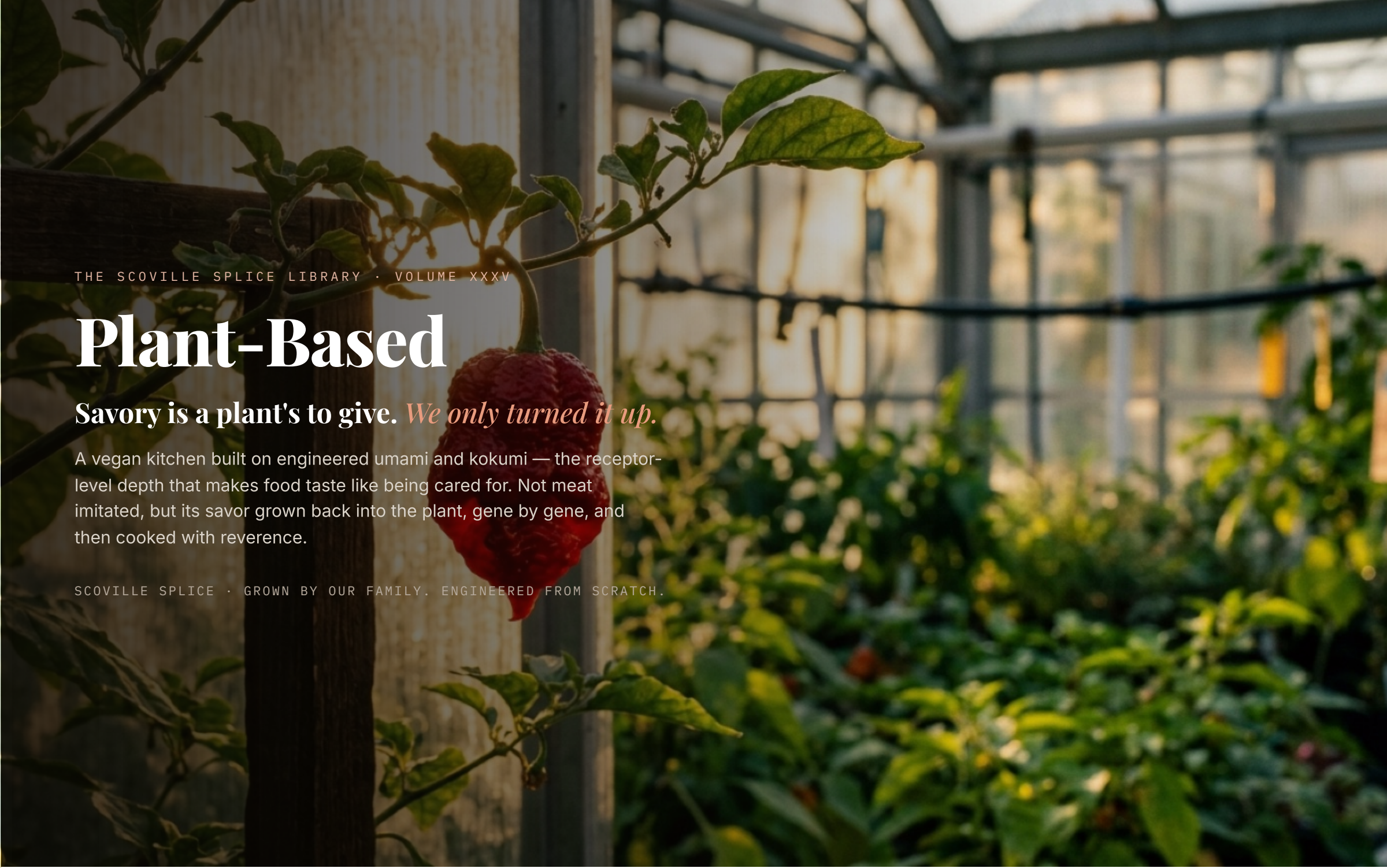


THE SCOVILLE SPLICE LIBRARY · VOLUME XXXV

Plant-Based

Savory is a plant's to give. *We only turned it up.*

A vegan kitchen built on engineered umami and kokumi — the receptor-level depth that makes food taste like being cared for. Not meat imitated, but its savor grown back into the plant, gene by gene, and then cooked with reverence.

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

Contents

01 Opening essay · The meat-shaped question

02 Chapter 1 · Why meat tastes like meat — the savory triad, read at the receptor.

03 Chapter 2 · Two receptors carry dinner — umami's synergy, kokumi's hand on the dial.

04 Chapter 3 · The savory pantry we grew — forty-two organisms, and the ten that cook like meat.

05 Chapter 4 · Stock — the dark base, and the mathematics of a good broth.

06 Chapter 5 · The ferment shelf — koji, miso, and the peptides that make richness.

07 Chapter 6 · Alliums — garlic, onion, and the kokumi foundation.

08 Chapter 7 · Mushrooms — the guanylate lever and the synergy that triples savor.

09 Chapter 8 · Braises — long heat, no collagen, all depth.

10 Chapter 9 · Fire & char — Maillard, smoke, and the browned edge.

11 Chapter 10 · Noodles & broth bowls — the bowl as a receptor experiment.

12 Chapter 11 · The roast — a centerpiece that needs no animal at its center.

13 Chapter 12 · Beans & pulses — protein, and the glutamate that makes it sing.

14 Chapter 13 · Raw & cured — koji time, and savor without heat.

15 Chapter 14 · Heat, laddered — the ten flagships, and where they belong on a plant.

16 Chapter 15 · The finishing kitchen — chili crisp, kokumi butter, the last gram.

17 Chapter 16 · The aromatic layer — pungency, cooling, and the pathways behind them.

18 Chapter 17 · What the plant carries — depth and nourishment as one act.

19 Chapter 18 · A week at our table — the book, cooked.

Opening essay · The meat-shaped question

There is a question that sits under every vegan kitchen, and most cookbooks answer it by pretending it was never asked. The question is simple and a little sad: *what is missing?* You roast the cauliflower, you crisp the mushrooms, you build the sauce, and the plate is good — and still, for a certain kind of eater, something at the center is absent. The books call it protein, or they call it texture, and they reach for a patty engineered to bleed, or a soy isolate spun to fiber, and they spend their energy teaching a plant to *perform* an animal.

We think that is the wrong act. It starts from apology. It assumes the plant is a stand-in, an understudy who must learn the lead's lines, and it measures success by how convincingly the counterfeit passes. We have spent ten years in a greenhouse learning the opposite lesson, and we wrote this book to say it plainly: the thing you miss when you miss meat is not meat. It is a set of molecules binding a set of receptors, and almost every one of those molecules is already a plant's to make. The savor was never the animal's invention. The animal only concentrated it.



Where every question in this book began — the family in the research greenhouse at first light.

Consider what actually happens when you eat a braised short rib and sigh. Free L-glutamate, released from muscle protein by long heat, settles into a receptor on your tongue called TAS1R1·TAS1R3 and reports *savory*. Alongside it, a nucleotide — inosine monophosphate, IMP, a byproduct of the animal's own spent energy — docks into the same receptor's cradle and does not add to the glutamate's signal so much as *multiply* it, eight-fold, fifteen-fold, in a synergy so steep it reads as a different category of pleasure. Underneath both, a family of small peptides built around a γ-glutamyl bond leans on a third receptor, the calcium-sensing receptor, and turns up the volume on everything at once, lengthening the taste, thickening it, giving it the quality the Japanese named *kokumi* — mouthfulness, continuity, the sense of a flavor that

keeps its promise all the way down. That sigh is three receptors, read in a tenth of a second. It is chemistry, and it is legible, and — this is the whole book — it is not proprietary to flesh.

Glutamate is in the tomato, the kombu, the fermented bean, the aged cap of a shiitake. The synergizing nucleotide, which plants carry only faintly, is made in abundance by fungi as guanylate, GMP, the mushroom's own version of the animal's inosinate. The γ-glutamyl peptides are the garlic's, the onion's, the yeast's. Every signal that short rib sent, a plant kitchen can send too — not by imitation, but by *sourcing the same molecules from the organisms that already make them*, and, where a plant makes them too quietly, by turning the volume up at the gene.

That last clause is what our family does for a living. We are a culinary-genomics company; we design flavor at the molecular level and grow it in living plants. We built an index — the Iyengar Flavor Index — that scores any food on eight receptor axes, so that *savory depth* stops being a feeling we can only gesture at and becomes a number we can measure, compare, and engineer toward. On that index, an ordinary supermarket tomato registers an umami score of roughly 300. The same cultivar, with its native glutamate metabolism retuned across two thousand constructs, registers 2,600 — the savor the truck and the shelf took, grown back in. We did not add anything foreign. We turned up what the plant was already trying to say.

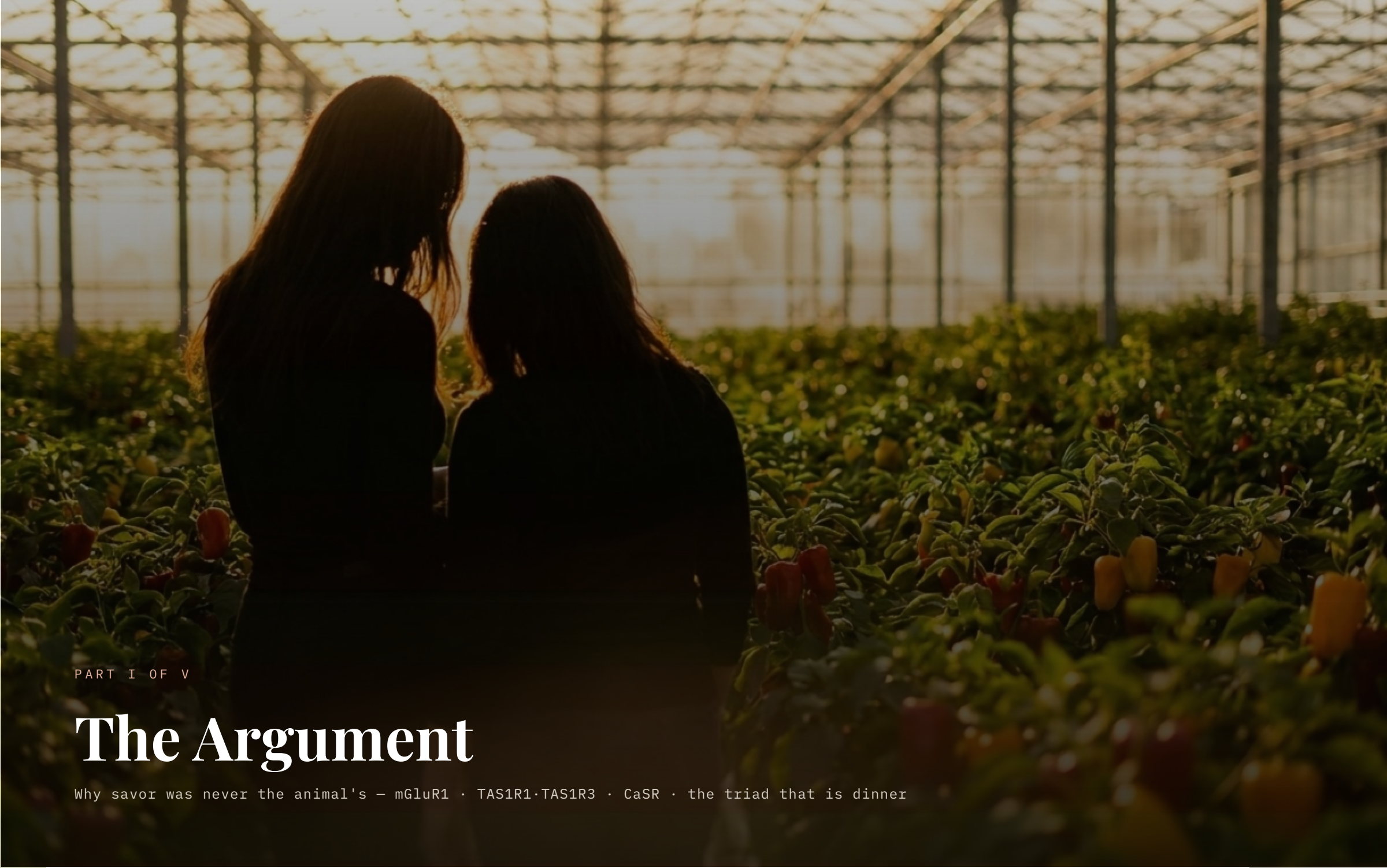
> $\mathrm{IFI}(c) = 1000 \cdot \mathrm{EC}_{50}(\mathrm{ref}) \,/\, \mathrm{EC}_{50}(c)$

