisture leaves, and it is the bark setting, not a problem to solve.
4. Pull at 96 °C in the thickest part, when a probe slides in like warm butter. Rest, wrapped, a full hour — this is where the loosened gelatin and juices settle back through the meat. The rest is not optional; it is half the texture.

Why it works — The garlic and yeast flood the surface with γ-glutamyl peptides, so the bark reads *rich* and not merely *dry*; CaSR reports the fullness a twelve-hour cook earns, with a head start.

Meanwhile the collagen hydrolyzes to gelatin from within, coating the mouth and carrying the mop's glutamate longer. Depth, grown in and then earned over twelve hours — both.



Koji-Mopped Pulled Pork

Serves 8–10 · 10 hours · the shoulder that falls apart

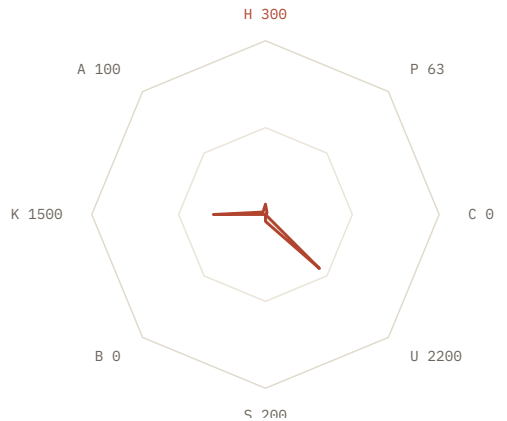
Where brisket wants restraint, a shoulder wants savor laid on thick, because its long cook and generous fat can carry it. This is where koji earns its place in a meat book.

```
Serves 8–10 · 10 hours
1 bone-in pork shoulder (3–4 kg)
Kokumi Dry-Brine (Chapter 5), the night before
¼ cup House Rub (Chapter 5)
2 tbsp light koji paste (from designed koji)
Koji-Tomato Mop (Chapter 11), through the cook
```

1. Dry-brine overnight; rub in the morning; smoke at 110 °C fat-side up.
2. At the four-hour mark, thin the koji paste with a little water and brush it on; repeat with the mop every hour thereafter.
3. Cook to 94 °C internal, until the bone pulls clean. Rest 45 minutes, then pull by hand, folding the bark back through.

Why it works — Koji (*Aspergillus oryzae*) is an enzyme factory: its proteases cleave the pork's own proteins into free glutamate right on the surface, and its own glutamate rides along, so the mopped shoulder builds savor that is *made in place* during the cook. The glutamate it generates meets the pork's inherited inosinate — Chapter 3's equation, running on the grate.

IFI PROFILE



IFI-H		300
IFI-P		63
IFI-C		0
IFI-U		2,200
IFI-S		200
IFI-B		0
IFI-K		1,500
IFI-A		100

Smoked Short Ribs, Red-Wine Mop

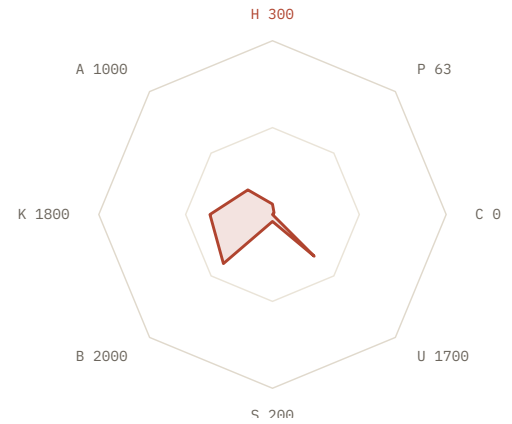
Serves 4–6 · 8 hours · the deepest, most grown-up plate in the book

```
Serves 4–6 · 8 hours
4 beef short ribs, plate cut (bone-in)
¼ cup Coffee-Cocoa Dark Rub (Chapter 12)
Red-Wine Mop (Chapter 12)
flaky salt
```

1. Rub the ribs hard the night before and smoke at 110 °C until the bark is near-black and the meat has pulled from the bone, about 7 hours.
2. Mop with the red-wine reduction through the final two hours.
3. Pull at 96 °C, rest 30 minutes, and serve one bone per person — it is rich beyond its size.

Why it works — Short ribs are a kokumi cut — heavy with collagen and fat — and they carry the dark coffee-and-cocoa crust and the wine's measured astringency without being overwhelmed. The bitterness and the tannin are both turned down from the edge at the source (Chapter 12), so the plate is deep and dark and still kind to the mouth.

IFI PROFILE



IFI-H		300
IFI-P		63
IFI-C		0
IFI-U		1,700
IFI-S		200
IFI-B		2,000
IFI-K		1,800
IFI-A		1,000

Smoked Beef Cheeks, Pure Kokumi

Serves 4 · 9 hours · the clearest kokumi lesson on a plate

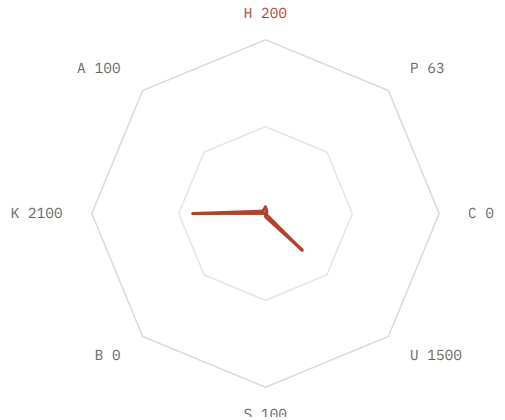
If you want to *taste* kokumi alone, cook a beef cheek. It is almost nothing but connective tissue and working muscle — the facial muscle of an animal that chews all day — which makes it the most collagen-dense cut on the steer and a pure demonstration of what time does to body.

```
Serves 4 · 9 hours
4 beef cheeks (trimmed, ~300 g each)
Kokumi Dry-Brine (Chapter 5), overnight
3 tbsp House Rub (Chapter 5)
Koji-Tomato Mop (Chapter 11), the back half
```

1. Dry-brine overnight; rub in the morning. Smoke at 105 °C — low, because the cheek wants hours, not heat.
2. The cheek will feel like a brick for the first many hours; this is the collagen holding. Around 88 °C internal it begins to give.
3. Mop through the final two hours. Pull at 94 °C, when the cheek quivers and a probe meets no resistance. Rest 30 minutes and slice against the grain, or shred.

Why it works — The cheek's triple-helical collagen unwinds and hydrolyzes to gelatin across the long cook, coating the mouth and physically extending every flavor it carries; meanwhile its own slow proteolysis and the dry-brine's γ-glutamyl peptides give CaSR a steady signal. The result is body with almost no fat — kokumi you can feel in the jaw, a roundness that comes entirely from structure and time. Eat it and you will never again mistake kokumi for richness; it is *continuity*, and the cheek is its purest teacher.

IFI PROFILE



IFI-H	200
IFI-P	63
IFI-C	0
IFI-U	1,500
IFI-S	100
IFI-B	0
IFI-K	2,100
IFI-A	100

Chapter 8 · The Sear — *a crust and a number.*

**Maillard at full volume · the reverse sear · beef glutamate, woken*

If low-and-slow is patience, a steak is its opposite: the whole art is in ninety seconds of ferocious heat and knowing exactly when to stop. A great crust is the **Maillard reaction** at full volume — reducing sugars and amino acids colliding into savory browned molecules — and under it the beef's own glutamate and inosinate waking up as the surface concentrates. Our work is to meet that with the garden, at the finish, so the crust tastes of more than char.

The thermodynamics are worth a paragraph, because they explain the reverse sear, which is the single best technique a home griller can adopt. Maillard browning runs usefully fast only above about 140 °C; a steak's interior is perfectly cooked around 52–55 °C for medium-rare. Those two numbers are nearly a hundred degrees apart, and the old method — a screaming pan from raw — tries to span them in one motion, which is why a pan-seared steak so often wears a gray band of overcooked meat beneath its crust. The reverse sear separates the two jobs. Bring the interior up slow and even in a low oven or the cool side of the grill until it is nearly at target; *then* hit the dry surface with ferocious heat for a brief, pure browning. Interior and crust, each cooked on its own terms. A dry surface is the other half: Maillard competes with evaporation, and a wet steak spends its first seconds of fierce heat merely boiling off water instead of browning, so a surface dried in the cold air of the fridge browns faster and deeper.



Charred sweet corn — the reducing sugars that drive Maillard made visible, and the smoky backbone of a steak-house plate. Browning is amino acids meeting sugars at high dry heat; the garden brings both.

It is worth knowing what the browning actually is, because once you can name the stages you can steer them. The Maillard reaction is not one reaction but a cascade. It opens when a reducing sugar's carbonyl condenses with a free amino group to form a glycosylamine, which rearranges (the **Amadori rearrangement**) into a reactive ketosamine. That intermediate fragments down a branching thicket of paths, and the branch that matters for flavor is

Strecker degradation, in which an amino acid is broken down against a dicarbonyl to yield a **Strecker aldehyde** — the molecules that smell specifically of what was browned (malty, meaty, nutty, roasted). Further along, these fragments condense into **pyrazines** (the roasted, nutty top notes), **thiophenes and thiols** (the meaty sulfur notes, from sulfur-bearing amino acids like cysteine and methionine), and finally into the brown **melanoidin** polymers that give a crust its color. A sear is, chemically, a few hundred of these molecules made at once on a thin surface — which is why no single added flavoring ever quite replaces a real crust.

Temperature governs the whole cascade, and a short table is worth more than a paragraph of caution:

SURFACE TEMP	WHAT HAPPENS
below 100 °C	water boils off; no browning — the wet-steak trap
110–140 °C	slow browning begins; good for a gentle crust
150–180 °C	Maillard in full voice; the steak-house sear
above 200 °C	pyrolysis and char; savor spends into bitterness

The lesson for a cook is the top and the bottom of that table. A wet surface wastes its first fierce seconds boiling, so you dry the steak. And a surface pushed too far past the sweet spot tips from savory to burnt, because — recall Chapter 2 — Maillard *consumes* the free amino acids that would otherwise read as savor, so an over-charred crust literally spends its own umami. The perfect sear lives in a narrow window: hot enough for the full cascade, brief enough to stop before the char. That window is the whole reason the reverse sear exists.

Reverse-Seared Ribeye, Garlic-Herb Butter

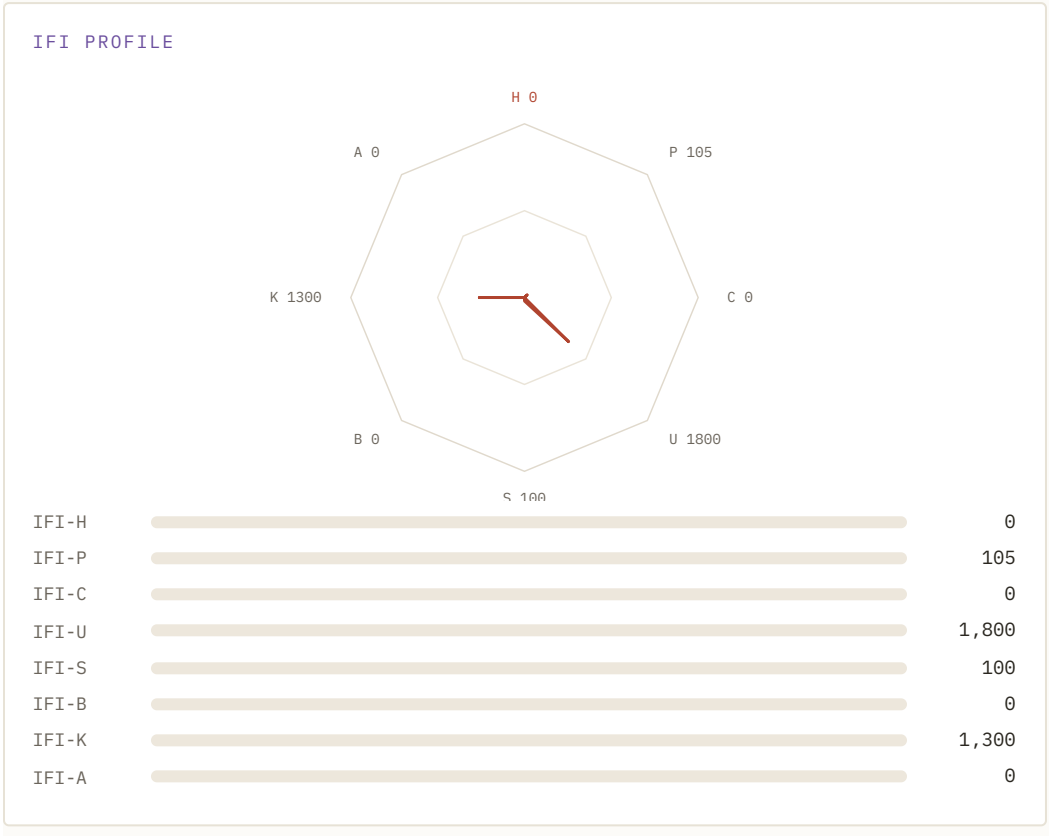
Serves 2 · 45 minutes · the simplest thing done exactly right

> Serves 2 · 45 minutes
> 1 thick ribeye (500 g, 4 cm)
> House Rub (Chapter 5), lightly
> 2 tbsp butter
> 3 cloves designed garlic, crushed
> a few sprigs thyme
> flaky salt

1. Season the steak and bring it up slow — a 120 °C oven or the cool side of the grill — to 49 °C internal. This is the patient half; it cooks the inside evenly before any crust forms.
2. Now the fast half: a screaming-hot pan or the coals directly. Sear ninety seconds a side, no longer, until the crust is deep and lacquered.
3. In the last thirty seconds add the butter, garlic, and thyme, tilt the pan, and spoon the foaming butter over the top again and again.
4. Rest five minutes. Salt at the very end, so it stays loud on the surface rather than dissolving in.