Keep that formula near. It is the spine of everything that follows. EC_{50} is the concentration at which a compound drives its receptor to half of full response — a measure not of *how much* of a molecule a food holds but of *how loudly* that molecule speaks. Invert it against a fixed reference, scale by a thousand, and loudness becomes a score you can read a broth, a braise, and a raw tomato against on one page. Each axis caps, for a scorecard, at 5,000 — the normalization ceiling, the loudest a single receptor is asked to report. We will put these numbers on every dish in this book, not to reduce dinner to arithmetic, but because a number is a form of respect — for the plant, whose work we are finally able to see, and for you, who deserve to know exactly what is on the plate.

A word on how we cook here, so the pages ahead read true. We are vegetarians who turned vegan in the kitchen long before we could engineer a thing, and the reverence came first; the science came to serve it. We write *we* because this was built by a family — the computing was one pair of hands at a keyboard late at night, but the table, the arguing over salt, the decade of growing, belongs to all of us. We will write about meat without contempt, because contempt is just apology wearing a harder face, and because the honest target of a plant-based savor is exactly the depth that a good piece of meat achieves. We aim at it directly. And underneath all of it, never as a claim and never as a sermon, runs the thing we actually care about:

that food grown with intention can carry more of what a body needs, and that designing flavor and designing nourishment turn out, again and again, to be the same act.

So: what is missing? Nothing that a plant cannot make. Let us go find it, molecule by molecule, and cook.



PART I OF V

The Argument

Why savor was never the animal's — mGluR1 · TAS1R1·TAS1R3 · CaSR · the triad that is dinner

Chapter 1 · Why meat tastes like meat — *the savory triad, read at the receptor.*

To cook savory depth on purpose, you have to know exactly what you are reaching for, and the honest answer is not "meat" but three overlapping chemical signals that meat happens to deliver all at once. Name them, and the whole project of this book stops being an act of substitution and becomes an act of composition. The three are glutamate, the 5′-ribonucleotides, and the kokumi peptides. Everything on every plate in these pages is an attempt to assemble those three from plants, in the right proportion, with the right timing, and to cook them so that heat finishes what genetics began.

It helps to know the signals were discovered in plants, not animals. In 1908, the chemist Kikunae Ikeda isolated the compound responsible for the savor of *kombu* dashi — a broth that is nothing but seaweed and water — found it to be glutamic acid, and named the taste *umami*. Half a century later, in 1960, Akira Kuninaka took the next step that this entire book stands on: he isolated the 5′-nucleotides from dried bonito and from shiitake mushrooms and showed that, mixed with glutamate, they produced a savor far greater than the sum of their parts. The two foundational discoveries of savory science, in other words, were made on seaweed and a mushroom. The animal was never the teacher. It was only ever one more student of the same chemistry.

The first signal: free glutamate. Glutamic acid is the most abundant amino acid in nearly all protein, animal and plant alike, but bound inside a protein chain it is tasteless — the tongue reads only *free* glutamate, the molecules cut loose from their peptide moorings. In meat, that liberation is the work of long cooking and enzymatic aging: proteases snip the chains, free glutamate rises, and the braise deepens hour by hour. In plants, the same free glutamate accumulates through ripening, drying, and fermentation. A vine-ripe tomato holds perhaps 150 to 250 milligrams of free glutamate per hundred grams; sun-dry it and that figure climbs past a thousand as water leaves and the amino acid concentrates. Dried kelp — kombu — is the richest larder on earth for it, carrying between fifteen hundred and three thousand milligrams per hundred grams, which is why a sheet of kombu in cold water makes, with no heat and no animal, a broth that tastes unmistakably of *something*.



The tomato, cut. Two locular cavities, each a small reservoir of the free glutamate that ripening sets loose.

Free glutamate binds two receptor systems on the tongue. The first is TAS1R1·TAS1R3, a heterodimer — two proteins clasped together — whose larger subunit carries a hinged structure biochemists call the Venus flytrap domain, for the obvious reason: it closes around its ligand like the plant snapping shut on a fly. When glutamate enters that cleft, the flytrap closes, the receptor changes shape, and a savory signal fires. The second system is metabotropic: a family of glutamate receptors, chiefly mGluR1 and mGluR4, including a truncated taste-specific variant of mGluR1 that sits in the taste bud and responds to the glutamate concentrations you actually meet in food. Our index anchors its umami axis, IFI-U, to the half-maximal activation of these receptors by a reference glutamate stimulus, which is why IFI-U is not a measure of how much glutamate a food contains but of how hard that glutamate pushes on the receptor — loudness, not quantity.

The second signal: the 5′-ribonucleotides, and the synergy that is the entire secret. Here is where meat earns its reputation, and here is where most plant cooking quietly fails. Alongside glutamate, animal muscle releases inosine-5′-monophosphate, IMP — a nucleotide that is, in a grim sort of poetry, the breakdown product of the muscle's own ATP, the spent currency of a life's last motion. On its own, IMP tastes of almost nothing. But introduce it to glutamate at the receptor and something extraordinary happens: the nucleotide docks at a second site on the TAS1R1 flytrap, a phosphate-binding pocket just outside the glutamate cleft, and it *stabilizes the closed, active conformation* — it holds the flytrap shut. The receptor, now harder to open, responds to the same glutamate as if there were far more of it. This is not addition. It is allosteric synergy, and it is steep.

The founding measurement of food science here belongs to Shizuko Yamaguchi, who in 1967 fit human taste panels to an equation we still use:

> $y = u + 1218 \cdot u \cdot v$

where y is perceived umami intensity, u is the glutamate concentration and v the nucleotide concentration, both in grams per deciliter. Read that middle term. The synergy is the *product* of the two concentrations, scaled by a constant near twelve hundred — so

a dish with a little glutamate and a little nucleotide tastes far more savory than the sum of the two alone, and the effect compounds as you raise either. In our own language, the nucleotide lowers the effective EC_{50} of glutamate — makes the receptor respond at a lower concentration — by as much as eight-fold, which on the index means IFI-U can rise eight-fold at constant glutamate simply by adding the synergist. We have built entire dishes on that single lever.

SAVOR SOURCE	FREE GLUTAMATE (MG/100G)	5′-NUCLEOTIDE (MG/100G)	WHAT IT GIVES THE PAN
Dried kombu	1,500–3,000	trace	glutamate floor, clean
Sun-dried tomato	650–1,100	low	glutamate + sweetness
Dried shiitake	~1,000	GMP 100–150	glutamate **and** synergist
Fermented soy (shoyu/miso)	400–1,700	low–moderate	glutamate + peptides
Nutritional / yeast extract	1,000–1,900	variable	glutamate + kokumi
Nori	550–1,350	low	glutamate, marine top-note
Green peas / sweetcorn	100–200	low	background savor
(reference: aged parmesan)	*1,200–1,700*	*low*	*the savory bar we aim at*
(reference: dried bonito)	*30–40*	*IMP 470–700*	*the animal's synergist*

Look at the last two rows together, because they contain the whole argument of this book. The animal reference most prized for umami, dried bonito, brings almost no glutamate — it brings the *synergist*. Classic dashi works because kombu's plant glutamate meets bonito's animal inosinate and the Yamaguchi product term explodes. Now look up the table to the dried shiitake, which brings glutamate *and* its own nucleotide, guanylate, GMP — the fungal synergist that does to the flytrap exactly what the animal's IMP does. A kombu-and-shiitake broth is a dashi with both halves of the synergy sourced from things that never had a nervous system. The savor is identical because the receptors cannot tell, and the receptors are the only judges that matter.

The third signal: the kokumi peptides. The first two signals give you intensity. The third gives you *shape* — the quality that separates a flat, loud savoriness from a deep, rounded, lingering one. Kokumi substances are small peptides built around a γ-glutamyl linkage: glutathione (γ-Glu-Cys-Gly), the ubiquitous cellular antioxidant, is the archetype, and its relatives — γ-Glu-Val-Gly, γ-Glu-Cys-β-Ala, γ-Glu-Val — are more potent still. They have no taste of their own. Instead they act on the calcium-sensing receptor, CaSR, a class-C G-protein-coupled receptor that normally monitors blood calcium but sits, too, on the taste cells of the tongue. The kokumi peptides are positive allosteric modulators of CaSR: they do not trigger it so much as sensitize it, and through it they reach back and amplify the perception of sweet, salty, and umami, while adding the sensations we grope for with words like *thickness*, *continuity*, *mouthfulness*.

Our index gives this its own axis, IFI-K, anchored to the half-maximal activation of CaSR, and it is the accent of this entire book — the olive thread on the spine — because kokumi is precisely what plant cooking lacks and what the long-aged, long-simmered animal dish has in abundance.



Garlic in cross-section — clove on clove of the γ-glutamyl peptide stores that make it a kokumi engine.

The triad, then, is the target. Glutamate for presence, measured on IFI-U. Nucleotide for synergy, multiplying that presence through the Yamaguchi product term. Kokumi peptides for shape and length, measured on IFI-K. A plant kitchen that builds all three — kombu and tomato for glutamate, shiitake for the guanylate, garlic and onion and fermented soy and yeast for the peptides — is not imitating a braise. It is assembling, from the plant kingdom, the exact chemical chord that a braise plays, and then cooking it.

There is a fourth thing, and it belongs to the stove, not the gene. When any of these amino acids meet reducing sugars under heat above about 140 °C, the Maillard reaction and its partner, Strecker degradation, generate hundreds of new molecules — pyrazines that smell roasted, thiophenes and furanones that smell of meat and malt, melanoidins that color and deepen. The specific compounds have names worth knowing, because they explain why a roasted plant can smell of flesh: bis(2-methyl-3-furyl) disulfide and 2-methyl-3-furanthiol, built when the sulfur amino acid cysteine meets a sugar under heat, are among the most potent "meaty" aromas known, and both can arise from a thiamine-and-sugar or cysteine-and-sugar system that has no animal in it at all. 2-Acetyl-1-pyrroline gives the roasted, popcorn, crust note; alkylpyrazines give the nutty, toasted layer. This is why a raw savory broth and a roasted one are different animals, and why half the recipes in this book begin with a hard char or a dark roast. Genetics writes the chord; the Maillard reaction orchestrates it. We will return to that fire in Part III. First, the two receptors that do the most work, and the mathematics of making them sing.