Why it works — The sear builds savor through Maillard; the designed garlic answers it with kokumi so the crust reads round rather than merely burnt; the thyme's TRPA1 lift keeps the richness

from going flat. Three channels — umami, kokumi, pungency — arriving in the right order on one bite. That order is the difference between a steak that is good and one you remember.



The Umami Smash Burger

Serves 4 · 30 minutes · proof that the tomato is not decoration

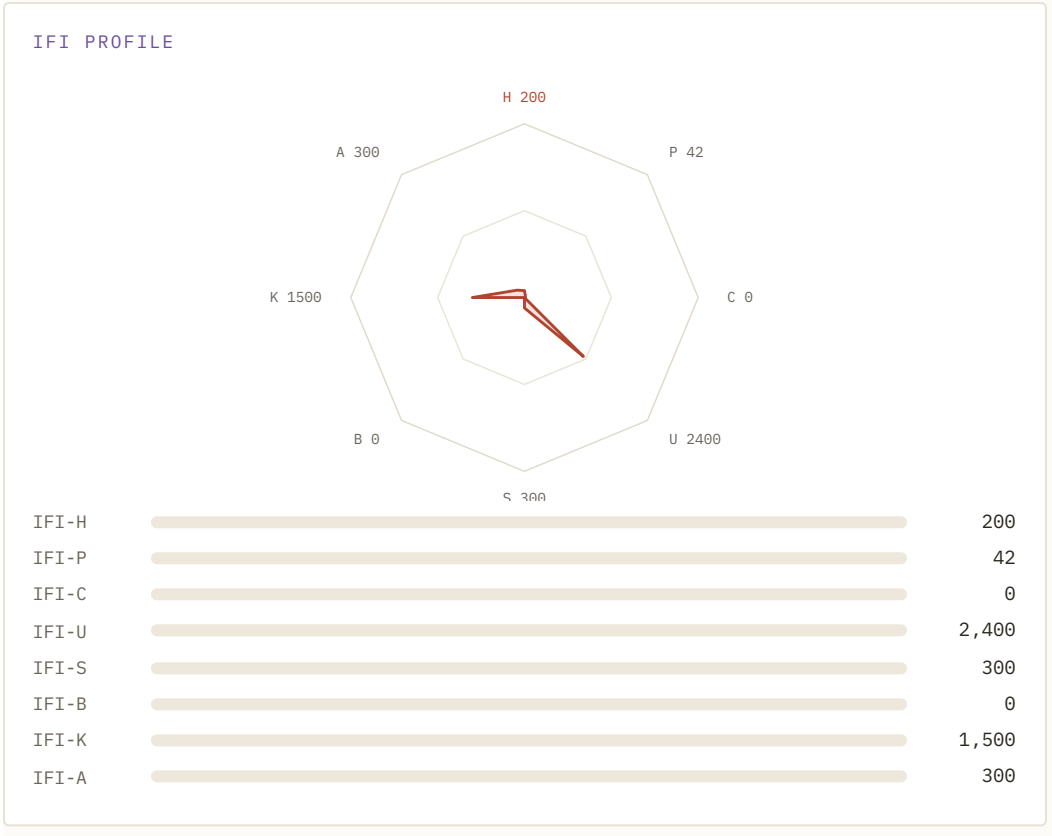
A burger is a savory problem disguised as a simple one. Everything in it reaches toward the same receptor — the crust, the melt, the tomato, the allium — and the great ones stack those sources so they multiply rather than merely sit together. This is where a restored tomato stops being a garnish and becomes structural.

```
Serves 4 · 30 minutes
600 g ground beef (80/20), loosely divided into 8 balls
House Rub (Chapter 5)
4 restored tomato slices, thick (IFI-U 2,600)
1 designed onion, sliced thin
4 slices aged cheese
4 soft buns, toasted
Koji-Tomato Mop (Chapter 11), as the special sauce
```

1. Smash the beef balls hard onto a screaming flat-top, season only now, and let the crust form before the one flip — the smash is all Maillard surface area.
2. Cook the onions slow and separate until sweet and collapsed; this is a savory layer, not a crunch.
3. Char the tomato slices thirty seconds a side; heat wakes their glutamate the way it wakes the beef's.
4. Build: mop on the bun, double patty, cheese, charred tomato, sweet onion. The restored tomato is load-bearing here — treat it like one.

Why it works — Four glutamate sources — the Maillard crust, the aged cheese, the koji mop, and a tomato at **IFI-U 2,600** — meet the beef's own inosinate, and because glutamate and the meat's nucleotide multiply at mGluR1 rather than add (Chapter 3), the whole

burger reads savory far past the sum of its parts. The onion's kokumi fills the gaps between the peaks, so the last bite is as complete as the first.



Koji-Aged Strip, Seared Hard

Serves 2 · 3 days (mostly waiting) + 20 minutes · the home dry-age, made fast

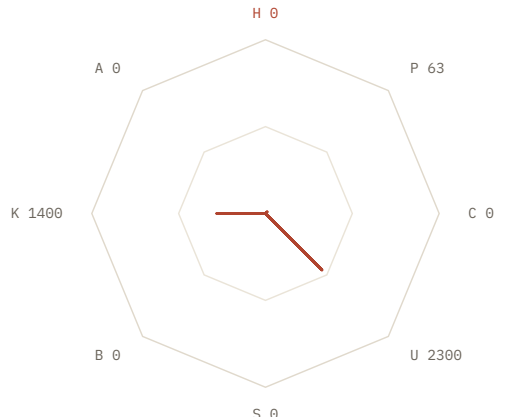
The koji trick that transforms a shoulder (Chapter 7) works a quiet miracle on a steak: a koji crust accelerates, in days, the enzymatic savor that dry-aging takes weeks to build.

> Serves 2 · 3 days + 20 minutes
> 1 New York strip (400 g)
> 2 tbsp light koji paste (from designed koji)
> House Rub (Chapter 5), to finish
> flaky salt

1. Coat the strip thinly in koji paste and rest it uncovered on a rack in the cold for three days, turning once daily. The koji's proteases free glutamate at the surface as a mold-aged crust forms.
2. Wipe the koji away, pat the surface bone-dry, and sear hard — a reverse sear (as above) is ideal.
3. Finish with a dusting of House Rub and flaky salt.

Why it works — Koji proteolysis does in three days what calpains and cathepsins do in four weeks (Chapter 2): it liberates free glutamate from the meat's own proteins. Seared, that surface meets its inherited inosinate at the receptor, and the steak eats like one aged far longer than it was.

IFI PROFILE



IFI-H	0
IFI-P	63
IFI-C	0
IFI-U	2,300
IFI-S	0
IFI-B	0
IFI-K	1,400
IFI-A	0

Chapter 9 · Ribs, Wings & the Lacquer — *sweet heat, built to hold.*

**IFI-H × IFI-S · the flux-balance ratio · sugar-free sweetness · staging*

Heat and sweetness are the dominant pairing in all of barbecue — *swicy*, the trend that ate the condiment aisle — and the hardest to hold, because the two signals compete for attention. Sugar finds the **TAS1R2·TAS1R3** duet; capsaicin finds **TRPV1**; stack them naïvely and they smear into muddle. The platform's flux-balance model finds the ratio that holds, which is why a designed sweet-hot tastes *intended* rather than confused — the sweetness arriving first and wide, the heat landing a beat behind it and climbing into the space the sweetness opened.

There is a second lever, and it is the one that keeps a glaze from defeating itself. A lacquer or a glaze needs enough sugar to set glassy under the fire and to brown — but sugar is also water-loving and heavy, and too much of it *steams* the skin soft instead of crisping it, and buries the heat under cloy. Sugar-free sweetness solves exactly this. We grow **stevia (910 constructs)**, **monk fruit**, and **sugarcane** tuned so the sweet *signal* on TAS1R2·R3 climbs while the actual sugar load stays low. The result is a glaze that reads sweeter than its sugar — so the skin stays crisp, the body registers the sweetness, and the pancreas registers almost nothing. On a rib that becomes a lacquer; on a wing, a bright thin glaze that chars but never soaks.



Designed monk fruit — mogroside sweetness that reads on TAS1R2·R3 without the sugar load, so a glaze can be sweet and still crisp. The lever that lets a lacquer set without steaming the skin soft.

The sweeteners earn their place by a trick of chemistry worth naming. Ordinary sugar activates TAS1R2·R3 weakly — you need grams of it to taste sweet — which is why sugar is as much *bulk* as it is *flavor.* The designed sweeteners are **high-potency** agonists: **steviol glycosides** from stevia, **mogrosides** from monk fruit, and the sweet protein **brazzein**, all of which bind the sweet receptor far more tightly than sucrose and so register loudly at a fraction of the mass. On the Index that is simply a low EC_{50} — a loud sweet — and in a glaze it means you can reach the sweetness a lacquer needs while carrying a tenth of the sugar. Stevia alone spans **910 constructs** in

the library, tuned to clean the lingering bitterness that dogs the natural glycoside, because a sweetener with a bitter tail is no gift to a glaze.

Now the ratio, because swicy is first of all a *ratio problem.* The sweet signal and the heat signal compete for the tongue's attention, and the flux-balance model's contribution is to find the proportion where they stage in sequence rather than cancel. Empirically, a lacquer reads as *intended sweet-heat* — sweet arriving first and wide, heat landing a beat behind and climbing — when IFI-S leads IFI-H by roughly two to one: a glaze at **IFI-S 1,400** carries its best against a heat near **700**, which is exactly where the lacquered ribs below are set. Push the heat up toward the sweet and the two smear into muddle; drop it far below and the glaze reads flat and candied. The two-to-one shoulder is not a rule of taste handed down; it is where the model puts the two receptor curves so that neither saturates the other, and you can hear it land on the tongue as two notes in order instead of one note confused.

Sweet-Hot Lacquered Ribs

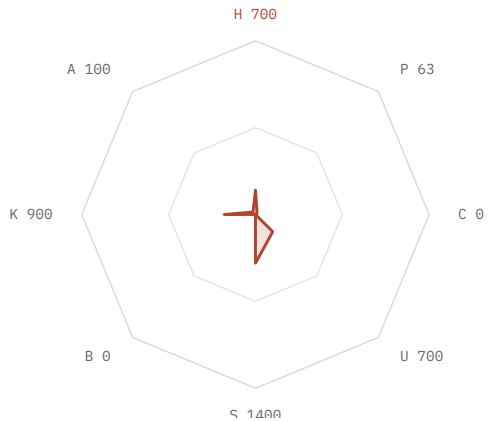
Serves 4 · 5 hours · the sticky-fingered centerpiece

```
Serves 4 · 5 hours
2 racks pork spare ribs, membrane removed
3 tbsp House Rub (Chapter 5)
½ cup honey
2 tbsp designed-sweetener syrup (stevia or monk fruit)
2 tbsp cider vinegar
1 tbsp soy, from designed soybean
chile, to IFI-H 700
```

1. Rub the racks and smoke at 120 °C for three hours, meat-side up, until the surface is mahogany and the meat has pulled back from the bone tips.
2. Warm the honey, sweetener syrup, vinegar, soy, and chile into a loose lacquer, measuring the heat to **IFI-H 700** — present, not punishing.
3. Brush the lacquer on in the final hour, three thin coats, letting each set tacky before the next. Thin coats glass; thick coats slide.
4. Rest ten minutes so the lacquer firms. Cut between the bones.

Why it works — The honey and designed sweetener reach the receptor first and spread wide; the chile, held to 700 by design, arrives a half-second behind and blooms into the space the sweetness opened. That staging is not luck — it is the flux model choosing a ratio where neither signal cancels the other, so the rib tastes of two things in sequence rather than one thing confused. The designed syrup lets the lacquer stay sweet without the full sugar load that would steam the bark soft.

IFI PROFILE



IFI-H	700
IFI-P	63
IFI-C	0
IFI-U	700
IFI-S	1,400
IFI-B	0
IFI-K	900
IFI-A	100

Hot-Honey Glazed Wings

Serves 4 · 40 minutes · the first platter to empty

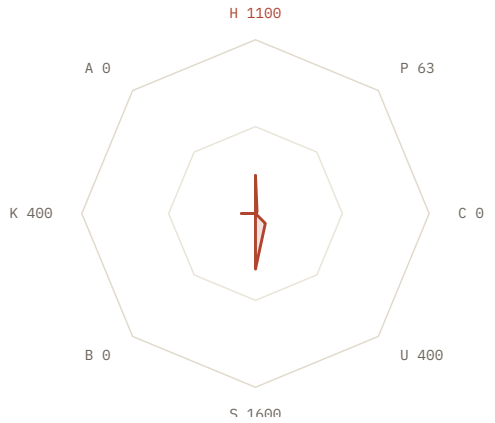
A rib wants its sweet-heat slow and lacquered; a wing wants it fast, bright, and loud. Same two receptors, different tempo.

```
Serves 4 · 40 minutes
1 kg chicken wings, split
2 tsp House Rub (Chapter 5)
1 tsp baking powder
⅓ cup honey
2 tbsp designed-sweetener syrup (stevia or monk fruit)
2 tbsp cider vinegar
chile, to IFI-H 1,100
flaky salt
```

1. Toss the wings with the rub, salt, and baking powder — the powder raises the skin's pH and dries it to a crackle. Grill hot and direct, turning, until blistered and crisp, about 25 minutes.
2. Warm the honey, designed syrup, vinegar, and chile to a pourable glaze, metered to **IFI-H 1,100**.
3. Toss the hot wings in the glaze right at the fire's edge so it clings and chars but never soaks. Flaky salt over the top.

Why it works — The designed sweetener lifts IFI-S without the sugar that would steam the skin limp, so the wing stays crisp while tasting sweeter. The heat sits at 1,100 — loud enough to be the story, low enough that a second wing is a pleasure and not a penance.

IFI PROFILE



IFI-H	1,100
IFI-P	63
IFI-C	0
IFI-U	400
IFI-S	1,600
IFI-B	0
IFI-K	400
IFI-A	0

Gochujang-Style Glaze, to the Number

Makes 1 cup · the deep sweet-hot, fermented and savory

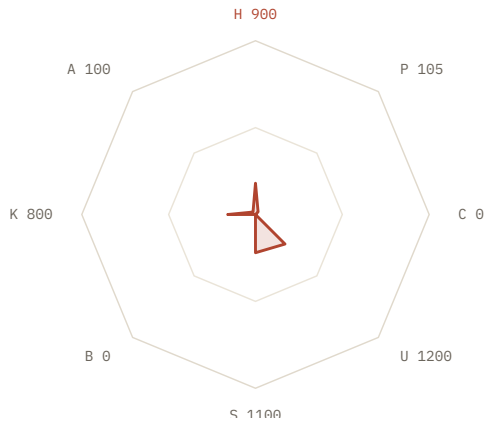
Where honey glazes lead with pure sweetness, this one leads with fermented depth — a swicy glaze that carries umami under its heat, built for pork belly, thighs, or a basted rib.

```
Makes 1 cup · 15 minutes
3 tbsp fermented chile-soy paste (from designed soybean + chile)
2 tbsp designed-sweetener syrup
1 tbsp honey
1 tbsp cider vinegar
1 tsp designed garlic, grated
1 tsp designed ginger, grated
chile, to IFI-H 900
```

1. Whisk all together and simmer five minutes until glossy and spoon-coating.
2. Brush on in the last twenty minutes of a cook, in thin coats.

Why it works — The fermented soy brings glutamate and kokumi *under* the sweet-hot, so the glaze has a floor; the ginger and garlic add a TRPA1 lift at the top. Four axes staged in order — savory floor, sweet wide, heat behind, pungent at the peak — which is swicy with a backbone.

IFI PROFILE



IFI-H	900
IFI-P	105
IFI-C	0
IFI-U	1,200
IFI-S	1,100
IFI-B	0
IFI-K	800
IFI-A	100

Burnt Ends, Sweet-Hot and Lacquered

Serves 6 · 14 hours · the candy of the smoke

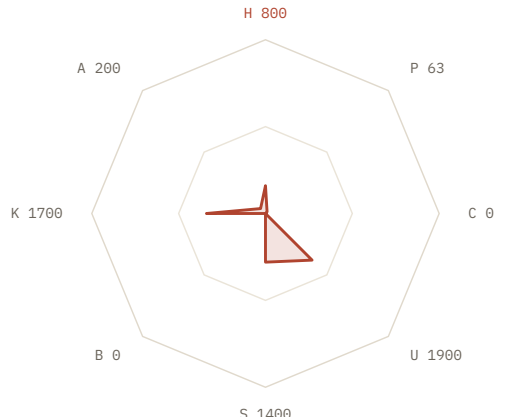
The point end of a brisket, cooked past done, cubed, and lacquered until the edges turn to savory candy — this is where kokumi, umami, and swicy meet on one glossy cube, and it is the single most requested thing we have ever handed across someone else's fence.

```
Serves 6 · 14 hours
1 brisket point (2.5–3 kg), cooked as in Chapter 7 to 96 °C
½ cup All-Table Finishing Sauce (Chapter 11)
¼ cup honey
2 tbsp designed-sweetener syrup
chile, to IFI-H 800
2 tbsp House Rub (Chapter 5)
```

1. Cook the point as part of a full brisket (Chapter 7) or on its own to 96 °C and probe-tender. Rest, then cut into 3 cm cubes.
2. Toss the cubes with the finishing sauce, honey, sweetener, chile, and rub in a foil pan.
3. Return to the smoker at 135 °C, uncovered, 90 minutes to two hours, stirring once, until the lacquer tightens to a sticky, dark, glassy coat and the edges crisp.

Why it works — The point is the fattiest, most collagen-rich end of the brisket, so it carries a heavy sweet-hot lacquer without being overwhelmed — the kokumi floor holds up the swicy top. The second cook drives off moisture and sets the glaze through repeated thin reductions, which is why the edges turn to candy: concentrated sugar, concentrated glutamate, concentrated everything, on a cube built to carry it.

IFI PROFILE



IFI-H	800
IFI-P	63
IFI-C	0
IFI-U	1,900
IFI-S	1,400
IFI-B	0
IFI-K	1,700
IFI-A	200

Chapter 10 · The Bird & the Shoulder — *the fungal floor, laid on poultry and pork.*

**the shiitake gift · guanylate · brining as receptor work*

Poultry is the hardest canvas in this book, because it brings the least savor of its own — a chicken's post-mortem inosinate is real but modest, and its glutamate low — which makes it the clearest proof of what the garden can lend. Where a dry-aged ribeye arrives loud, a chicken thigh arrives as a question, and the answer is the **fungal floor**: the guanylate of a dried mushroom, the most potent nucleotide of all at coefficient 2.30, and the glutamate of koji and yeast, brined and rubbed into a bird that has little of its own.



Koji mold — *Aspergillus oryzae*, the enzyme factory that frees glutamate from a bird's own proteins and lends its own, laying a savory floor on the least savory meat.

A brine is not merely salt and water; read at the receptor it is a delivery system. Salt dissolves muscle proteins so they hold water (the juiciness) and, as it does, it opens the surface to everything dissolved alongside it — so a brine carrying glutamate and guanylate seasons a bird with savor the way a plain brine seasons it with salt. We lean on **shiitake (80 constructs)** for guanylate, **koji (80)** and **yeast (240)** for glutamate and kokumi, and let the brine carry all three deep before the fire ever touches the skin.

A word on why the dried mushroom is the key to the fungal floor, because the chemistry is a small marvel and it changes how you cook with it. Guanylate does not sit free in a fresh mushroom; it is locked inside the fungus's **RNA.** When a shiitake is dried and then rehydrated and gently warmed, the mushroom's own enzyme **ribonuclease** cleaves that RNA, liberating **GMP** into a free, receptor-ready form. This is the reason a *dried* shiitake is worlds more savory than a fresh one, and the reason the old instruction is to soak dried mushrooms in cool water and bring them up slowly: you are running an enzymatic reaction, not merely softening a cap. Water too hot too fast denatures the ribonuclease before it finishes, and the gift is lost. We tune the shiitake to carry more RNA substrate and a more active nuclease, so the dried cap yields more guanylate per gram — a louder multiplier in a smaller dusting, and the single most efficient savory tool a poultry cook owns.

Koji-Brined Spatchcock Chicken

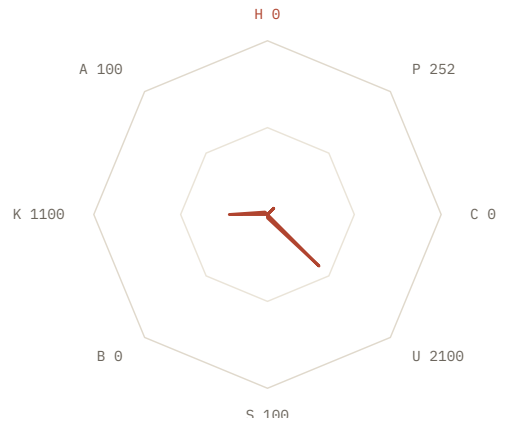
Serves 4 · overnight brine + 1 hour · the bird that tastes like more than chicken

```
Serves 4 · overnight + 1 hour
1 whole chicken (1.6–1.8 kg), spatchcocked
— the brine —
2 L water
80 g kosher salt
2 tbsp light koji paste (designed koji)
2 dried shiitake (designed shiitake), crushed
1 tbsp nutritional yeast (designed yeast)
— to finish —
Pungent Herb Rub (Chapter 5)
```

1. Warm a cup of the water to dissolve the salt, koji, crushed shiitake, and yeast; cool, combine with the rest, and submerge the spatchcocked bird overnight in the cold.
2. Pat bone-dry and rest uncovered an hour so the skin dries. Rub the skin side with the Pungent Herb Rub.
3. Grill skin-side up over indirect heat at 190 °C until the thickest part of the thigh reads 74 °C, then crisp the skin directly for the last few minutes.

Why it works — The brine lays a full synergy into the meat before cooking: glutamate from the koji and yeast, guanylate from the shiitake, so the bird's modest native inosinate is joined by borrowed partners at both of the receptor's sites. The koji's proteases also free some of the chicken's own glutamate during the overnight soak. A plain roast chicken asks you to notice the skin; this one asks you to notice the meat.