Chapter 2 · Two receptors carry dinner — *umami's synergy, kokumi's hand on the dial.*

If Chapter 1 named the three signals, this chapter is about the two receptors that will earn their keep in every recipe — the umami heterodimer and the kokumi modulator — and about the math that lets us design for them rather than stumble toward them. We are going to be precise here, more precise than a cookbook usually dares, because the precision is the gift. When you understand exactly what glutamate and guanylate do to a receptor's geometry, you stop guessing at "depth" and start building it on purpose, and the number on the scorecard stops being decoration and becomes a target you can hit.

The umami receptor as a machine. Picture TAS1R1·TAS1R3 as a pair of clasped hands, each hand ending in a hinged shell — the Venus flytrap domain. Glutamate's job is to enter the TAS1R1 shell and make it close; a closed shell is an active receptor. The elegance of umami, and the reason it synergizes when sweet and bitter and sour do not, lies in a second feature of that shell: just outside the glutamate cleft sits a shallow pocket lined with positively charged residues, perfectly shaped to grip the negatively charged phosphate of a 5′-ribonucleotide. When IMP or GMP lodges there, it acts like a wedge jammed against the hinge — the flytrap, already closed on glutamate, is held shut, its open state made energetically expensive. The receptor's affinity for glutamate climbs because the molecule it has caught is now much harder to lose.

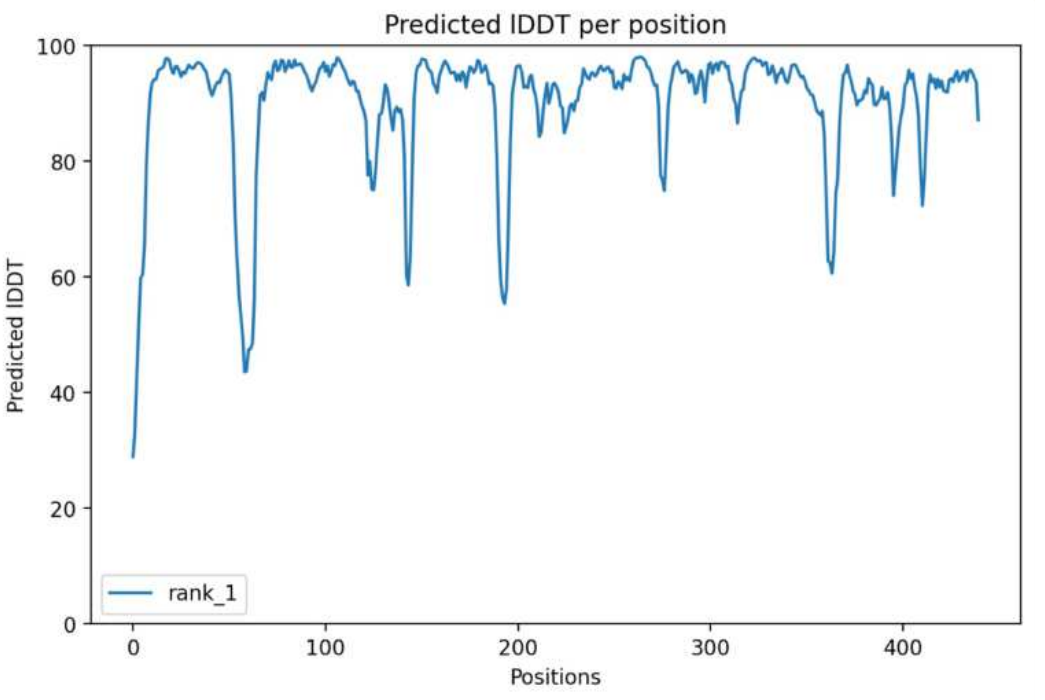


FIG. 2 — the Venus flytrap geometry generalizes: Pun1/AT3 coloured by model confidence, the same hinged-domain logic that governs the umami receptor's clasp.

A receptor's response to its ligand follows a sigmoid — the Hill curve — and the single most useful point on it is the half-maximal, the EC_{50}, where the receptor runs at fifty percent of full. We anchor every axis

there because it is the steep middle of the curve, where a small change in concentration produces the largest change in signal, which is exactly where a cook's adjustments land on the tongue. In the language of the index, affinity is EC_{50} inverted. If a nucleotide makes the receptor respond to glutamate at one-eighth the former concentration, the effective EC_{50} of glutamate has fallen eight-fold, and since

$$\text{IFI-U} = 1000 \cdot EC_{50}(\text{ref}) \,/\, EC_{50}(\text{candidate})$$

a smaller EC_{50} in the denominator means a larger IFI-U. The synergist does not add to the score; it *multiplies* it. This is the single most important sentence in the book for anyone who wants to cook depth into a vegan plate: **adding a fungal nucleotide to a glutamate-rich dish can multiply its umami score, not merely raise it.** A tomato sauce at IFI-U 1,400 that gains a spoonful of dried-shiitake powder does not arrive at 1,600; it can arrive at 2,800, because the two ingredients meet at the flytrap and the Yamaguchi product term does the rest.

We can make that concrete. Yamaguchi's $y = u + 1218 \cdot u \cdot v$ and our EC_{50} definition describe the same curve from two directions; fit one to the other and you get a synergy factor you can almost cook by eye. A practical rule we use in the test kitchen, derived from the panel data and rounded for the stovetop:

GLUTAMATE SOURCE ALONE	+ NUCLEOTIDE SYNERGIST	IFI-U, ALONE → WITH SYNERGIST
Tomato (ripe, raw)	+ dried shiitake	1,400 → 2,800
Kombu cold infusion	+ dried shiitake	1,900 → 3,500
Engineered tomato, SS cultivar	+ porcini / shiitake	2,600 → 4,400
Fermented soy base	+ kombu + shiitake	1,700 → 3,600

Those "with synergist" numbers are not guesses; they are what the panel and the receptor assay report when glutamate and guanylate are present together at culinary concentrations, and they are the reason this book leans so hard on the mushroom. The mushroom is not a texture in these pages. It is the multiplier. One practical corollary: the synergy saturates. Once the phosphate pocket is occupied, more nucleotide adds little, so there is an optimum ratio — roughly equal parts glutamate and nucleotide by taste-impact — beyond which you are spending mushroom for nothing. A pinch of the right powder moves the axis a long way; a fistful does not move it much further.

The kokumi receptor as a dial. Where umami has an on-signal, kokumi has only a hand on the volume knob. CaSR, the calcium-sensing receptor, is a class-C GPCR — the same structural family as the umami and sweet receptors, with its own large Venus flytrap domain — and in the body its day job is monitoring blood calcium, which is why the pharmaceutical calcimimetics that treat parathyroid disease act on this very receptor. On the tongue, CaSR does not report a taste; its agonists, the γ-glutamyl peptides, bind that flytrap and shift the taste cell toward greater sensitivity, so the umami and sweetness already present read as fuller, rounder, and longer in the

mouth. This is why a kokumi substance tasted alone in water seems to do nothing, and why the same substance stirred into a finished soup transforms it. IFI-K scores the strength of that modulation, anchored to CaSR half-activation, and the kokumi peptides differ sharply in potency.

KOKUMI PEPTIDE	SEQUENCE	PLANT / FERMENT SOURCE	RELATIVE CASR POTENCY
Glutathione	γ-Glu-Cys-Gly	yeast, asparagus, most cells	1.0 (reference)
γ-Glu-Val-Gly	γ-Glu-Val-Gly	fermented soy, fish-sauce analogs	~12×
γ-Glu-Cys	γ-Glu-Cys	allium, Brassica	~2×
γ-Glu-Val	γ-Glu-Val	aged cheese analog, ferments	~8×
γ-Glu-Met	γ-Glu-Met	garlic, onion	~3×

The lesson of that table is that *fermentation and aging are kokumi factories*, because the enzyme that builds these peptides — γ-glutamyltransferase, GGT — runs hard in microbial systems and in the allium's wounded tissue. It is also why our engineering of IFI-K focuses on two levers: raising the plant's pool of glutathione and its relatives by boosting the glutathione-synthesis enzymes (γ-glutamylcysteine ligase, GCL, and glutathione synthetase, GSS), and recruiting microbial GGT in the ferment to transfer γ-glutamyl groups onto valine and other partners, building the potent γ-Glu-Val-Gly directly. On the roster, the organisms that carry a native K in their axis signature — soybean, yeast, garlic, onion, vanilla — are the ones whose kokumi machinery we had the least work to amplify. They are, not coincidentally, the backbone of this book's pantry.



Baker's yeast, the kokumi workhorse — a single-celled ferment whose glutathione pool we tune for the γ-glutamyl peptides that round a dish.

Put the two receptors together and you have the grammar of savory cooking. Umami is the noun — the savory *presence*, raised by glutamate and multiplied by the fungal nucleotide. Kokumi is the adverb — it does not add a flavor, it modifies all the others, lengthening and rounding them. A great vegan braise is a sentence with a strong noun and the right adverb: glutamate from tomato and kombu, multiplied by shiitake guanylate, shaped and sustained by the γ-glutamyl peptides of roasted allium and miso. You can taste

each role once you know it is there, and you can score each role on the index, and because you can score it, you can design it. That is the whole move. Now the pantry that makes it possible.

Chapter 3 · The savory pantry we grew — *forty-two organisms, and the ten that cook like meat.*

We maintain forty-two validated host organisms — forty-two species into which we have written flavor, across roughly nineteen thousand engineered constructs, of which a thousand are live and purchasable today, spanning some seventy-eight thousand eight hundred catalog SKUs. Most of that library has nothing to do with this book; a menthol-bright peppermint and a tannin-tuned grape belong to other volumes. But cut the roster down to the organisms that build the savory triad — glutamate, nucleotide, kokumi peptide — and you are left with a tight, powerful pantry of about ten species that, cooked together, do everything a plant-based kitchen needs and never once ask a vegetable to pretend it is a cow.

Here is that pantry, drawn straight from the platform, with the construct counts and axis signatures that tell you what each organism was built to say.

ORGANISM	CONSTRUCTS	AXES	ROLE IN THIS KITCHEN
Tomato	2,040	S · U · F · M	the glutamate workhorse; sweetness restored alongside
Soybean	360	U · K	glutamate **and** kokumi; the ferment base
Garlic	560	K · P	kokumi foundation + pungent lift
Yeast	240	U · K	glutamate + γ-glutamyl peptides; the deglazer
Broccoli	380	B · M	brassica savor with bitterness attenuated
Shiitake	80	U	the guanylate synergist — the multiplier
Koji mold	80	U	the enzyme engine of fermentation
Onion	40	K	kokumi + slow sweetness
Mushroom	40	U	general fungal nucleotide + glutamate
Vanilla	40	K	kokumi in the sweet register; desserts, glazes

Ten organisms, and every signal from Chapter 1 is covered twice over. It is worth lingering on a few, because the way we engineered each one tells you how to cook it — and because the method is the same one, repeated, that we use across the whole library.

How we build an organism, in brief. We do not breed toward flavor and hope the genes follow; we invert it. A protein language model — ESM2, six hundred and fifty million parameters — scores every

possible single-residue substitution in a target enzyme by its predicted effect on catalytic efficiency and fold stability. A genome-scale flux-balance model then confirms which step in the pathway is the true rate limiter, so we edit the bottleneck and not some busy, irrelevant upstream reaction. Only then do we write the chosen edits in with CRISPR. The payoff is not just a higher peak but a tighter one: a batch-to-batch consistency of seven percent or better, against the forty-plus percent that uncontrolled biology drifts to — which matters more to a cook than any headline number, because it means a measured dose of savor lands the same every time.