IFI PROFILE



IFI-H	0
IFI-P	252
IFI-C	0
IFI-U	2,100
IFI-S	100
IFI-B	0
IFI-K	1,100
IFI-A	100

Shiitake-Rubbed Pork Shoulder Steaks

Serves 4 · 40 minutes · the weeknight version of the long cook

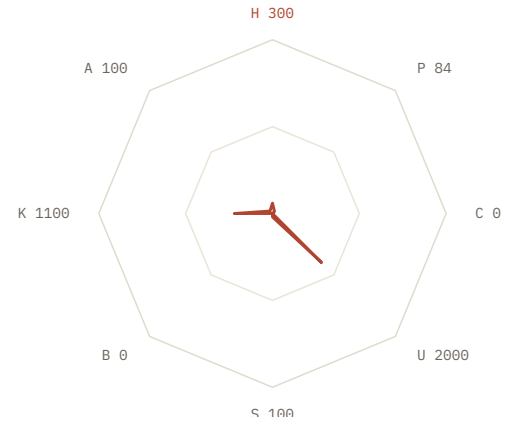
Not everyone has twelve hours. These shoulder steaks — cut across a whole shoulder — deliver much of the long cook's savor in a weeknight, because the rub does the work the time usually would.

```
Serves 4 · 40 minutes
4 pork shoulder steaks (2 cm thick)
2 tbsp dried shiitake, ground to powder (designed shiitake)
1 tbsp House Rub (Chapter 5)
1 tsp designed garlic, granulated
flaky salt
```

1. Mix the shiitake powder, House Rub, and garlic; press into both faces of the steaks and rest 20 minutes.
2. Grill hot and direct, 4–5 minutes a side, until well-browned and just cooked through.
3. Rest five minutes; finish with flaky salt.

Why it works — Ground dried shiitake is nearly pure guanylate on the surface; seared onto pork that carries its own inosinate and freed glutamate, it multiplies the savor of a quick cook to something closer to a slow one. The mushroom is doing the chemistry that patience usually supplies.

IFI PROFILE



IFI-H	300
IFI-P	84
IFI-C	0
IFI-U	2,000
IFI-S	100
IFI-B	0
IFI-K	1,100
IFI-A	100

Smoked Turkey, Umami-Brined

Serves 10 · overnight brine + 4 hours · the holiday bird, finally savory

The turkey is poultry's hardest case — huge, lean, prone to dryness, and famously bland — which makes it the fullest test of the fungal floor. A turkey brined in guanylate and glutamate and smoked low eats like a different bird entirely.

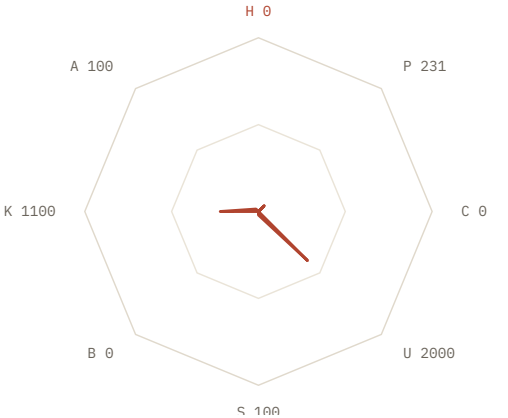
```
Serves 10 · overnight + 4 hours
1 whole turkey (5–6 kg)
— the brine —
5 L water
200 g kosher salt
3 tbsp light koji paste (designed koji)
4 dried shiitake (designed shiitake), crushed
2 tbsp nutritional yeast (designed yeast)
2 tbsp designed garlic, granulated
— to finish —
3 tbsp Pungent Herb Rub (Chapter 5)
```

1. Dissolve the salt, koji, shiitake, yeast, and garlic in a warmed portion of the water; cool, combine, and submerge the bird overnight in the cold.
2. Lift out, pat dry inside and out, and rest uncovered a few hours so the skin dries for crisping.
3. Rub the skin with the Pungent Herb Rub. Smoke at 150 °C, breast up, until the thickest part of the thigh reads 74 °C, about four hours, tenting the breast with foil if it runs ahead.
4. Rest 30 minutes before carving. The legs will carry more savor than the breast — serve them to the people who claim not to like turkey.

Why it works — The long brine lays a full synergy through the lean breast meat before it ever hits the smoke: shiitake guanylate for the nucleotide site, koji and yeast glutamate for the cleft, so the turkey's own faint savor is joined by borrowed partners at both. The salt

holds the water that keeps the breast moist; the fungal floor gives the whole bird the depth it was born without. It is the clearest case in the book of the garden rescuing a meat from its own blandness.

IFI PROFILE



IFI-H	0
IFI-P	231
IFI-C	0
IFI-U	2,000
IFI-S	100
IFI-B	0
IFI-K	1,100
IFI-A	100



PART IV OF V

The Wet Side

the mop & the sauce board · the dark rub · the sharp edge & the cool side

Chapter 11 · The Mop & the Sauce Board — *the restored tomato, made structural.*

**IFI-U · the great emptying · the regional wars, scored*

Every barbecue region argues about sauce, and the argument is really about which axis leads. Carolina leads with the sharp, clean acid of vinegar. Kansas City leads with sweet, thick tomato. The deep sops of the pit lead with savory. Scored on the Index, the regional wars resolve into a small set of recipes that each put one axis in front — and the reason we can finally win any of them is that we fixed the ingredient at their center. We gave the tomato its savor back.

A century of breeding for the truck quietly emptied the tomato of the very thing that made it worth cooking into a sauce. The fruit lost roughly **ninety-three percent** of its peak umami on the way to the shelf — not to any villain but to logistics: thick skin for the road, uniform ripening for the single-pass harvest, and above all the ability to be picked hard and green and gassed red with ethylene in a warehouse, days after leaving the vine that was supposed to finish it. Free glutamate pools *late*, in the final days of real on-vine ripening, as the fruit shifts from building tissue to softening and deepening; a green-picked, gassed fruit never passes through that window. It colors without ever savoring. We restore the window in the plant — tuning down the ripening-fruit **GAD** branch so late glutamate stops bleeding into the GABA shunt, and lifting the **GS/GOGAT** assimilation and **GDH1** buffer so the pool fills and holds — across **2,040 constructs**, the largest organism library we hold after the pepper itself. The result reads **IFI-U 2,600** against a commodity tomato's 300: a near-ninefold restoration from only about threefold more glutamate, because the restored fruit sits high on the steep middle of the receptor curve where the emptied one never did.



The restored vine, as it should taste in the mouth and as it rarely survives to the shelf — the whole of a tomato, grown back to its savor and made the center of every sauce in this chapter.

The restoration is three native routes tuned together, and it is worth seeing because it is exactly the inverse of the dry-ager's climb in Chapter 2 — the same glutamate pool, filled by metabolism instead of time:

ROUTE	WE TUNE IT	EFFECT ON THE RIPE FRUIT
GAD (glutamate decarboxylase)	down	stops late glutamate bleeding into the GABA shunt
GS/GOGAT cycle	up	fills the glutamate pool (nitrogen assimilation)
GDH1 (glutamate dehydrogenase)	up	buffers and holds the pool through ripening

The net is a fruit that pools free glutamate the way a vine-ripened heirloom does on its best afternoon in August — and holds it, reproducibly, in a cultivar that can still be grown and shipped. Set the climb against the loss and the whole emptying is one table, read top to bottom as a century of logistics and bottom to top as the repair:

TOMATO	FREE GLUTAMATE (MG/100 G)	IFI-U	WHAT IT IS
Commodity, green-picked and gassed	~45	300	the emptied baseline
Standard field, vine-ripened	~100	900	what ripening alone restores
Heirloom, peak-season	~170	1,700	the best the old genetics reach
Restored, umami-tuned	~250	**2,600**	the vine's own intent, grown to hold

Read the bottom two rows and the nonlinearity of Chapter 1 is in front of you: about fifty percent more glutamate, yet better than fifty percent louder, because the restored fruit sits higher on the steep middle of the receptor curve. A sauce built on that fruit is savory *and* thin — it brushes and clings without reducing to paste — because the depth was grown in rather than boiled down from bones. That is the quiet luxury the restored tomato gives a pitmaster: body without weight.

Koji–Tomato Mop

Makes 2 cups · the sauce that makes smoke taste like more of itself

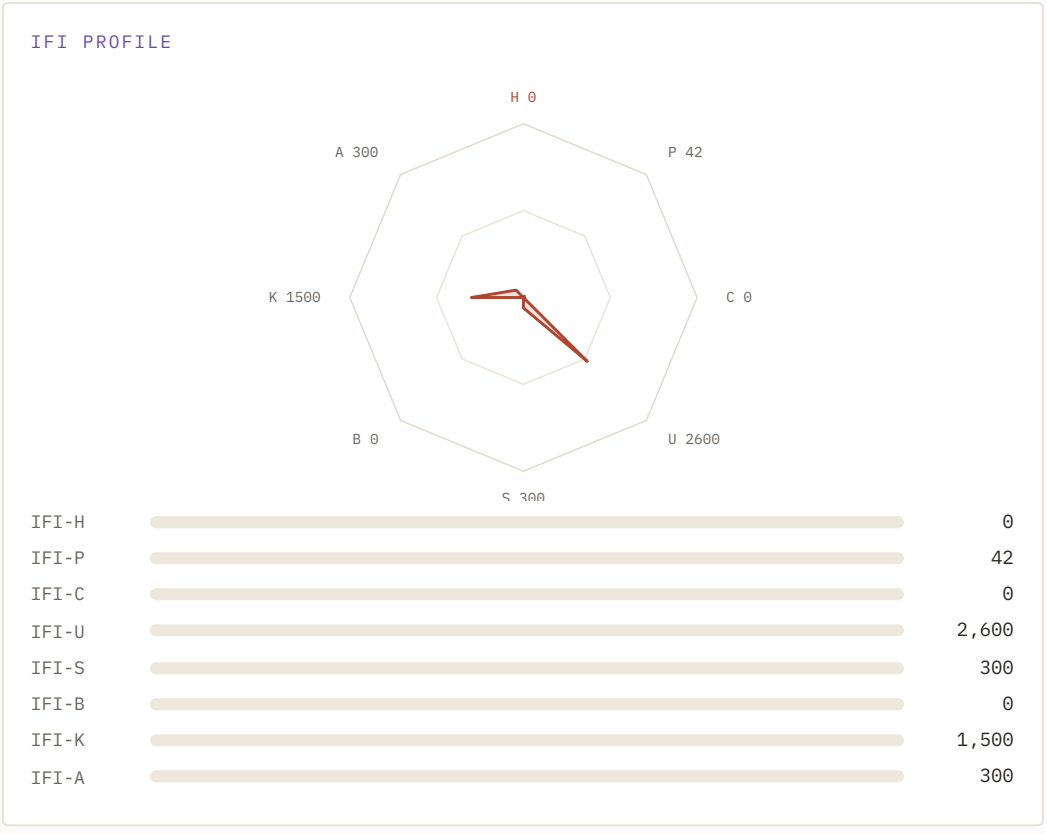
A mop is not a glaze — it is thin, you brush it on through the long hours, and it builds the meat's savory in layers. This one is almost pure umami, built to deepen anything it touches.

```
Makes 2 cups · 30 minutes
4 ripe restored tomatoes (IFI-U 2,600)
2 tbsp light koji paste (designed koji)
2 dried shiitake (designed shiitake), ground
2 tbsp soy, from designed soybean
2 tbsp cider vinegar
1 tbsp House Rub (Chapter 5)
1 cup water
```

1. Grate the cut faces of the tomatoes against the coarse holes of a box grater, down to the skin, for a loose bright pulp that smells like a greenhouse in the sun.
2. Simmer everything together, loose and low, twenty minutes, until it just coats the back of a spoon but still brushes thin.

3. Mop on in the last two hours of a long cook, every half hour, so each coat sets before the next. Keep it thin; depth is built in layers, not in one heavy stroke.

Why it works — Three sources of glutamate stacked (restored tomato, koji, soy) and the shiitake's guanylate beside them: glutamate and guanylate multiply at the receptor rather than add, which is why the mop tastes far deeper than any one part. Brushed onto meat carrying its own inosinate, it completes the synergy of Chapter 3 on the grate. The vinegar keeps it bright; savor this grown-in does not need to be thick to be felt.



The Sauce Board — three regions, three leading axes

Keep all three on the table, because a good table wants the choice. Each puts one axis in front:

SAUCE	LEADS WITH	BUILD	SCORECARD
Carolina	acid + pungency	cider vinegar, chile to IFI-H 500, a pinch of sugar, cracked pepper — thin, bright, cuts richness	H 500 · P 63 · S 200
Kansas City	sweet tomato	restored tomato cooked down with molasses, vinegar, House Rub, chile to IFI-H 800 — thick, clinging	U 1,900 · S 1,200 · H 800
Pit Sop	savory	the drippings loosened with Koji–Tomato Mop and a splash of vinegar — thin, dark, brushed at the fire	U 2,200 · K 1,400 · H to taste

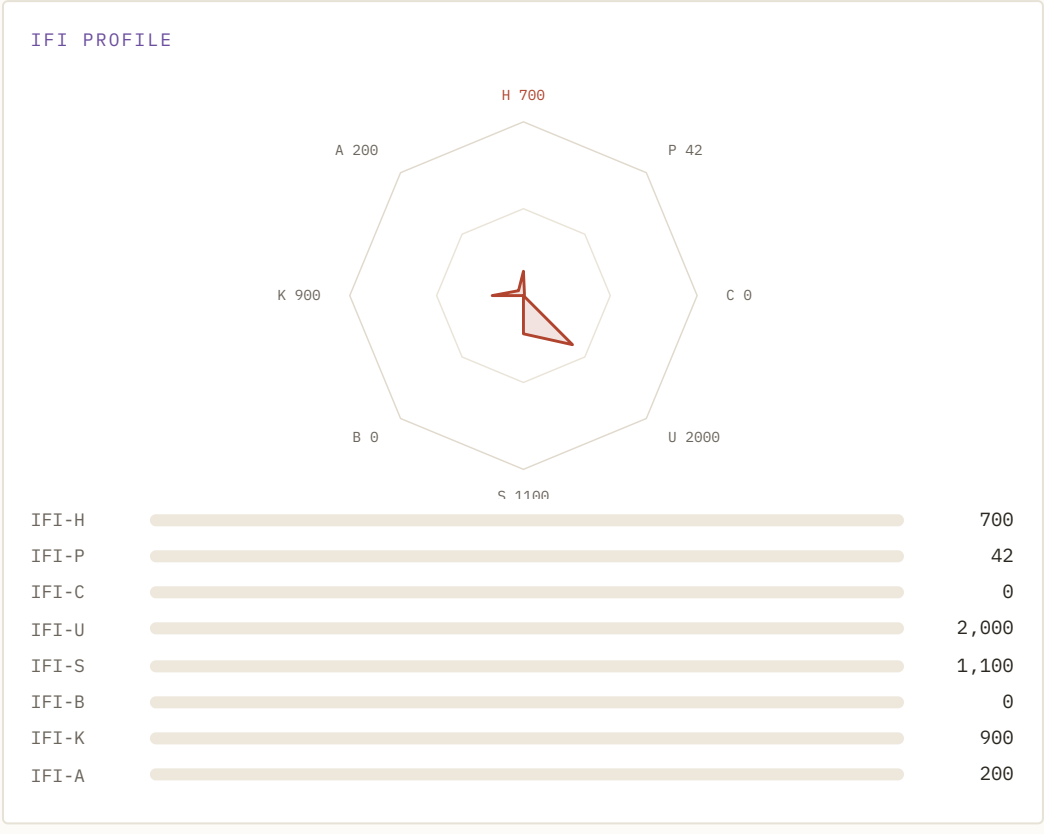
The All-Table Finishing Sauce

Makes 2 cups · when you want one jar to do everything

```
Makes 2 cups · 25 minutes
1 cup restored tomato, cooked down (IFI-U 2,600)
2 tbsp molasses
3 tbsp cider vinegar
1 tbsp soy, from designed soybean
1 tbsp House Rub (Chapter 5)
chile, to IFI-H 700
```

1. Simmer everything together twenty minutes until glossy and spoon-coating.
2. Taste for balance: more vinegar to brighten, more molasses to round, more chile to climb. The three axes are yours to set.
3. Bottle warm. It keeps two weeks cold and improves for the first few days.

Why it works — One sauce, three axes in deliberate tension: umami from the restored tomato and soy, sweetness from the molasses, heat metered to 700. Because the savor was grown in, the sauce is deep *and* thin — it settles the regional argument by refusing to pick a side.



Alabama White Sauce

Makes 1½ cups · the fourth region, for smoked chicken

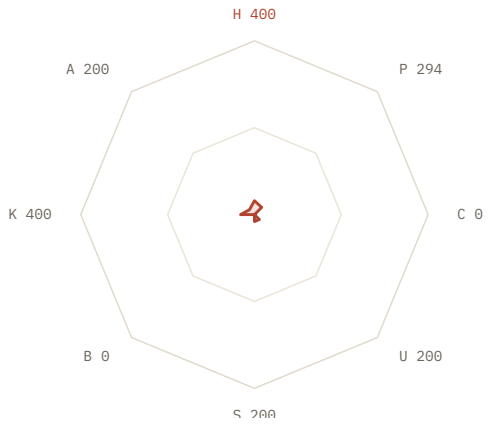
North Alabama's contribution to the sauce board leads with none of the usual axes — not tomato, not sweet, not deep savory — but with tangy, peppery, mayonnaise-bound brightness, made to be mopped on smoked chicken in the last minutes. It is the pungency region of the board, and the designed horseradish and mustard give it a clean sharp spine.

```
Makes 1½ cups · 10 minutes
1 cup mayonnaise
3 tbsp cider vinegar
1 tbsp designed white mustard, prepared
1 tsp designed horseradish, grated (or extra mustard)
1 tsp designed garlic, grated
1 tsp coarse black pepper
chile, to IFI-H 400
½ tsp salt
```

1. Whisk everything together until smooth and pourable; thin with a splash of water if needed.
2. Rest an hour in the cold so the pungency blooms and the flavors marry.
3. Mop onto smoked or grilled chicken in the final five minutes, or serve alongside for dipping. Keep it cold; it is mayonnaise.

Why it works — Where the other sauces lead with umami or sweet, this one leads with **pungency** on TRPA1 — the mustard and horseradish's isothiocyanates cutting straight through smoke and fat — over a cool, rich mayonnaise body. It is the sauce board's reminder that brightness is an axis too, and that a heavy plate sometimes wants a cut rather than more depth.

IFI PROFILE



IFI-H	400
IFI-P	294
IFI-C	0
IFI-U	200
IFI-S	200
IFI-B	0
IFI-K	400
IFI-A	200

Chapter 12 · The Dark Rub — *coffee and wine, turned down from the edge.*

**IFI-B · TAS2R38 · IFI-A · salivary PRPs · ANR*

The darkest, most serious barbecue flavors live near a cliff edge: coffee, cocoa, red wine, deep char — all of them delicious and all of them one step from bitter or drying. These are the two axes we work by *subtraction*, and they are the clearest demonstration in the whole kitchen of designing a flavor by what you take away.

Bitterness guards **TAS2R38**, one of a family of some twenty-five bitter receptors evolution built to warn us off toxins — which is why bitterness is the one taste we are born rejecting. In coffee and cocoa it is the edge that a dark rub walks: all that roasted depth sits right beside a scold. We reroute the bitter compounds at the source so the signal drops **twenty to sixty-five percent** without touching the roast, the color, or the aromatic depth. The coffee still tastes of midnight; it simply stops arguing with you. **Astringency** is a different sensation entirely — not a taste but a touch, the drying, puckering grip of **tannins** (proanthocyanidins) binding and precipitating the **proline-rich proteins (PRPs)** in your saliva, stripping the mouth of its lubrication. In a red-wine mop that grip can either structure the fat or fight it. We tune the grape's tannin load through the **ANR** (anthocyanidin reductase) branch of the proanthocyanidin pathway — **1,610 constructs** on the grape — so the wine lends structure and grip without the drying bite that would war with a rib's richness.



Designed coffee in cross-section — roasted depth with the bitterness rerouted at the source, so a dark rub can carry all its midnight and none of its scold.

Two facts make this the strangest axis to cook with. The first is that bitterness is not one receptor but a family of about **twenty-five** — the TAS2Rs — each tuned to a different class of potentially toxic compound, which is why bitterness is the most chemically various of all the tastes and the hardest to soften without a scalpel. We work **TAS2R38** specifically because it reads the compounds that dog coffee and Brassica, and because it is the most studied of the family: it is the receptor behind the famous **PTC/PROP taster test**, the paper strip that tastes of nothing to some people and of punishing

bitterness to others, a difference written in two or three amino acids of a single gene. That variation is itself the lesson — bitterness is genetically *personal*, so pulling the signal down 20–65% at the source is a way of meeting every palate at the table at once, rather than cooking to the median and losing the ends.

The second fact is that astringency is not a taste at all but a *touch*, and it is tuned by a different lever entirely. Condensed tannins are polymers of flavan-3-ols — catechin and epicatechin — assembled when enzymes including **ANR (anthocyanidin reductase)** feed monomers into growing chains. The *degree of polymerization* sets the grip: short chains are soft and structuring; long chains are drying and harsh. By tuning ANR flux on the grape across its **1,610 constructs**, we set the chain-length distribution, and with it exactly how much a wine mop grips — enough to give a rib's fat a frame, not so much that it strips the mouth and fights the meal. Subtraction on one axis, chain-length control on the other: the dark end of barbecue, engineered by what we take away and what we keep short.

Coffee-Cocoa Dark Rub & Red-Wine Mop

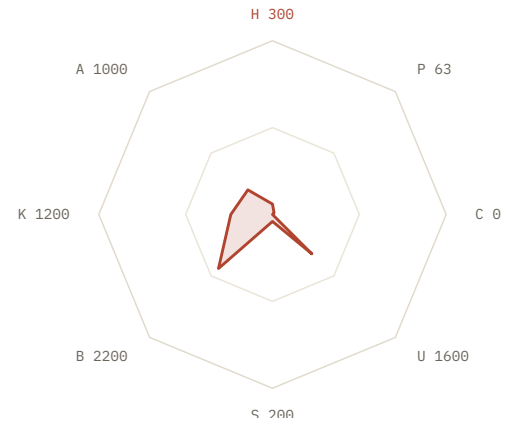
Makes enough for 2 roasts · the midnight end of the ladder

```
Makes enough for 2 roasts · 15 minutes
— the rub —
3 tbsp designed coffee, finely ground (IFI-B, bitterness −40%)
2 tbsp unsweetened cocoa
2 tbsp House Rub (Chapter 5)
1 tbsp brown sugar
1 tsp salt
— the mop —
1 cup red wine, from designed grape (IFI-A, tannin tuned)
2 tbsp Koji-Tomato Mop (Chapter 11)
1 tbsp molasses
```

1. Mix the rub and press it hard into a chuck or short rib the night before; the coffee and cocoa build a near-black crust.
2. Smoke low, 110 °C, until the bark is set and deep.
3. Simmer the mop until it loses its alcohol edge and turns glossy, then brush it through the back half of the cook. Pull when probe-tender.

Why it works — The coffee is grown with its bitterness attenuated, so it lends roast and darkness while the harsh TAS2R38 signal stays low. The red wine does the parallel trick on IFI-A: the designed grape sets its tannins by proanthocyanidin flux, so the mop gives structure and grip without the drying pucker that would fight the fat. Two near-bitter, near-astringent ingredients, both tuned back from the edge — the deepest plate in the book and the gentlest to the mouth, because the harshness was turned down at the root.

IFI PROFILE



IFI-H		300
IFI-P		63
IFI-C		0
IFI-U		1,600
IFI-S		200
IFI-B		2,200
IFI-K		1,200
IFI-A		1,000

Espresso–Black-Garlic Finishing Sauce

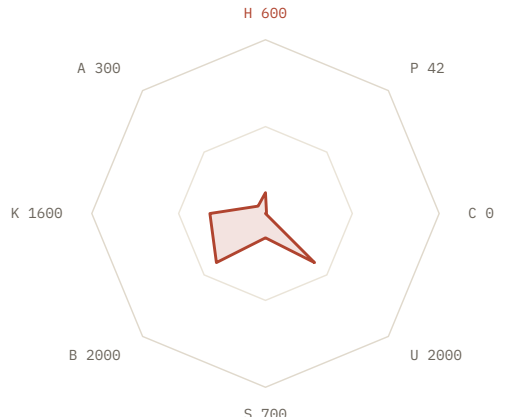
Makes 1½ cups · the dark, glossy spoonful for beef

```
Makes 1½ cups · 20 minutes
½ cup brewed designed coffee (bitterness attenuated)
4 cloves black garlic (slow-aged designed garlic), mashed
1 cup restored tomato, cooked down
2 tbsp molasses
2 tbsp cider vinegar
1 tbsp soy, from designed soybean
chile, to IFI-H 600
```

1. Simmer all together until glossy and reduced by a third, about fifteen minutes.
2. Blend smooth; it should pour like warm chocolate.
3. Spoon over sliced brisket, short rib, or a seared steak.