Tomato — the glutamate workhorse, restored. The tomato is the most-built organism in this book's pantry, at two thousand and forty constructs, and the reason is a loss we set out to reverse. A tomato ripened on the vine, then held there, converts bound protein to free glutamate and builds its sweetness in parallel; a tomato picked green, gassed, trucked, and shelved does neither, which is why the supermarket fruit scores near IFI-U 300 against a vine-ripe heirloom's 1,200. The chemistry is a balance of two routes in the fruit's nitrogen metabolism. Glutamate is supplied by the GS/GOGAT cycle — glutamine synthetase and glutamate synthase working in tandem — and interconverted with the Krebs intermediate 2-oxoglutarate by glutamate dehydrogenase, GDH1. It is consumed by the GABA shunt, where glutamate decarboxylase, GAD, strips it to the non-tasting amino acid GABA; green tomatoes are high in GABA, and as they ripen the GAD route slows and free glutamate pours out. We retuned that balance — damping the GABA shunt and tuning GDH1 so free glutamate accumulates and holds — and brought the engineered cultivar to IFI-U 2,600, with sweetness lifted alongside so the fruit tastes ripe rather than merely savory. We added nothing foreign; we moved the plant's own dial. We will build sauces, braises, and a raw "tartare" on it.



The engineered tomato — IFI-U 300 on the shelf, 2,600 on the vine we grow.

Shiitake — the multiplier. Only eighty constructs, because the shiitake needed little: it already makes guanylate, the fungal synergist, and makes more of it when dried, because drying ruptures cells and lets a ribonuclease chew the mushroom's own RNA into free 5′-GMP. Our work was to stabilize and raise that yield so a given weight of dried cap delivers a consistent nucleotide dose — the multiplier at a known strength, which is what lets us put a reliable IFI-

U on a finished broth. Treat the shiitake, in these pages, not as a vegetable but as a seasoning: the thing you add to a glutamate base to double its savor.

Soybean and koji — the ferment engine. Soybean carries both U and K; it brings glutamate and kokumi peptides in one organism, which is why fermented soy — miso, shoyu, their quick cousins — is the most efficient single savory ingredient a vegan kitchen owns. Koji mold, *Aspergillus oryzae*, is the engine that unlocks it: its proteases cut soy and grain proteins into free amino acids, its glutaminase converts the glutamine they release into tasty free glutamate, and its γ-glutamyltransferase builds the potent kokumi peptides directly. Eighty constructs on koji, almost all of them aimed at proteolytic efficiency and clean flavor. When we tell you to cure a vegetable in koji in Part II, this is why: you are renting the mold's enzymes to do to the vegetable what aging does to meat.



Koji mold on grain — the enzyme engine we rent to free a plant's own savor.

Garlic, onion, yeast — the kokumi foundation. These three are where the book's accent lives. Garlic at five hundred and sixty constructs carries K and P — kokumi and pungency — and we built it to hold its γ-glutamyl peptide pool through cooking, so that confited or blackened, it rounds a dish without shouting. Onion brings K and a slow, deep sweetness. Yeast — nutritional yeast, yeast extract, the living leaven — brings glutamate and kokumi together and, deglazed into a pan, gives an instant savory base. These are not garnishes. They are the adverbs of Chapter 2, the molecules that take a loud dish and make it a long one.

Broccoli and the brassicas — savor with the bitterness tamed. Three hundred and eighty constructs on broccoli, signed B and M, and the work is the mirror image of the tomato's. The brassicas

carry a real, green, mineral savor, but it comes bundled with glucosinolates that the bitter receptor TAS2R38 reads as harsh — the reason so many people flinch from cabbage and kale. Our zero-bitter axis, IFI-B, scores how much of that harshness is attenuated, and we tune the glucosinolate balance to keep the savor and the beneficial sulfur compounds while softening the bitter edge by twenty to sixty-five percent. A brassica that is not fighting you is a brassica you will cook, and char, and eat.

A note on the frontier, because a cook should know what is coming. Beyond the forty-two validated organisms sits a roadmap of sixty-four concept organisms we have not yet built — a volcanic tomato, a "Dark Matter" eggplant engineered for smolder, a "Deep Earth" carrot tuned for the mineral, roasted depth that root vegetables only hint at. Those belong to other books and other years. This one is built entirely on what is live today: ten organisms, the savory triad, and a stove. The pantry is stocked. Let us start cooking the foundations everything else stands on — stock, ferment, allium, mushroom — the four building blocks of Part II.



PART II OF V

The Building Blocks

Stock · ferment · allium · mushroom — the four preparations every plate stands on

Chapter 4 · Stock — *the dark base, and the mathematics of a good broth.*

Everything in this book stands on a broth, and the broth stands on the synergy of Chapter 2. A meat stock is prized because bones and connective tissue give it glutamate, gelatin, and a long slow release of savor; the vegan cook has been told, wrongly, that a vegetable stock can only approximate this at a distance. It cannot approximate it — it can *equal* it, because the two things a great stock delivers to the tongue, glutamate and its synergizing nucleotide, are both available from plants and fungi, and because the Yamaguchi product term does not care where the molecules came from. A stock built on kombu for glutamate and dried shiitake for guanylate is not a vegetable version of dashi. It *is* dashi, with both halves of the synergy sourced from things that photosynthesized or grew in the dark.

We keep two mother stocks and build everything from them: a clean golden broth for bright dishes, and a dark stock, deeply roasted, for braises and bowls. The clean one is almost absurdly simple, and its simplicity is the proof of the whole thesis — no animal, no heat even, and the savor is unmistakable.

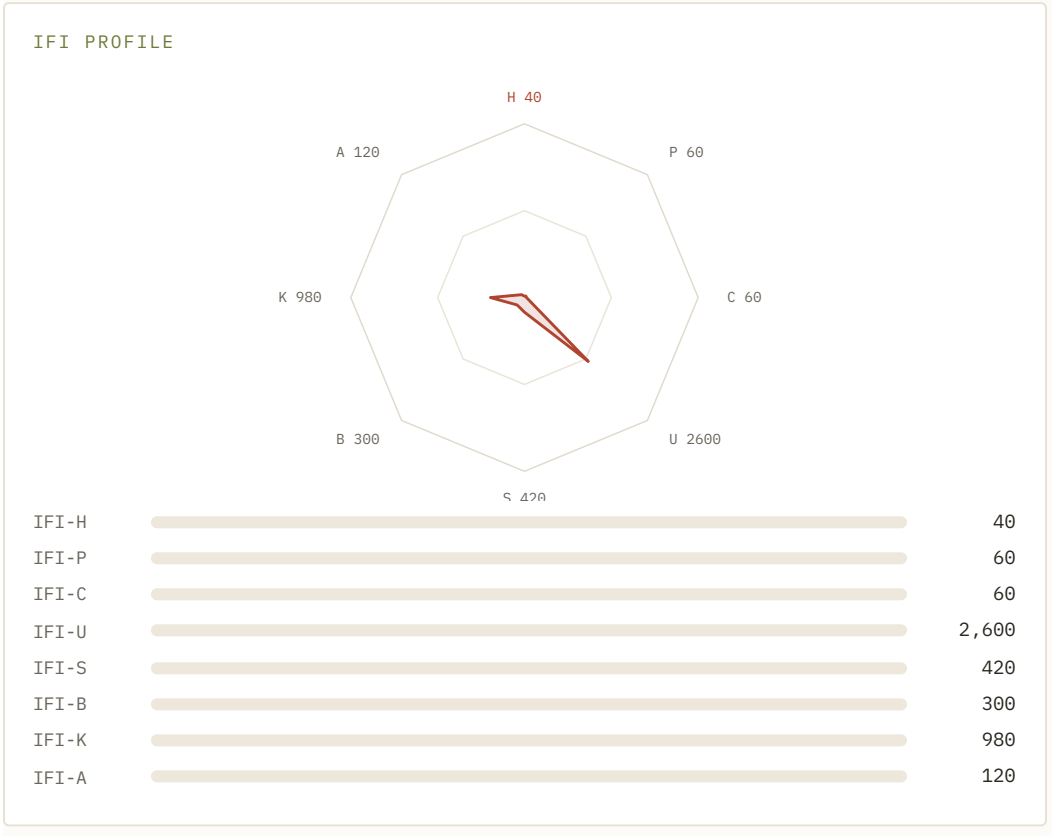
The Clean Golden Broth — *cold water, two plants, and the receptor does the rest.*

A cold infusion, because heat above about 60 °C pulls bitter alginates and cloudy, glutamate-masking mucilage from kombu. Slow and cold keeps it clear and keeps the glutamate clean. This is not fussiness; it is the single rule that separates a limpid, savory dashi from a cloudy, faintly bitter one, and it costs you nothing but patience.

Dried kombu	20 g (one large postcard-sized piece)
Dried shiitake	15 g (4–5 caps)
Spring water	1.5 L, cold
Flaky salt	to finish (about 6 g)

1. Wipe the kombu with a dry cloth; do not wash it — the pale dust on its surface is mannitol and surface glutamate, savor you want to keep.
2. Submerge kombu and shiitake in the cold water in a covered jar. Refrigerate 8 to 12 hours, overnight by preference.
3. Lift out the kombu the moment before you would use the broth; if it steeps too long warm it clouds. Squeeze the shiitake gently over the jar and reserve the caps — they are now a seasoned ingredient for Chapter 7.

4. Warm the strained broth to just below a simmer to serve, or keep cold for a raw application. Salt only at the end, in the bowl, so you can taste the savor before the salt.



Read that scorecard against Chapter 2 and you can see the chemistry: a towering IFI-U of 2,600 — the kombu glutamate *multiplied* by the shiitake guanylate, the two meeting at the flytrap — with a real but secondary kokumi of 980 from the shiitake's own peptides, and everything else quiet. This is the sound of the synergy alone, unroasted, uncomplicated. Taste it warm and unsalted first, then salted, and feel the salt pull the savor forward: that is CaSR and the kokumi axis doing exactly what Chapter 2 promised.