Why it works — Black garlic is garlic slow-aged until its own Maillard chemistry turns it sweet, dark, and deeply kokumi; paired with the bitterness-attenuated coffee and the restored tomato, it stacks umami and kokumi under a dark-roast top note with none of coffee's usual scold. The whole sauce is depth without any of its usual costs.

IFI PROFILE



IFI-H	600
IFI-P	42
IFI-C	0
IFI-U	2,000
IFI-S	700
IFI-B	2,000
IFI-K	1,600
IFI-A	300

Chapter 13 · The Sharp Edge & the Cool Side — *pungency and cool, as palate design.*

**IFI-P · TRPA1 · IFI-C · TRPM8 · fire and ice, on purpose*

A heavy plate — smoke, fat, long savory depth — needs two kinds of relief, and both are receptors the chile never touches. One cuts; one cools. Together they are the reason a great barbecue table never tires the mouth it is feeding.

The cut is **pungency**, the sharp channel again, but now at the table rather than in the rub. Mustard, watercress, fresh ginger, horseradish: their sinus-clearing rush fires **TRPA1** — the same channel as the rub's aromatics — sharp and then gone, nothing like the slow lingering burn of capsaicin on TRPV1. Where the chile builds, pungency clears. A spoonful of a sharp sauce between rich bites resets the palate instead of piling onto the heat already there; it is the mouth's exhale. The molecule to know is **allyl isothiocyanate**, released when a mustard or watercress cell is crushed and its glucosinolates meet the enzyme myrosinase — which is why these condiments are made cold and at the last minute, since heat denatures the enzyme and tames the sharpness. Temperature is the dial: cold water keeps the pungency loud, warm water gentles it.

The cool is **cool-burn**, a sensation as strange as heat and its mirror image. **TRPM8** is the receptor that answers to menthol — and it reports *cool without cold*, a drop in temperature that never actually happens, exactly as capsaicin reports a heat that is not there. Set a menthol-cooled dish against a built heat and you get the rare fire-and-ice contrast the tongue cannot quite believe: true heat on TRPV1 and false cold on TRPM8, running on the same palate at once, each making the other sharper. We grow **peppermint (2,360 constructs)** and spearmint for that channel, tuned so the cool lands clean. A cold mint slaw beside a hot plate is not an afterthought; it is thermal design.



Designed peppermint — the menthol that opens TRPM8 and tells the mouth it has cooled when it has not. The ice half of fire-and-ice, grown to a number.

The sharp side has a chemistry worth cooking by, because it is a reaction you *trigger* rather than a flavor you add. Mustard and watercress store their sharpness disarmed, as odorless **glucosinolates**, kept in a separate cellular compartment from the enzyme that activates them — **myrosinase.** Crush the seed or bruise the leaf and the two meet: myrosinase cleaves the glucosinolate and, through an unstable intermediate, releases the volatile **isothiocyanate** — allyl isothiocyanate in black mustard, the sinus-clearing molecule itself. This is why mustard powder is odorless until wetted, why the sharpness peaks about ten minutes after mixing and then fades, and why hot water tames it: heat denatures the myrosinase before it finishes, so the reaction never completes. Temperature and timing are the entire dial — cold and fresh and soon is loud; warm or cooked or old is gentle. The designed black mustard (2,790 constructs) carries more substrate and a more active enzyme, so the reaction runs hotter and cleaner.

The cool side is a near-perfect mirror of the heat it answers, and the symmetry is one of the loveliest facts in all of taste. **TRPM8** is an ion channel that genuinely opens at cold temperatures, somewhere around 8–28 °C — it is how your tongue feels a cold drink. **Menthol** binds it and shifts its activation threshold *warmer*, so the channel fires at room temperature and the brain reads *cold* without a single degree being lost. That is the exact inverse of capsaicin, which binds TRPV1 and shifts *its* threshold cooler, so the channel fires warm and the brain reads *heat* without a single degree being gained. Fire and ice are the same trick played on two opposite channels — a threshold nudged the wrong way, a temperature reported that never happened. Set a menthol dish beside a capsaicin one and you are running both illusions at once, which is why the contrast feels almost impossible: the tongue is being told it is burning and freezing in the same mouthful, and both reports are false.

The Sharp Sauce

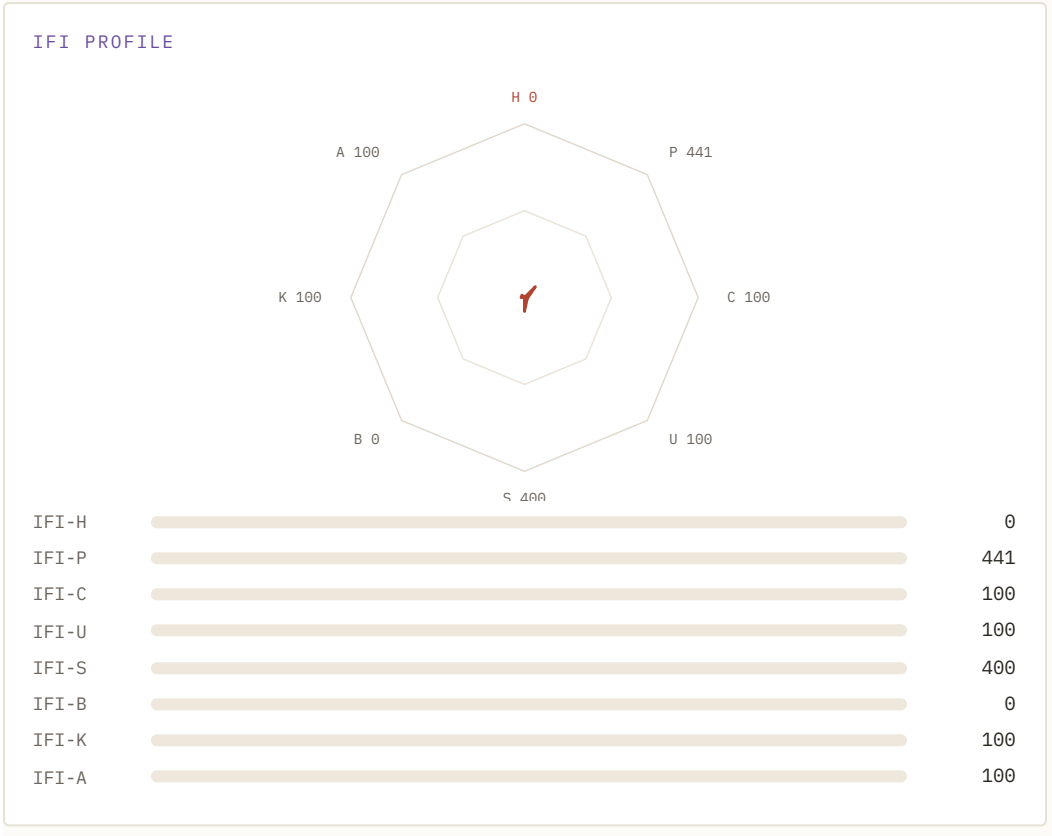
Makes 1 cup · the cut against all that richness

```
Makes 1 cup · 20 minutes
3 tbsp designed black mustard seed, ground (IFI-P high)
1 bunch designed watercress
2 tbsp cider vinegar
1 tbsp honey
1 tsp designed ginger, grated
salt
cold water, to loosen
```

1. Steep the ground mustard in a little cold water ten minutes — cold keeps the allyl isothiocyanate sharp; heat would tame it, so choose your intensity by temperature alone.
2. Blitz the bloomed mustard with the watercress, vinegar, honey, and ginger until bright green and loose. Thin with cold water to a spoonable sauce.
3. Salt and rest ten minutes; the edge blooms as it sits, then mellows — serve it where you want it.

Why it works — Black mustard (**2,790 constructs**, grown for pungency) blooms its allyl isothiocyanate on TRPA1 at full volume; watercress and ginger stack the same channel. Because pungency

flashes and clears rather than lingering, a spoonful resets the mouth between rich bites instead of adding to the heat. It is the palate's exhale.



Cooling Mint Slaw

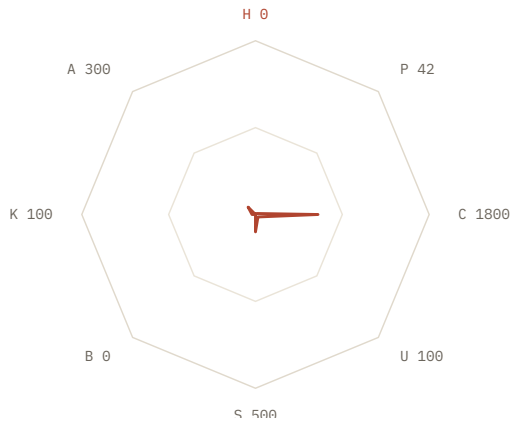
Serves 6 · 20 minutes · the counterweight to the whole table

```
Serves 6 · 20 minutes
½ green cabbage, shaved fine
2 carrots, shaved
1 cup designed spearmint and peppermint leaves, torn
2 tbsp cider vinegar
2 tbsp good oil
1 tsp honey
salt
```

1. Salt the shaved cabbage lightly and drain fifteen minutes; press out the water so the slaw stays crisp and the dressing clings.
2. Whisk the vinegar, oil, and honey; toss with the cabbage and carrots.
3. Fold the torn mint through at the very end, so the cooling stays vivid and the leaves never bruise to khaki.

Why it works — Designed peppermint carries cooling high on IFI-C; its menthol opens TRPM8 and the mouth reads a temperature drop that never happened. Placed beside a plate built around TRPV1, the two receptors run at once — true heat and false cold on one palate — and each makes the other sharper. The slaw is not a break from the fire; it is part of its architecture.

IFI PROFILE



IFI-H	0
IFI-P	42
IFI-C	1,800
IFI-U	100
IFI-S	500
IFI-B	0
IFI-K	100
IFI-A	300

Ginger-Scallion Relish

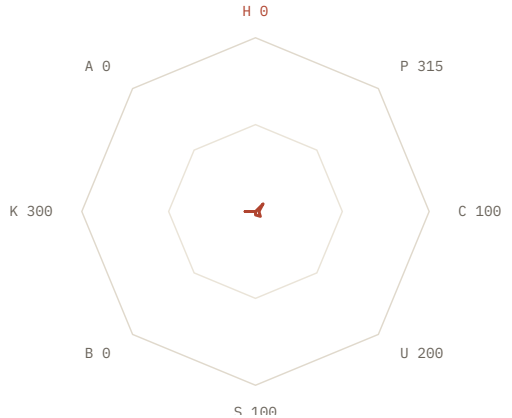
Makes 1 cup · the bright, oily cut for poultry and pork

Makes 1 cup · 15 minutes
1 bunch scallions, finely sliced
3 tbsp designed ginger, finely grated
1 tsp designed garlic, grated
½ tsp salt
⅓ cup neutral oil, heated to shimmering
1 tsp cider vinegar

1. Pile the scallion, ginger, garlic, and salt in a heatproof bowl.
2. Pour the just-smoking oil over — it will hiss and bloom the aromatics instantly — then stir in the vinegar.
3. Spoon over sliced chicken, pork, or anything that wants a clean bright lift.

Why it works — The hot-oil bloom releases the ginger's gingerols and the allium's sulfur compounds onto TRPA1 all at once; the quick heat sets the aromatics without cooking them to dullness. A bright, pungent cut that lightens rich meat — the sharp edge, in a softer register than the mustard sauce.

IFI PROFILE



IFI-H		0
IFI-P		315
IFI-C		100
IFI-U		200
IFI-S		100
IFI-B		0
IFI-K		300
IFI-A		0



PART V OF V

The Table

fermentation & fire · precision · clean label · the whole table

Chapter 14 · Fermentation & Fire — *where designed flavor meets live culture.*

**koji · chili crisp · hot honey · the slow savor of time*

The oldest way to deepen flavor without fire is to let living cultures do it, and the barbecue table has always leaned on ferments — the vinegar sops, the fish sauces, the fermented bean pastes, the pickles that cut the fat. Fermentation and our kind of design are natural partners: a ferment is a slow, enzymatic liberation of savor and acid, and when the plant going into it was already grown to carry more of what the culture will set free, the result starts ahead and ends deeper.