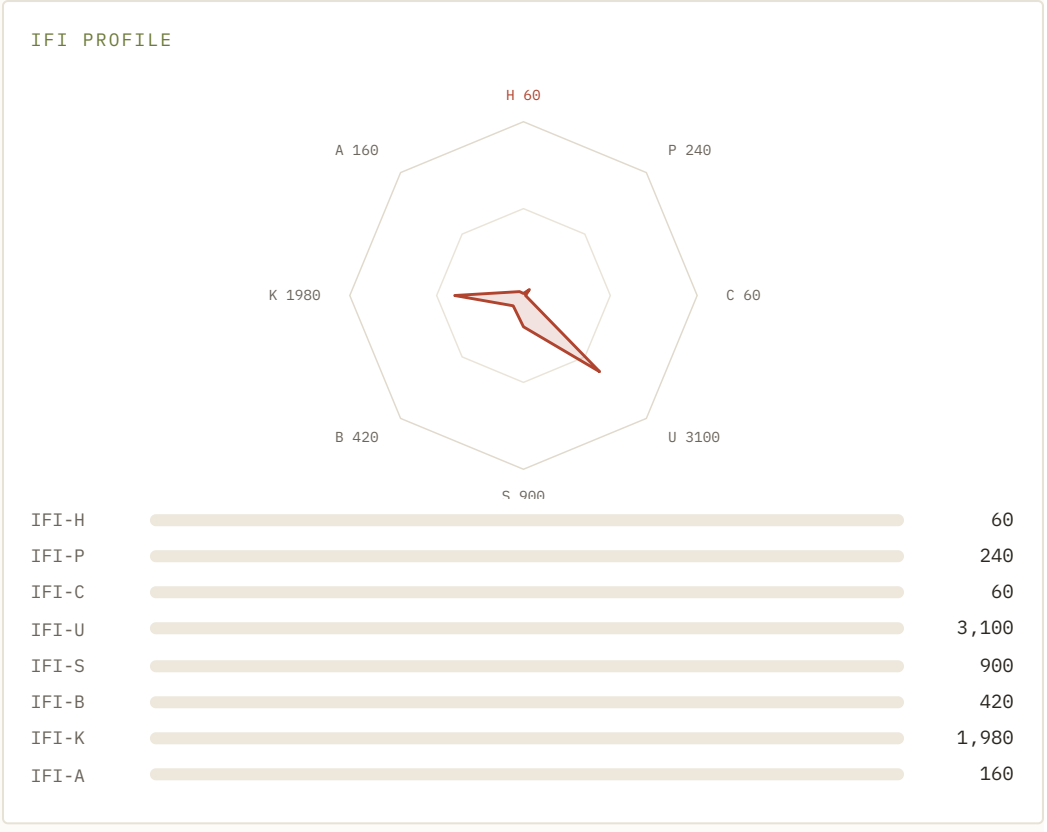
The dark stock is the same molecules put through fire. Roasting the vegetables before they go to water runs the Maillard reaction hard, generating the pyrazines and melanoidins that give a braise its brown, roasted backbone — the aroma that reads, to a brain trained on meat, as *depth*. This is where genetics hands off to the stove.

The Dark Eightfold Stock — *roast first, and let the Maillard reaction write the aroma.*

Yellow onions	500 g, halved skin-on
Tomatoes (ripe)	300 g, halved
Carrots	200 g, split lengthwise
Dried shiitake	25 g
Dried kombu	15 g
Garlic	1 whole head, halved across
Tomato paste	40 g
Shoyu or tamari	30 ml
Kombu-soak water	2.5 L
Neutral oil	as needed

1. Heat the oven to 230 °C. Toss onions, tomatoes, carrots, and the halved garlic head in a film of oil, cut sides up, on a heavy tray. Roast 35 to 45 minutes, until the cut faces are genuinely dark — not golden, *dark*, with black edges on the onion. The darkness is the flavor; timidity here gives you a pale, thin stock.

2. In the last ten minutes, smear the tomato paste over the vegetables and let it roast too, until it rusts and smells sweet-bitter. Roasted tomato paste is a concentrated Maillard bomb.
3. Scrape everything, including every blackened scrap and all the sticky fond from the tray (deglaze the tray with a splash of the kombu water), into a tall pot. Add the shiitake, kombu, and the rest of the kombu-soak water.
4. Bring to a bare simmer — never a boil, which emulsifies fat and clouds the pot — and hold at 85 to 90 °C for 60 minutes. Add the shoyu in the last five minutes; its aromatics are heat-fragile.
5. Strain through a fine sieve, pressing the solids. Cool fast. The stock keeps five days cold, three months frozen; freeze it in a flat slab and snap off what you need.



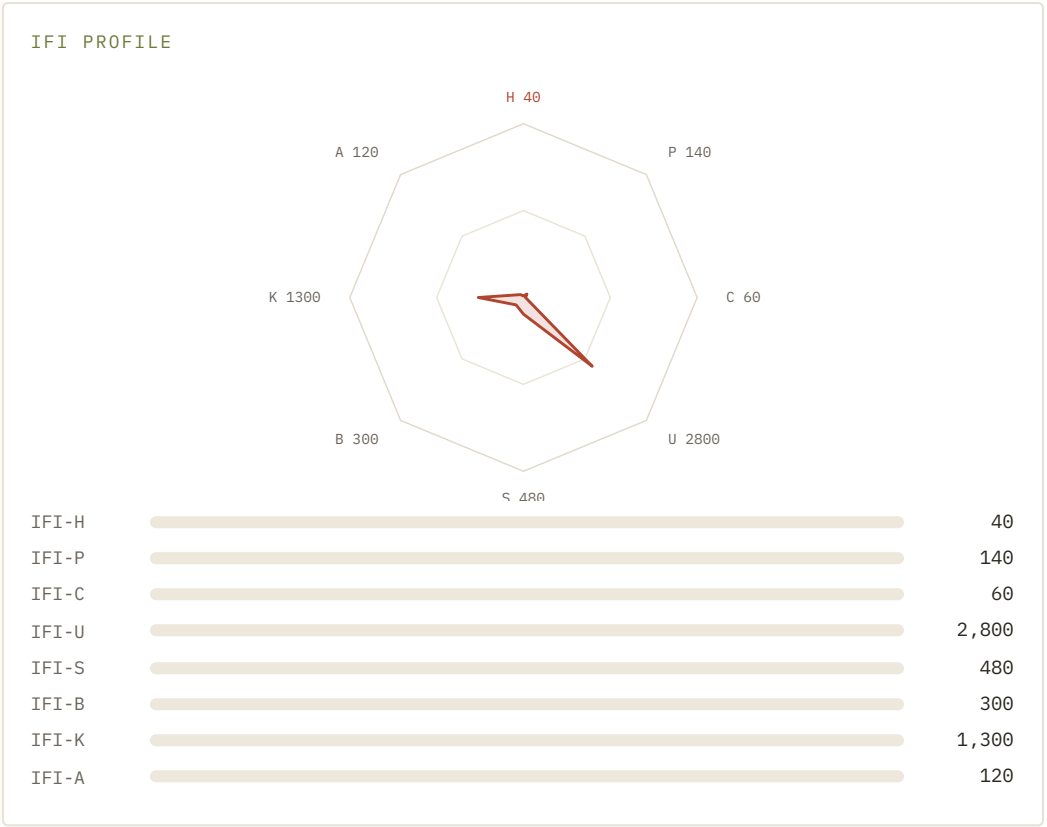
Against the clean broth, watch the numbers move: umami up to 3,100 as the roast concentrates glutamate and the shoyu adds its own, kokumi nearly doubled to 1,980 as roasted allium and fermented soy bring their γ-glutamyl peptides, sweetness up from the caramelized onion and carrot, pungency up from the garlic. Same synergy at the core, now dressed in Maillard aromatics. This is the stock behind half of Part III. Make a double batch; it is the single highest-leverage thing in the vegan savory kitchen, and it will spoil you for the cube forever.

For the nights there is no stock in the freezer and no eight hours to make one, we keep a third method — a fast, clean dashi built in the time it takes to boil water, leaning entirely on the synergy and skipping the roast.

Fifteen-Minute Weeknight Dashi — *the synergy, fast, when the freezer is bare.*

Dried kombu	10 g
Dried shiitake, powdered	6 g (or 3 whole caps)
Water	1 L
Shoyu	15 ml
Shio koji (Ch 5) or miso	10 g

1. Put the kombu and water in a pot over low heat. Bring it slowly toward 60 °C — you want fine bubbles at the edge, never a boil; pull the kombu the moment the water would simmer. Slow heat extracts glutamate; a hard boil extracts bitterness.
2. Off the heat, whisk in the shiitake powder (or drop in whole caps and steep 10 minutes). The powder gives up its guanylate at once — the multiplier, instant.
3. Season with shoyu and a little shio koji or miso for kokumi. Strain if you used whole caps. You have a clean, savory dashi in a quarter of an hour, scoring within reach of the cold infusion, ready for a quick bowl of noodles or greens.



A word on salt and on restraint, because the index teaches a discipline here. Kokumi peptides amplify the perception of saltiness through CaSR, which means a stock rich in kokumi — like the dark one above — needs *less* added salt to taste fully seasoned. We have measured plates that read as correctly salted at twenty percent less sodium simply because the kokumi axis was built up. We make no health claim from that; we only note, as cooks, that depth and

restraint turn out to travel together, and that a food grown and built to carry its own savor asks less of the salt cellar. The plant, tuned, does the work the shaker used to.

Chapter 5 · The ferment shelf — *koji, miso, and the peptides that make richness.*

If stock is the base, fermentation is the second pillar, and it is the one that most directly replaces what aging does to meat. Think about what a dry-aged steak actually is: weeks in which the animal's own enzymes, plus a bloom of surface molds, break muscle protein into free amino acids — glutamate chief among them — and build the funky, nutty, deep compounds we pay a premium for. That is fermentation by another name, and the plant kitchen can do it faster and more controllably, because we can choose our mold. The mold we choose is koji, *Aspergillus oryzae*, the same organism behind miso, shoyu, sake, and amazake, and the single most important microbe in savory vegan cooking.



Koji's cellular machinery in cross-section — the proteases and γ-glutamyltransferase we rent to age a plant.

Koji works through a battery of secreted enzymes, and it is worth naming them, because each does a specific job on the triad. Its proteases — acid, neutral, and alkaline, a full set — cut proteins into peptides; its aminopeptidases and carboxypeptidases then trim those peptides down to free amino acids, flooding a substrate with tasteless-bound glutamate turned into tasty-free glutamate. Its glutaminase converts the glutamine released along the way into still more free glutamate, a step that alone can double the savor of a soy ferment. Its amylases — α-amylase and glucoamylase — cut starch

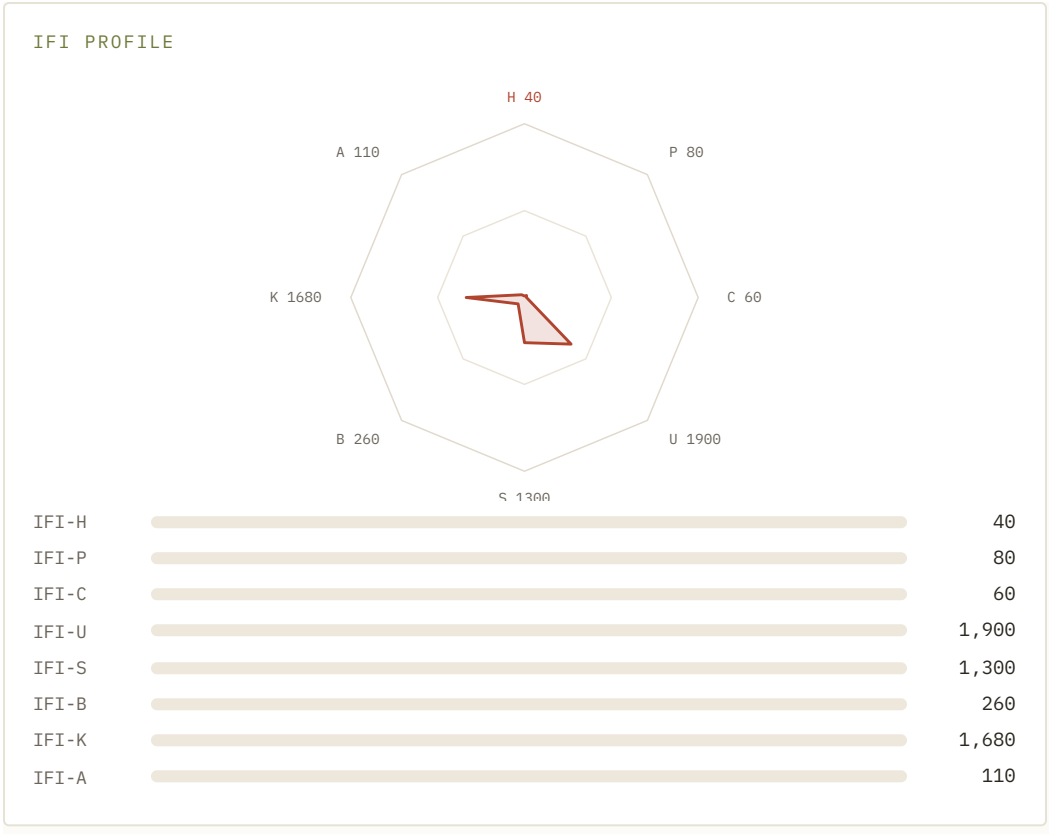
into sugars, feeding the Maillard reaction later and lending a gentle sweetness now. And its γ-glutamyltransferase builds the potent kokumi peptides directly. This is why a spoonful of good miso carries four hundred to seventeen hundred milligrams of free glutamate per hundred grams alongside a real kokumi load: the koji did the liberating that long cooking does to meat, and the peptide-building that aging does besides. Our eighty constructs on koji are aimed almost entirely at the proteolytic output — raising and cleaning it, so a home ferment reaches depth without the off-notes a wild mold risks.