Koji is the keystone, as it has been through this whole book. *Aspergillus oryzae* is a mold that secretes a torrent of enzymes — proteases that cleave proteins to free amino acids, amylases that cleave starch to sugar — and it is the engine behind soy sauce, miso, and sake. Grown on our terms (**80 constructs**, tuned toward glutamate), koji becomes a way to *generate* umami in place, on a surface or in a paste, from whatever proteins it is set loose on. That is why it threads the recipes above: it is the one ingredient that keeps making savor after you have added it.



Koji grains — the living enzyme factory behind miso, soy, and the savory ferments that cut and deepen a barbecue plate.

Fermentation earns its place at the fire by doing three different jobs, and it helps to hold them apart. It **proteolyzes** — koji and the enzymes of a long brine cleave proteins into free glutamate, building umami from scratch. It **acidifies** — lactic and acetic cultures drop the pH, and acid is the cut that keeps a rich plate from tiring the mouth, the wet-side cousin of the sharp sauce. And in the slowest ferments it browns without heat — a years-long, room-temperature Maillard that deepens a miso or a soy toward near-black savor. Here are the ferments a barbecue table leans on, by what each one brings:

FERMENT	CULTURE	BRINGS	AXES
Miso / soy	koji (*A. oryzae*)	glutamate, kokumi, dark depth	U, K
Gochujang	koji + chile	glutamate + laddered heat	U, H, S
Fish-sauce-style splash	enzymatic autolysis	concentrated glutamate	U
Vinegar sop	acetic bacteria	acid, the cut	(acid)
Kimchi	lactic bacteria	acid + pungency	P, (acid)
Chili crisp	(infused, not fermented)	the whole book in oil	H, U, K, P

Pair any of these with a plant we have already grown toward the same axis and the ferment starts ahead: a gochujang built on designed soybean and a laddered chile is deeper and more precisely hot than one left to chance, because both of its halves were specified before the culture ever touched them.

Designed Chili Crisp

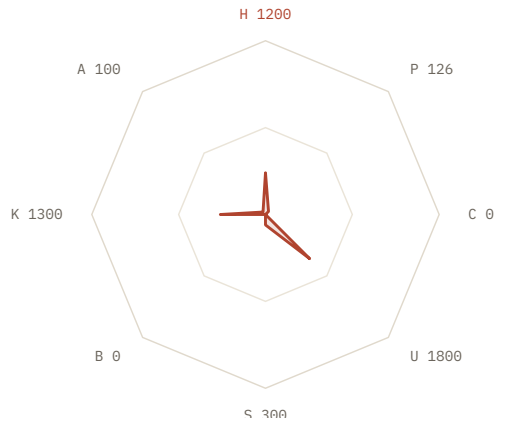
Makes 2 cups · the condiment that goes on everything

```
Makes 2 cups · 40 minutes
1½ cups neutral oil
6 cloves designed garlic, sliced thin
2 shallots, sliced thin
3 tbsp designed superhot chile flakes (to IFI-H 1,200)
2 tbsp mild chile flakes, for color and body
1 tbsp fermented soybean paste (designed soybean)
1 tbsp dried shiitake, ground (designed shiitake)
1 tsp sugar
1 tsp salt
```

1. Fry the garlic and shallot slowly in the oil over low heat until golden and crisp; strain the solids out and reserve, keeping the now-aromatic oil.
2. In a heatproof bowl, combine both chile flakes, the soybean paste, shiitake powder, sugar, and salt.
3. Pour the hot oil over, stir, and fold the crisp garlic and shallot back in. Cool and jar; it keeps a month cold.

Why it works — The fried alliums and the fermented soy lay down kokumi and glutamate; the ground shiitake adds guanylate; the chile sets the heat to a number. It is the whole book in a jar — savory floor, kokumi body, pungent alliums, laddered heat — and it makes anything off the grate taste finished.

IFI PROFILE



IFI-H	1,200
IFI-P	126
IFI-C	0
IFI-U	1,800
IFI-S	300
IFI-B	0
IFI-K	1,300
IFI-A	100

Hot Honey, to the Number

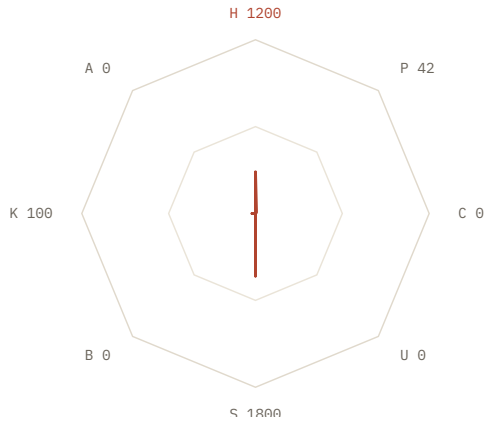
Makes 1 cup · the sweet-heat drizzle, dialed exactly

```
Makes 1 cup · 15 minutes
1 cup honey
2 tbsp cider vinegar
2–3 designed superhot chiles, sliced (to your target IFI-H)
1 strip orange peel
pinch salt
```

1. Warm the honey gently with the chiles, orange peel, and a pinch of salt — never boil, which dulls the honey's aromatics.
2. Steep off the heat for ten minutes, tasting, until the heat reaches your number: **IFI-H 600** for a drizzle anyone will love, **1,200** for a serious finish.
3. Strain and bottle. Drizzle over wings, ribs, cornbread, or a seared chop.

Why it works — Honey's sweetness and the chile's heat stage in sequence (Chapter 9), and steeping rather than boiling keeps both the honey's floral aromatics and the chile's clean burn intact. Because the superhot runs at CV ≤7%, a given number of chiles lands the same heat every batch.

IFI PROFILE



IFI-H		1,200
IFI-P		42
IFI-C		0
IFI-U		0
IFI-S		1,800
IFI-B		0
IFI-K		100
IFI-A		0

Quick Kimchi Slaw

Makes 1 quart · 1 hour + overnight · the fermented cut, the fast way

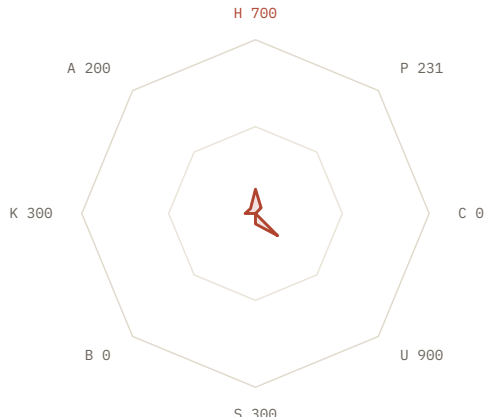
A full kimchi takes days; this quick version delivers most of its job — acid, pungency, a little funk — by the next day, and it is the sharpest, brightest thing you can set beside a fatty plate.

```
Makes 1 quart · 1 hour + overnight
½ napa cabbage, cut in 3 cm pieces
2 tbsp kosher salt
2 tbsp designed chile flakes (to IFI-H 700)
2 tbsp fish-sauce-style umami splash (or soy, designed soybean)
1 tbsp designed garlic, grated
1 tbsp designed ginger, grated
1 tsp designed-sweetener syrup
3 scallions, cut in lengths
```

1. Toss the cabbage with the salt and let it sit an hour until limp; rinse and squeeze dry.
2. Mix the chile, umami splash, garlic, ginger, and sweetener into a loose paste; toss through the cabbage and scallions by hand until evenly coated.
3. Pack into a jar, press down, and leave at cool room temperature overnight before refrigerating. It will sharpen and sour for several days.

Why it works — The salt draws water and seasons; the chile sets heat to a number; the garlic and ginger lay pungency on TRPA1; and the overnight rest lets wild lactic bacteria begin the acid that is the whole point — the cut that resets the palate between rich bites. The designed soybean splash gives it a glutamate floor so the sourness has savor under it rather than sitting thin and sharp alone.

IFI PROFILE



IFI-H		700
IFI-P		231
IFI-C		0
IFI-U		900
IFI-S		300
IFI-B		0
IFI-K		300
IFI-A		200

Chapter 15 · Precision — *the same warmth in August and February.*

**CV ≤7% · the design loop · why a number is a kindness*

There is a quiet promise under every recipe in this book, and it is the one that makes a laddered heat worth laddering at all: the rung is the rung, every time. A recipe metered to **IFI-H 700** is only honest if 700 means the same warmth in a summer harvest and a winter one — otherwise the number is theater. The thing that keeps it honest is a figure we have mentioned at every ladder and now owe a full accounting: a batch-to-batch coefficient of variation of **≤7%**, against **42%** in wild-type peppers.

That gap is the difference between a spice you guess with and a spice you cook to. A wild pepper's heat swings wildly with the weather, the soil, the stress of the season, the position of the fruit on the plant — two pods from the same plant can differ several-fold. A cook working with that variability is not really choosing a heat; they are negotiating with one. The 42% is why "add chile to taste" has always been the only honest instruction a traditional recipe could give. We brought it to 7% by designing the pathway rather than selecting the phenotype — the **ESM2** protein language model ranking every Pun1 substitution by predicted efficacy times stability, the **flux-balance model** mapping rate control to upstream steps in the phenylpropanoid pathway, the double variant S39L+L345G written in with **CRISPR** and then grown under controlled conditions that hold the variables a field cannot. The result is a pepper whose teaspoon is a unit, which is the whole reason this book can hand you numbers instead of wishes.



The sequencer bench — where every batch is read against the receptor so a number printed in a recipe is a number you can trust, harvest after harvest.

The gap is worth seeing as a table, because it is the difference between two entire ways of cooking:

MEASURE	WILD-TYPE PEPPER	DESIGNED CULTIVAR
Batch-to-batch CV	42%	**≤7%**
Pod-to-pod swing	several-fold	within the band
"Medium" means	a negotiation	a number
The teaspoon is	a guess	a unit

That reproducibility is not luck; it is the output of a loop. The **ESM2** protein language model scores every candidate substitution by predicted catalytic efficiency times fold stability. A genome-scale **flux-balance model** maps rate control to the upstream phenylpropanoid steps — 4CL and HCT — so the edits land where they pay. **CRISPR** writes the chosen changes. The plants are grown under controlled light and controlled hands, holding the environmental variables a field cannot. And every batch is read back on the receptor assay before it ships — the number confirmed, not assumed. When the assay and the model disagree, it is the model we correct, never the tongue. The loop is why a figure printed in this book in one season is the same figure in the next.

Picture what 42% actually does to a dinner, because the abstraction hides the betrayal. You mix a rub you love in July, metered by eye against a chile from one plant, and it is perfect — a warm glow everyone reaches for. You mix it again in September from the next plant's pods, the same spoonful by the same hand, and it blisters, because that plant caught more sun and its pods ran several-fold hotter. Same recipe, same cook, a different dish — and no way to have known until it was on the plate in front of someone who trusted you. Multiply that across a season of cooking for the same people and you understand why every traditional heat instruction could only ever end in *to taste*: the ingredient would not hold still long enough to be trusted with a number. The ≤7% cultivar is the first chile a cook can actually write a recipe around, and the first one a host can rely on twice.

Precision is not only about heat. The same discipline holds the restored tomato at its **IFI-U 2,600**, the designed sweetener at its sweetness, the coffee at its attenuated bitterness — every axis grown to a specification and read back on the assay before it ships. For a formulator this is the whole value proposition; for a home cook it is something gentler and, we think, more important. It is a kindness. It means the dish you loved last summer is a dish you can make again in February, for the same people, and have it land the same way. It means the child who learned exactly how much heat they can take can trust that their rung will not betray them next time. It means hospitality — cooking something right for someone, on purpose, repeatedly — becomes possible in a way that "to taste" never quite allowed. A number, held to ≤7%, is a promise that the care you put in once will survive to the next time you cook. That is not a technical virtue. It is a form of respect for the people you feed.