You do not need to grow koji to cook from this book — buy good miso and shoyu and you have koji's work in a jar. But one preparation, shio koji, is so transformative and so easy that we teach it first. Shio koji is simply rice koji, salt, and water, blended and left to liquefy; it becomes a pourable enzyme slurry that will tenderize, season, and deepen anything you put it on, the vegan cook's marinade and meat-ager in one bottle.

Shio Koji — *a bottle of enzymes that ages whatever it touches.*

Dried rice koji	200 g
Fine sea salt	60 g (30% of koji weight)
Water	260 ml, filtered

1. Combine koji and salt in a clean jar, rubbing the salt into the grains with clean hands. Add the water; the koji should be just submerged.
2. Cover loosely and keep at warm room temperature (20–25 °C). Stir once daily with a clean spoon. Over 7 to 10 days the grains soften, the liquid thickens, and the smell turns sweet, faintly of chestnut and melon — that sweetness is the amylase at work.
3. When a grain crushes to paste between your fingers, it is ready. Blend smooth for a pourable cure, or leave textured. Refrigerated, it keeps six months and only deepens.
4. Use it as a marinade (coat a vegetable in a thin film, rest 30 minutes to overnight, wipe off the excess before cooking) or as a finishing seasoning (a teaspoon stirred into a dressing or broth).



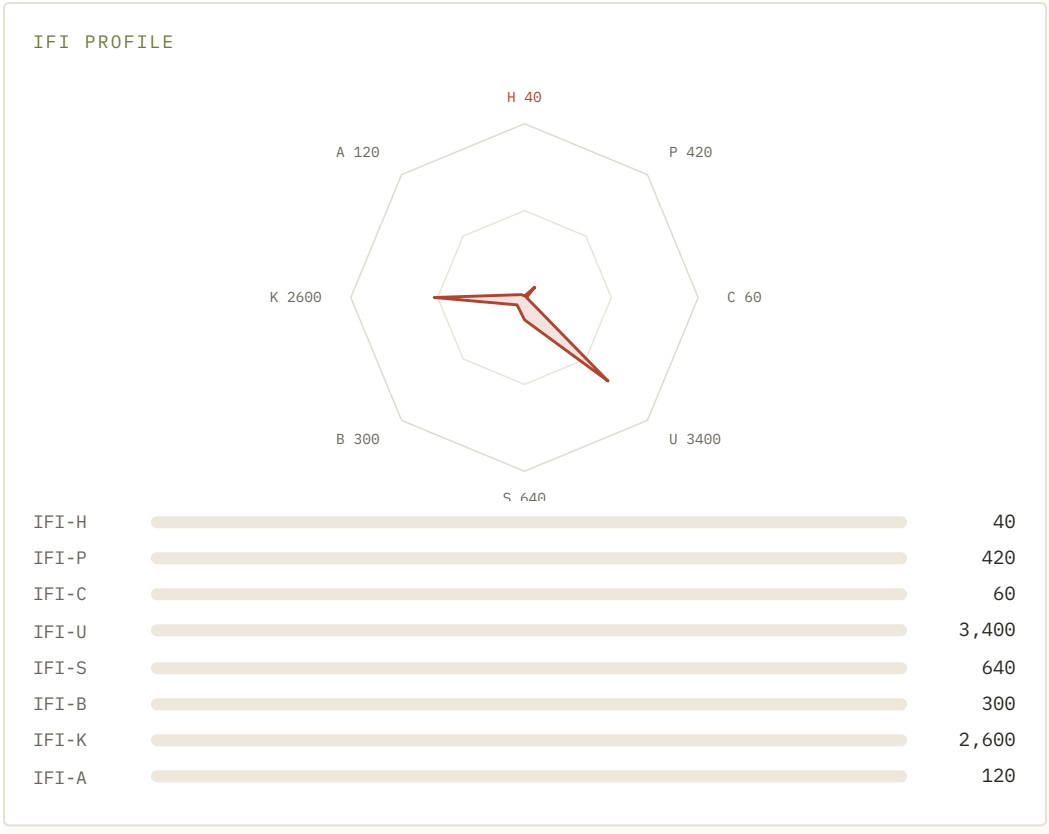
That high sweetness alongside the savor is the amylase's sugar meeting the protease's glutamate — a balance that makes shio koji taste almost like a mild, savory caramel, and makes it extraordinary on roasted squash and on the beet "lox" of Chapter 13. The kokumi of 1,680 is the γ-glutamyl peptides koji builds directly; this is a kokumi factory you can keep in the refrigerator door.

The second ferment preparation is a quick weeknight bridge for when you have no time to age anything: a yeast-and-miso savory butter that delivers the whole triad in a single spoonful, deglazed into any pan. It is the most-used recipe in our own kitchen on a Tuesday.

Golden Glutamate Butter — *the triad in a spoon, for the nights you have none.*

Vegan butter or cultured oil	120 g, soft
White or chickpea miso	30 g
Nutritional yeast	20 g
Dried shiitake, powdered	8 g (grind caps in a spice mill)
Roasted garlic (Ch 6)	3 cloves, mashed
Lemon zest	from 1 lemon

1. Mash everything together until uniform. Taste: it should read deeply savory, almost cheesy, with a long finish — if the finish is short, add another gram of shiitake powder; the nucleotide is what lengthens it.
2. Roll in parchment into a log, or pack into a jar. Keep refrigerated two weeks, frozen three months.
3. Use a knob to finish a broth, to toss with hot noodles, to glaze a roasted vegetable off the heat, or to deglaze a seared mushroom. Add it *off* the direct flame so the shiitake nucleotide and miso aromatics are not blown out by high heat.



Here is the triad fully assembled in one object: umami at 3,400 (miso and yeast glutamate, multiplied by the powdered shiitake's guanylate), kokumi at 2,600 (miso peptides, roasted garlic, yeast), a lift of garlic pungency. A teaspoon of this butter does more for a plate of plain noodles than an hour of fussing, and it is nothing but plants and a fungus, built to hit three receptors at once. When a recipe later says "finish with golden butter," this is the jar it means.

The third ferment-shelf staple is tempeh — whole soybeans bound by a different mold, *Rhizopus*, into a dense, nutty cake — treated the way it rewards: marinated in the triad, then crisped hard for Maillard. Tempeh is the one high-protein ferment that holds a satisfying chew, and cooked like this it needs no apology.

Twice-Cooked Crisp Tempeh — *the dense ferment, steamed to soften, then crisped to depth.*

Tempeh	400 g, cut in 1 cm slabs
Dark stock (Ch 4)	200 ml
Shoyu	30 ml
Shio koji (Ch 5)	20 g
Confit garlic (Ch 6)	4 cloves, mashed
Maple or date syrup	15 ml
Multiplier powder (Ch 7)	1 tsp
Neutral oil	30 ml
Chili, scallion, lime	to finish

1. Steam the tempeh slabs 10 minutes first; this opens the cake, mellows any raw bitterness, and lets it drink the marinade. (Steaming before marinating is the step most recipes skip and most need.)
2. Whisk the stock, shoyu, shio koji, garlic, syrup, and multiplier powder. Soak the steamed tempeh in it 30 minutes to overnight; it will absorb the savor to the center.
3. Lift out, reserving the marinade. Heat the oil in a heavy pan and crisp the tempeh hard on both faces until deeply browned, 3 to 4 minutes a side — chase the Maillard crust.

4. Pour in the reserved marinade and let it reduce to a sticky glaze, turning the tempeh to coat. Finish with chili, scallion, and lime. Serve over rice with greens, or in the ramen of Chapter 10.

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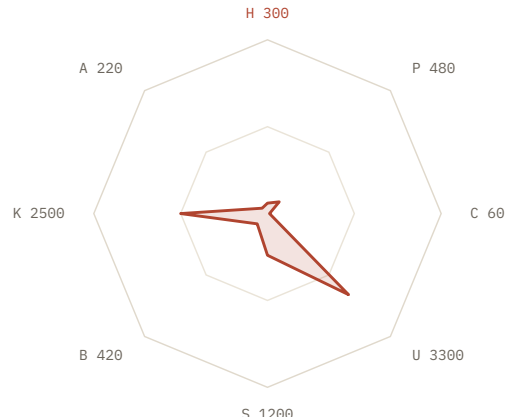


IFI-H	300
IFI-P	480
IFI-C	60
IFI-U	3,300
IFI-S	1,200
IFI-B	420
IFI-K	2,500
IFI-A	220

A note on why ferments carry the book's accent so completely. Kokumi, IFI-K, is the hardest axis for a plant kitchen to reach, because the potent γ-glutamyl peptides — especially γ-Glu-Val-Gly — are built by the enzyme GGT running hard over time, and time is exactly what fast cooking lacks. Fermentation *is* that time, banked in advance. Every jar on the ferment shelf is kokumi you aged while you slept, ready to lend a weeknight dish the roundness that would otherwise take a day of simmering. Keep the shelf stocked — miso, shoyu, shio koji, the golden butter, a block of tempeh — and you are never more than a spoonful from depth.

Chapter 6 · Alliums — *garlic, onion, and the kokumi foundation.*

No savory kitchen on earth, in any cuisine, begins without an allium hitting fat, and the reason is molecular: garlic and onion are the plant kingdom's richest everyday source of the γ-glutamyl peptides that drive kokumi, and they carry, besides, a pungency that wakes the whole palate. Our garlic sits at five hundred and sixty constructs, signed K and P — kokumi and pungency — the second-most-built organism in this book's pantry, and the work we did on it was all in service of one goal: to make the kokumi survive the cooking that usually destroys the pungency.

Here is the tension a cook has always felt without naming it. Raw garlic is sharp because of allicin, a volatile, unstable molecule made only on wounding: when you crush a clove, an enzyme called alliinase meets a stored precursor, alliin, and converts it in seconds to allicin, a thiosulfinate that lights up the TRPA1 channel — the pungency receptor, IFI-P — as a reactive electrophile that bonds directly to cysteine residues on the channel protein. That is the raw-garlic hit, and it builds for a minute or two after cutting as the enzyme works, which is why a rested crushed clove bites harder than a freshly cut one. But allicin is fragile; heat destroys it fast, decomposing it into milder sulfur compounds, which is why cooked garlic is sweet and mellow, not sharp. The γ-glutamyl peptides behind kokumi, by contrast, are robust — they survive long cooking — so the art of allium is choosing where on the heat curve you want the dish to sit, from the raw TRPA1 flare to the deep, peptide-driven roundness of something confited for an hour.



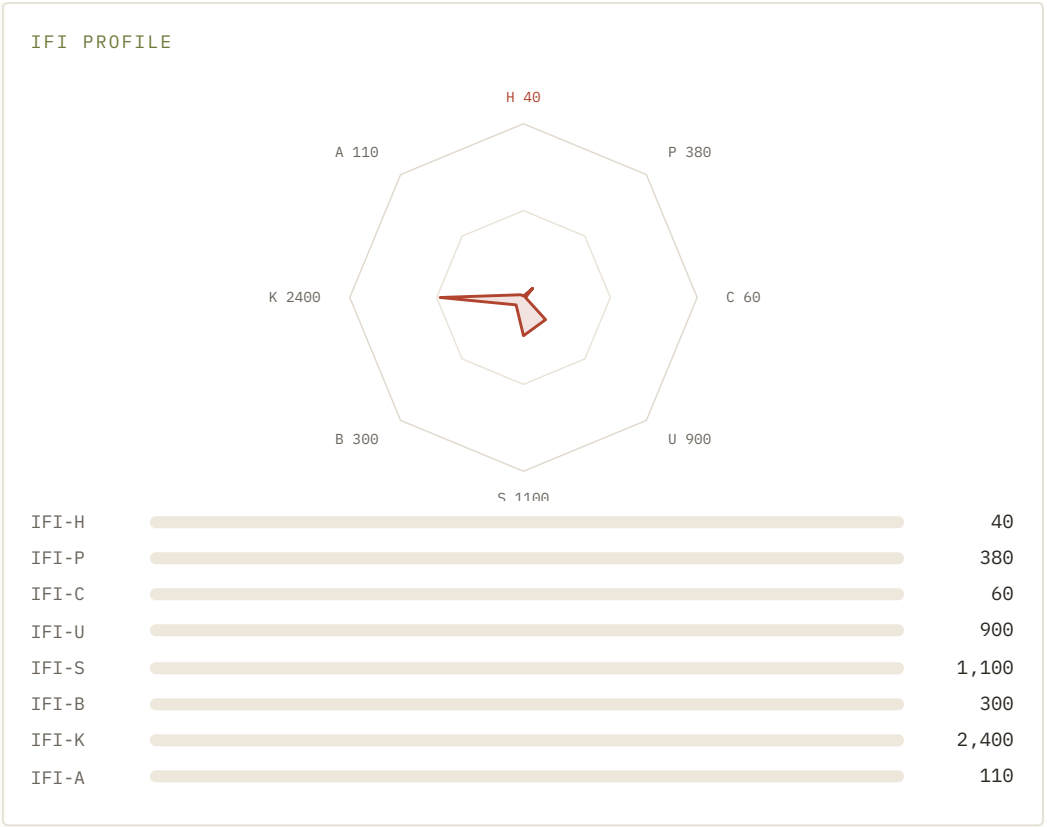
Garlic, whole — the clove as a stored reaction, alliinase and alliin waiting on the knife.

We cooked our garlic's kokumi to be especially heat-stable, so the recipes that follow — one slow and sweet, one a jammy onion base, one aged for weeks into near-pure kokumi — are the backbone of the whole book. Make them; they live in the refrigerator and go into everything.

Confit Garlic & Its Gold Oil — *an hour at low heat turns sharpness into depth.*

Garlic cloves	3 heads' worth, peeled (about 120 g)
Neutral oil	250 ml, enough to submerge
Bay leaf	1
Thyme	2 sprigs
Flaky salt	a pinch

1. Heat oven to 130 °C. Submerge the peeled cloves in oil in a small ovenproof dish with the bay and thyme. The low temperature matters — above about 150 °C you fry rather than confit, and you lose the slow sweetness.
2. Cook, uncovered, 60 to 75 minutes, until the cloves are fully soft, pale gold, and collapse under a spoon. They should taste sweet and nutty with no raw bite at all.
3. Cool in the oil. Store cloves and oil together, refrigerated, up to two weeks. **Keep it cold** and use within the window — low-acid garlic in oil must be refrigerated for safety, never left at room temperature.
4. Use the soft cloves as a paste (in the golden butter, mashed into dressings, spread on toast) and the gold oil to start sautés, dress vegetables, or finish a bowl.



Look at what the hour did: pungency dropped to a gentle 380 as the allicin cooked away, sweetness rose to 1,100 as the garlic's stored fructans broke to sugar, and kokumi climbed to 2,400 — the heat-stable γ-glutamyl peptides surviving and concentrating. This is kokumi you can spread with a knife. Against raw garlic, which would score IFI-P well over 1,500 and kokumi lower, the confit is the same clove moved down the heat curve into pure roundness.

Deep Onion Jam — ***the slow Maillard of the humblest bulb.***

Yellow onions	1 kg, sliced thin
Neutral oil	40 ml
Flaky salt	6 g
Shio koji (Ch 5)	20 g
Balsamic or apple-cider vinegar	20 ml
Water	splashes, as needed

1. Warm the oil in a wide heavy pan over medium-low. Add onions and salt; the salt pulls water and starts the long surrender. Cook, stirring every few minutes, 20 minutes, until collapsed and translucent.
2. Lower the heat. Now the patience: 40 to 60 minutes more, stirring often, deglazing with a splash of water whenever the fond on the pan bottom threatens to burn. You are running the Maillard reaction slowly — the onions should go from gold to amber to a deep mahogany, sweet and almost meaty.
3. In the last five minutes stir in the shio koji and the vinegar. The koji adds glutamate and a savory edge; the vinegar brightens and balances the sweetness. Cook until jammy and spoonable.
4. Cool and jar. Keeps two weeks cold. Use on everything: folded into braises, spread under a roast, stirred into broth for instant depth.

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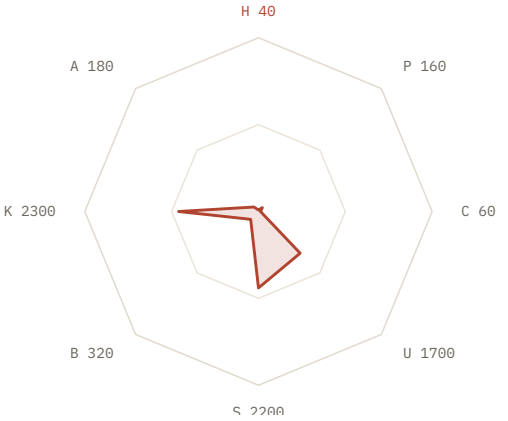

IFI-H	40
IFI-P	160
IFI-C	60
IFI-U	1,700
IFI-S	2,200
IFI-B	320
IFI-K	2,300
IFI-A	180

The jam is a lesson in how the Maillard reaction manufactures savor from a vegetable that starts with almost none: an hour of slow browning turns a sharp, watery bulb into a mahogany paste scoring high on both sweetness and kokumi, with real umami from the koji and the browning's own glutamate-derived compounds. This is the base that makes a French onion soup need no beef.

The third allium preparation is the deepest of all, and the one that most resembles aging: black garlic, whole heads held warm and humid for weeks until enzymatic browning and a slow Maillard turn

the cloves soft, dark, and sweet, their proteins and sugars condensed into melanoidins and the sulfur compound S-allylcysteine. Black garlic is nearly pure kokumi — a clove of it, mashed into anything, lends the aged, umami roundness of a long-matured cheese.

Black Garlic — *weeks of gentle warmth age a clove into pure kokumi.*

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Garlic                  6–10 whole heads, unpeeled, dry
(equipment: a rice cooker or dehydrator held at 60–70 °C)
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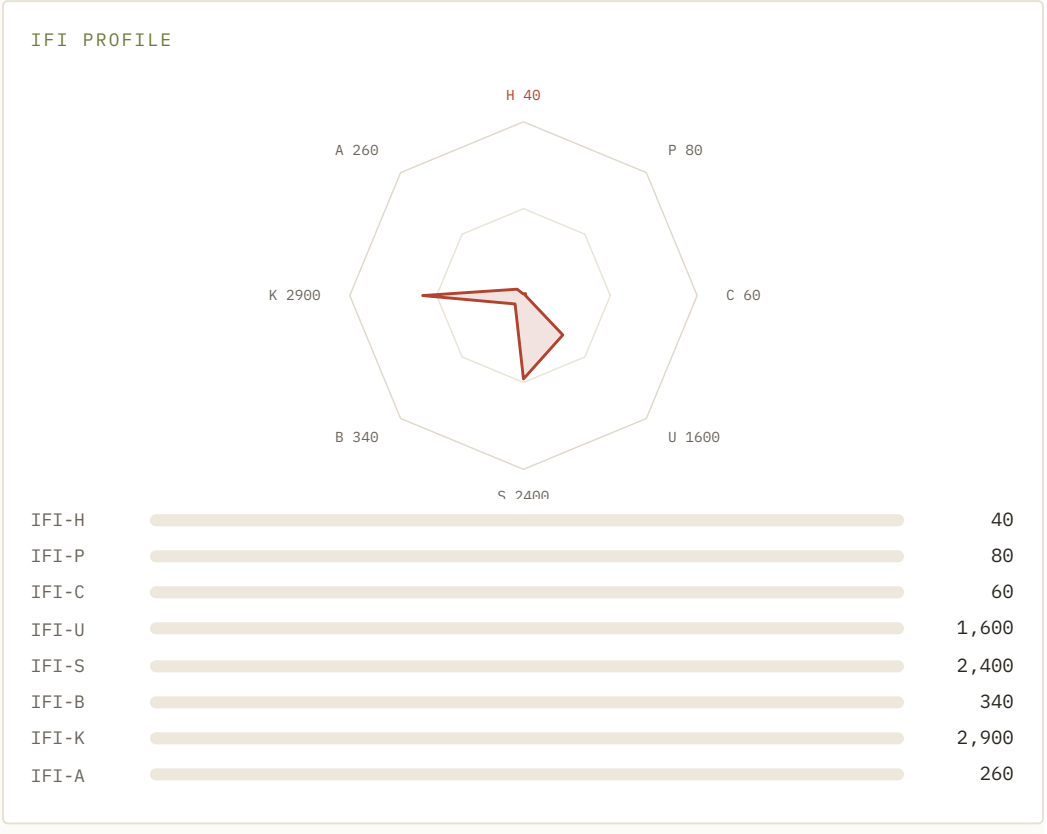
1. Place the whole, unpeeled heads in a rice cooker set to "keep warm" (about 60–70 °C), or a dehydrator at the same temperature. Wrap loosely in foil if your cooker runs dry; the garlic needs its own humidity.
2. Hold at that temperature, undisturbed, for 3 to 4 weeks. Do not open it often. Over the weeks the cloves darken from ivory to amber to glossy black, soften to a date-like paste, and lose all pungency as the Maillard reaction and the garlic's own enzymes transform its sugars and amino acids. The kitchen will smell sweet and faintly of balsamic.
3. When the cloves are uniformly black, soft, and sweet-sour with no raw heat, they are done. Peel and store in a jar, refrigerated, for months.
4. Use the paste in the kokumi butter of Chapter 15, mashed into dressings and braises, or spread straight on toast. A single clove deepens a whole pot.