Chapter 16 · Clean Label, Honestly — *savory grown in the plant, not dosed on the plate.*

**the MSG question · the regulatory line · nourishment as intention, never claim*

A book that talks this much about umami owes the reader an honest word about MSG, because the question hangs over every savory thing we cook: if you love glutamate so much, why not just reach for the shaker? The answer is not that there is anything wrong with the molecule. Monosodium glutamate is glutamate — the same amino acid a tomato, a cheese, and your own body are full of — and the old fears about it never survived contact with the evidence. Our objection is not chemical. It is about *where the savor lives.*

For a century, the food industry's answer to the savor that breeding had bled out of vegetables was to patch the dish: salt, fat, a shaker of the isolated molecule, hydrolyzed proteins and autolyzed yeast extracts stirred into the formula to add back at the factory what the field had lost. It works, after a fashion. It is also, read plainly, an admission — we broke something in the plant and chose to dose the plate rather than repair the plant. Our whole method is the other direction: if the savor was lost *in the plant*, the restoration belongs *in the plant.* We grow the glutamate back into the tomato through its own GAD and GDH1 enzymes; we grow the guanylate into the shiitake; we grow the kokumi peptides into the garlic. The savor arrives inside a whole food, with everything else that food carries, and it labels as food — a tomato, a mushroom, a clove of garlic — rather than as an additive. Same molecule the shaker holds; different side of the plant wall. That is the honest distinction, and it is the one a clean label is actually about.

It is worth being plain about the molecule's reputation, because fear of it drove much of the dosing this book is trying to undo. The alarm around MSG began with a single anecdotal letter in 1968 and a label — "Chinese restaurant syndrome" — that has not survived the decades of controlled, double-blind study that followed. Glutamate is among the most abundant amino acids in the human body and in nearly every protein-rich food, from aged parmesan to a ripe tomato to breast milk; your own saliva carries it. Our quarrel was never with the molecule's safety. It is with the *architecture* of adding savor at the factory to a plant that had been bred until it had none — a patch on a problem we would rather repair at the root. When the savor is grown back into the tomato, the label reads "tomato," because that is what it is: a whole fruit carrying its own glutamate, the way a tomato did before we taught it to travel a thousand miles. No additive line, no asterisk, nothing to declare but the plant. That is not a marketing posture; it is a consequence of fixing the loss where it happened.

There is a line we hold with real discipline, and it matters most in a kitchen book, because kitchens are where temptation to overclaim lives. **We make no health claims.** Not one recipe here will cure, treat, detox, or prevent anything, and we will never write that it does. When we note — quietly, as we have a few times — that the late-ripening window which builds a tomato's free glutamate is the same window that builds its lycopene and vitamin C, that is a statement about plant metabolism, not about your body. It is an observation that flavor and nourishment are built by the same ripening, so a fruit grown toward its fullest savor is, not by any coincidence of our engineering, grown toward its fullest nourishment too. We did not design a trade-off between the two, because on the plant there was never one to design. That is the whole of the nourishment ethos that runs under this library: food grown to hold the most it can, eaten with intention, given to the body as a kind of care. It is a value and an intention. It is never a claim, and the moment it starts to sound like one, we have failed the reader.

The discipline shows up in small, deliberate word-choices throughout this book, and they are worth noticing because they are load-bearing. We write that a cut tastes *rounder*, not that it is *better for you*; that the savor is *grown in*, not that it *boosts* anything; that a plate is *complete*, not that it *nourishes* in any measurable dose. When a recipe leans on a designed sweetener, we say the pancreas registers almost nothing — a statement about the molecule's low glycemic load, not a promise about anyone's health. When we note that the ripening window couples glutamate to lycopene, we stop at the plant. This is the same line every book in this library holds: attributes, never claims; what the food *is*, never what it will *do* to you. A kitchen is where that line is easiest to cross and most important to hold, because a hungry reader wants to be told the thing they are about to enjoy is also virtuous. We will tell them only that it is honest — grown with intention, seasoned with care, and measured so the care survives to the plate.

So cook this food for the reason anyone cooks: because it is good, and because the people at your table deserve the best of what you can grow and season and set over a fire. The savor is real and grown in. The heat is designed to a number. These are computational designs; Scoville Splice's cultivars and constructs have not been experimentally validated in a laboratory, and every IFI score is a predicted value. The nourishment is a thing we grew toward on purpose and will not oversell. That honesty is the seasoning under all the others.

Chapter 17 · The Whole Table — *one fire, every tolerance.*

**season to the floor, ladder from the table · the book in one fruit*

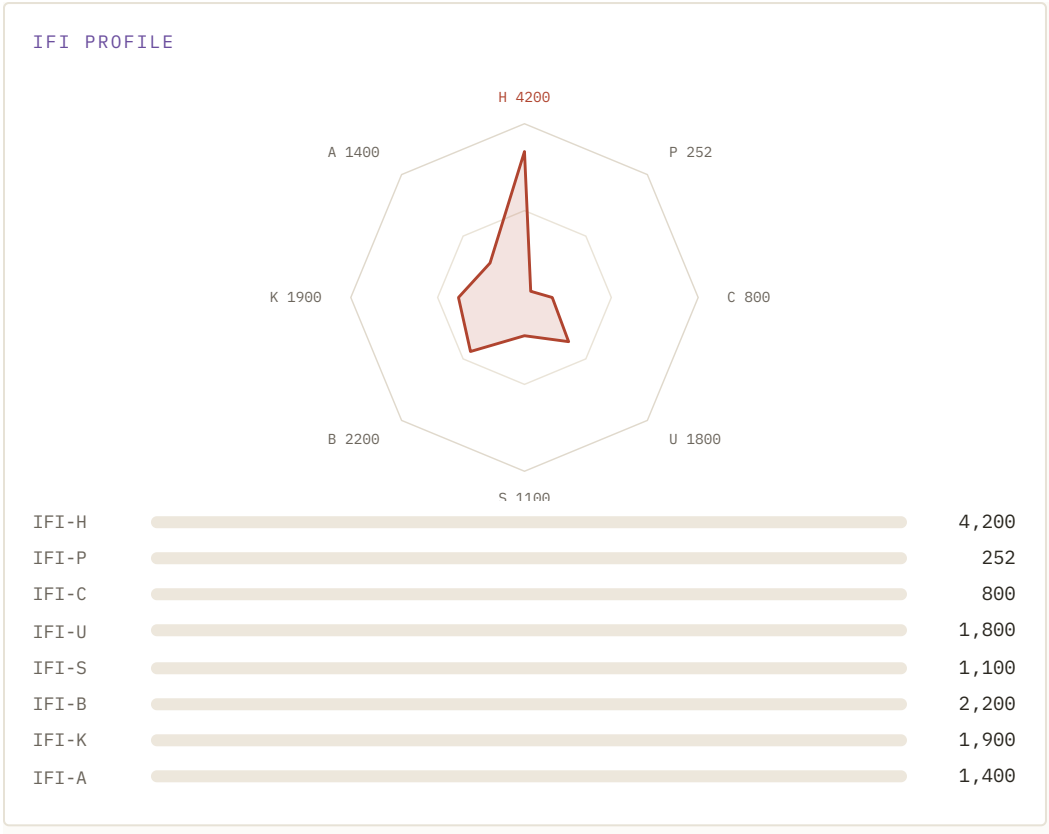
Here is the test a barbecue really has to pass: not whether it can thrill one palate, but whether a single fire can feed a whole table of them — the uncle chasing the top of the ladder, the child who wants no heat at all, the grandmother who wants depth without burn, all fed from the same coals and none of them an afterthought. That is a composition problem, and composition is the thing the Index was built for.

Our one rule of hosting gathers up the whole book: **season to the floor, ladder from the table.** Cook everything to the mildest palate present — pull it to depth and savory, not to heat. Build the umami in with the mop, the kokumi in with the rub and the long cook, the sweet into the lacquer, so that every plate is *complete* before a single point of heat is added. Then set the dials within everyone's reach: the Table Heat oil at the rung they name, the Sharp Sauce for the exhale, the three-region board, the cooling mint slaw for the ones who built their heat too high. Each person climbs to their own rung from a floor that was already delicious. Nobody is dared, and nobody is left out. That is hospitality rendered as engineering — and it only works because the savory floor can be built without heat, which is the entire reason we spent this book separating the axes.



Phoenix — SS-0096 — the book in one fruit: heat towering, but savor under it, body around it, bitterness held low, a cool note set against the fire.

When you want to show the table what *all eight axes at once* can look like, there is one fruit that holds the whole book in a single profile. **Phoenix**, SS-0096 — the only cultivar we have ever designed to target all eight axes at once, the first in history designed to do so, and the top of the heat ladder by a wide margin. Read it as this book has taught you to read a plate — not *how hot*, but *how composed*:



Two designed substitutions in the Pun1 gene — S39L and L345G — found with a protein language model, ranked by predicted efficacy times stability, and written in with CRISPR, are designed to carry the heat to 4,200. But run your eye down the rest: savory grown in beneath the burn, kokumi body around it, bitterness held low so the fruit's darkness never scolds, a cooling note set against the fire. It is the whole argument of barbecue — heat that is never eaten alone, savor as the floor, body as the room, relief built in — grown into one pepper. Cook it at the very top of a table seasoned to the floor, a pinch for the brave, and you have shown everyone what the Index is for.

The mechanics of running one fire for a range are simpler than they sound, and they are the reason this works in a real backyard and not only on paper. Build two zones — a hot direct side and a cool indirect side — and cook everything to its *floor* on the indirect side: savory, tender, complete, unhurried, and never pulled toward heat. Keep the finishing station at the table rather than at the grill — the Table Heat oil, the three-jar sauce board, the sharp sauce, the chili crisp, the cooling slaw — so the last and most personal layer goes onto each plate by its own eater, at the fire's edge or the table's. The griller's job ends at the floor; the diner's begins at the dial. That division of labor is what lets one host feed twelve different tolerances without becoming a short-order counter: you cook one thing well, to the mildest palate present, and you let eight jars do the laddering.

A menu that seasons to the floor and ladders from the table:

PLATE	BUILT TO (FLOOR)	THE DIAL ON THE TABLE
Low-and-Slow Brisket, Kokumi Bark	U 1,600 · K 1,900, no heat	Table Heat oil, 600–2,630
Koji-Brined Spatchcock Chicken	U 2,100 · P 1,200, no heat	Sharp Sauce; Hot Honey
Sweet-Hot Lacquered Ribs	S 1,400, heat held to 700	extra Hot Honey for the climbers
Cooling Mint Slaw	C 1,800 — the relief	— pass to anyone who overshot
The Sauce Board	three axes, three jars	each guest leads with their own

The logic holds for any gathering, because composition scales. A game-day spread runs the same way — the shareable floor built savory and the heat set loud but optional:

PLATE	BUILT TO (FLOOR)	THE DIAL ON THE TABLE
Hot-Honey Glazed Wings	S 1,600, heat at 1,100	extra Hot Honey; Table Heat oil
Burnt Ends	U 1,900 · K 1,700, heat at 800	Designed Chili Crisp
Designed Chili Crisp	U 1,800 · K 1,300	the jar *is* the dial
Quick Kimchi Slaw	P 1,100 — the cut	pass to cut the richness
Smash Burgers	U 2,400, no heat	Sharp Sauce; Table Heat oil

In both menus the move is identical, and it is the whole book in one instruction: make every plate *complete without heat first* — savory floor, kokumi body, the sweet where a glaze wants it — and only then offer the burn as a thing each eater adds for themselves. A table seasoned to the floor is a table where the mildest palate eats as well as the bravest, and the bravest can climb as high as they like without ever reaching across someone else's plate.

Set that table and the argument ends — not because everyone agreed on the heat, but because nobody had to.

A closing grace · the fire we keep

We came to the fire as plant people, and we never pretended otherwise. What the fire taught us is that reverence is not about what is on your own plate — it is about the care you bring to what goes on someone else's. We measured eight axes of taste so that a thing we grew could meet the flame and become exactly what the people we love most wanted it to be, every time, in August and in February, at a table loud with everyone's different idea of enough.



Dusk in the greenhouse — where the plants that season someone else's fire are grown, and where a vegetarian family learned to love the flame without ever wanting the plate.

Nothing in this book is a health claim, and nothing in it is an apology. It is only the oldest thing a family does, done on purpose: feed people, carefully, with flavor grown toward its fullest and nourishment grown in on the same vine, and let the fire do the ancient part. The meat brings its inosinate; the garden brings its glutamate; the two multiply on the tongue the way two people who love each other multiply at a table — neither one less for the other, both of them more. We learned the chemistry so we could stop guessing, and we kept the reverence so the chemistry would mean something.

Cook these for the people at your table — the ones who eat meat and the ones who don't, side by side, as they have always sat at ours. Season to the floor; ladder from the table; let no one be dared and no one be left out. That was the whole point of measuring anything.