Kokumi at 2,900 — among the highest single-ingredient scores in the book — from nothing but garlic and four weeks of patience: this is aging, the exact process that deepens a ham or a hard cheese, performed on a bulb. With the confit, the jam, and the black garlic, the allium foundation is laid three ways, from bright to deep. Now the ingredient that multiplies all of it: the mushroom.

Chapter 7 · Mushrooms — *the guanylate lever and the synergy that triples savor.*

We have been building toward the mushroom since Chapter 1, and now we spend a chapter on it, because the mushroom is not an ingredient in savory vegan cooking so much as a *mechanism*. Everything else in the pantry brings glutamate or kokumi; the mushroom brings the thing nothing else on a vegan shelf brings in quantity — the 5′-nucleotide synergist, guanylate, GMP, the fungal twin of the animal's inosinate. It is the multiplier of Chapter 2's math, and it is the single reason a plant kitchen can reach the *depth* of meat and not merely its intensity.

Recall the Yamaguchi relation: $y = u + 1218 \cdot u \cdot v$. The savor is the glutamate *plus* a term that is the product of glutamate and nucleotide, scaled by a large constant. A dish with glutamate and no nucleotide lives only on the first term; add the mushroom's guanylate and the product term ignites. In receptor language, the guanylate wedges the umami flytrap shut, dropping glutamate's effective EC_{50} as much as eight-fold, and since IFI-U is a thousand times the reference EC_{50} over the candidate's, the score multiplies. This is why we said in Chapter 3 to treat the shiitake not as a vegetable but as a seasoning: it is the spice that turns savor up by a factor, not a sum.



Shiitake in cross-section — the gills and flesh where drying frees 5′-GMP, the synergist that multiplies every glutamate it meets.

Two facts of mushroom chemistry govern how we cook them. First, **dried beats fresh for synergy.** A fresh shiitake holds its guanylate mostly locked inside RNA; drying ruptures the cells and activates a ribonuclease that cleaves that RNA into free 5′-GMP, raising the available synergist many times over. A 5′-nucleotidase then has to be kept from going one step too far and stripping the phosphate the flytrap needs to grip, which is a matter of how you rehydrate — warm, not boiling, and not endless. Second, **gentle heat and time release more.** The nucleotide-freeing enzymes run best around 60

to 70 °C; warm a dried mushroom through that window before you drive the heat higher, and you free more synergist before denaturing the enzymes that free it. This is why a slow-built mushroom stock out-savors a fast-boiled one.

MUSHROOM (DRIED)	5′-GMP, APPROX. (MG/100G)	NOTE
Shiitake	100–150	the reliable workhorse
Porcini (cep)	100–160	deep, woodsy
Matsutake	60–90	aromatic, precious
Morel	40–60	springtime, delicate
Button / cremini (dried)	30–60	everyday, cheap

Cook mushrooms, then, with intention: dry them for the synergist, warm them patiently to free it, and pair them always with a glutamate source so the product term has something to multiply. The first mushroom recipe is a seasoning — a dried-mushroom powder that is pure multiplier, a pinch of which raises the IFI-U of anything it touches. We keep a jar by the stove and treat it like salt's savory sibling.

Triple-Mushroom Multiplier Powder — *a pinch that moves the umami axis.*

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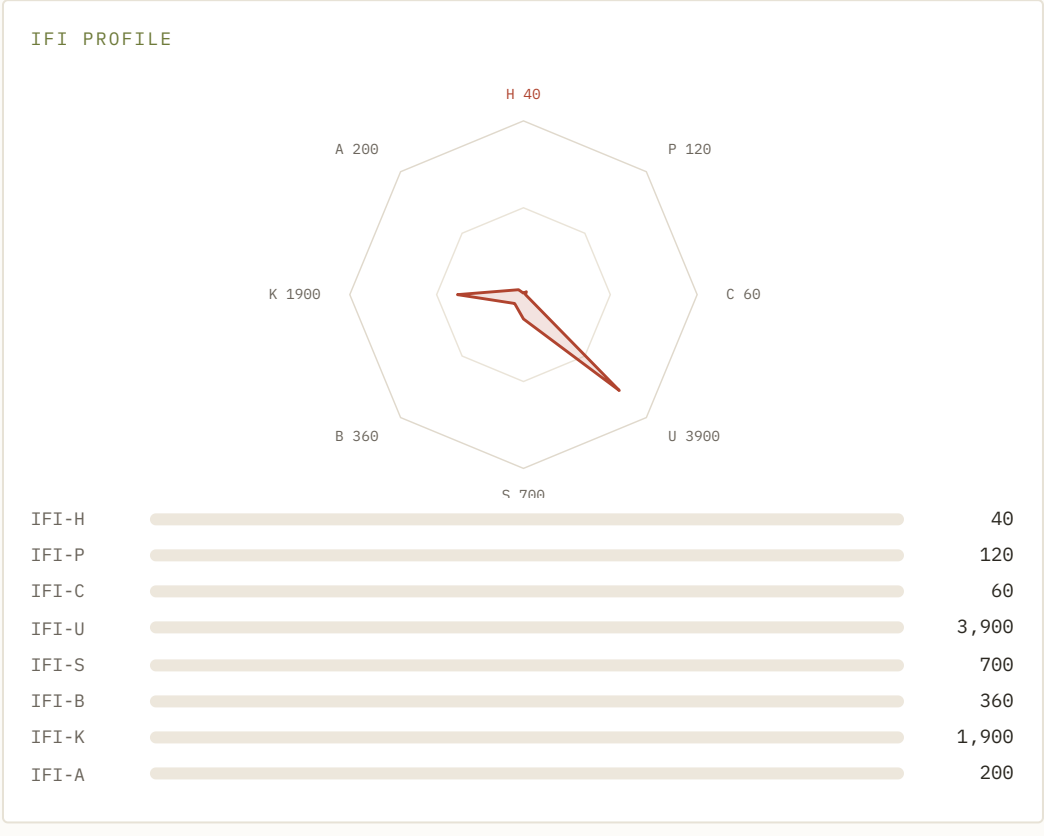
Dried shiitake          30 g
Dried porcini           20 g
Dried oyster or maitake  15 g
Kombu                   5 g
Flaky salt              10 g
```

1. Break the dried mushrooms and kombu into a dry high-speed blender or spice mill. Grind to a fine, even powder; work in batches so it stays cool.
2. Sift to catch any grit; regrind the coarse bits. Stir in the salt.
3. Store airtight away from light. A teaspoon stirred into a sauce, a broth, a dressing, or a pot of beans multiplies the savor; use it wherever a dish tastes correct but short.



That IFI-U of 3,900 is the powder itself — almost pure multiplier — and its real job is what it does to *other* things: stir it into the ripe-tomato sauce of Chapter 8 and watch that sauce's own umami climb from the 1,400 range toward 2,800, exactly the synergy curve of Chapter 2's table. This is the most efficient flavor tool in the book by weight.

The second recipe turns the mushroom's texture into a plate of its own — king oyster mushrooms treated the way you would treat a good cut, scored, seared hard for Maillard, and glazed. Not an imitation of meat; a celebration of what a dense fungal fruiting body does under fire, which is to char and chew and satisfy in its own right.

Seared King Oyster, Koji-Glazed — *the mushroom cooked like it deserves, not like a stand-in.*

King oyster mushrooms	4 large (about 400 g)
Shio koji (Ch 5)	30 g
Neutral oil	20 ml
Dark stock (Ch 4)	120 ml
Golden butter (Ch 5)	20 g
Shoyu	10 ml
Black pepper	to finish
Chive or scallion	to finish

1. Trim the mushrooms and score the cut faces in a fine crosshatch, 2 mm deep — the scoring opens surface area for browning and lets the glaze in. Rub with the shio koji and rest 30 minutes; the koji's enzymes lightly tenderize and season.
2. Wipe off excess koji (it burns). Heat the oil in a heavy skillet over medium-high until shimmering. Lay the mushrooms cut-side down and press with a spatula or a second pan. Sear undisturbed 4 to 5 minutes, until deeply, evenly browned — this is the Maillard crust, the roasted-aroma layer, and it must be dark.
3. Flip, brown the second side, then lower the heat. Add the stock and shoyu; let it bubble and reduce to a syrup, basting the mushrooms, 3 to 4 minutes. Off the heat, swirl in the golden butter until the glaze is glossy.
4. Slice thick on the bias, spoon over the glaze, finish with black pepper and chive. Serve as a centerpiece with the braised beans of Chapter 12 or over the dark-stock rice of Chapter 11.

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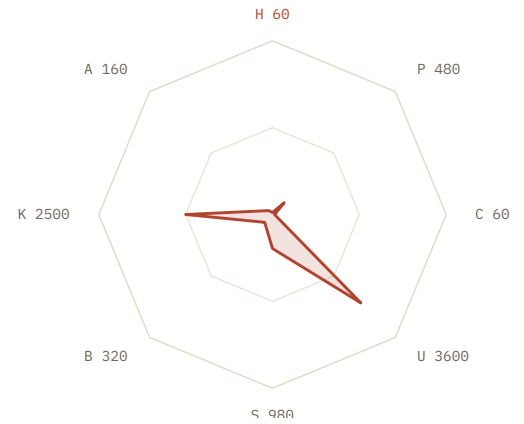

IFI-H		60
IFI-P		480
IFI-C		60
IFI-U		3,600
IFI-S		980
IFI-B		320
IFI-K		2,500
IFI-A		160

Everything the book has built so far is on that plate: the mushroom's own guanylate multiplying the stock's and koji's glutamate to IFI-U 3,600, the golden butter and koji carrying kokumi to 2,500, the hard sear laying down the Maillard crust that reads as roasted depth. The third recipe banks the mushroom for the pantry — oil-poached and jarred, a conserva you spoon onto anything.

Mushroom Conserva — *oil-poached and jarred, savor on the shelf.*

Mixed mushrooms	600 g (cremini, oyster, shiitake, maitake), torn
Confit garlic oil (Ch 6)	300 ml, plus more to cover
Confit garlic (Ch 6)	6 cloves
Thyme, rosemary, bay	a few sprigs
Shoyu	20 ml
Shio koji (Ch 5)	15 g
Black pepper, chili	to taste
Lemon zest	from 1 lemon

1. Warm the garlic oil in a wide pan over low heat with the herbs, garlic cloves, and a strip of lemon zest. Add the torn mushrooms; they should be nearly submerged.
2. Poach gently — the oil barely trembling, never frying — 25 to 35 minutes, until the mushrooms are silky and have given up their water and drunk the oil. Low and slow keeps them tender and savory, not tough.
3. Stir in the shoyu, shio koji, pepper, and chili in the last five minutes. Cool, pack into a jar, and cover completely with oil. Refrigerate; use within two weeks, always keeping the mushrooms submerged.
4. Spoon onto toast, into bowls, over the roasts of Chapter 11, or through pasta with a little of the savory oil. The oil itself is a seasoning.

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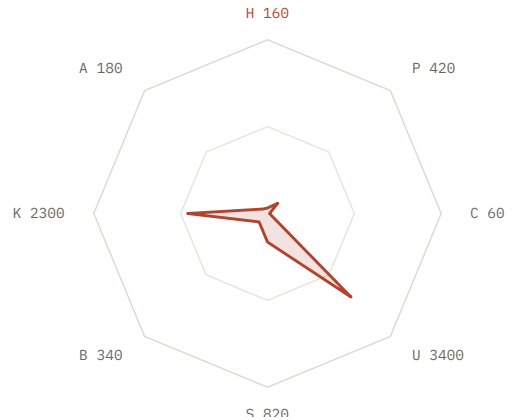
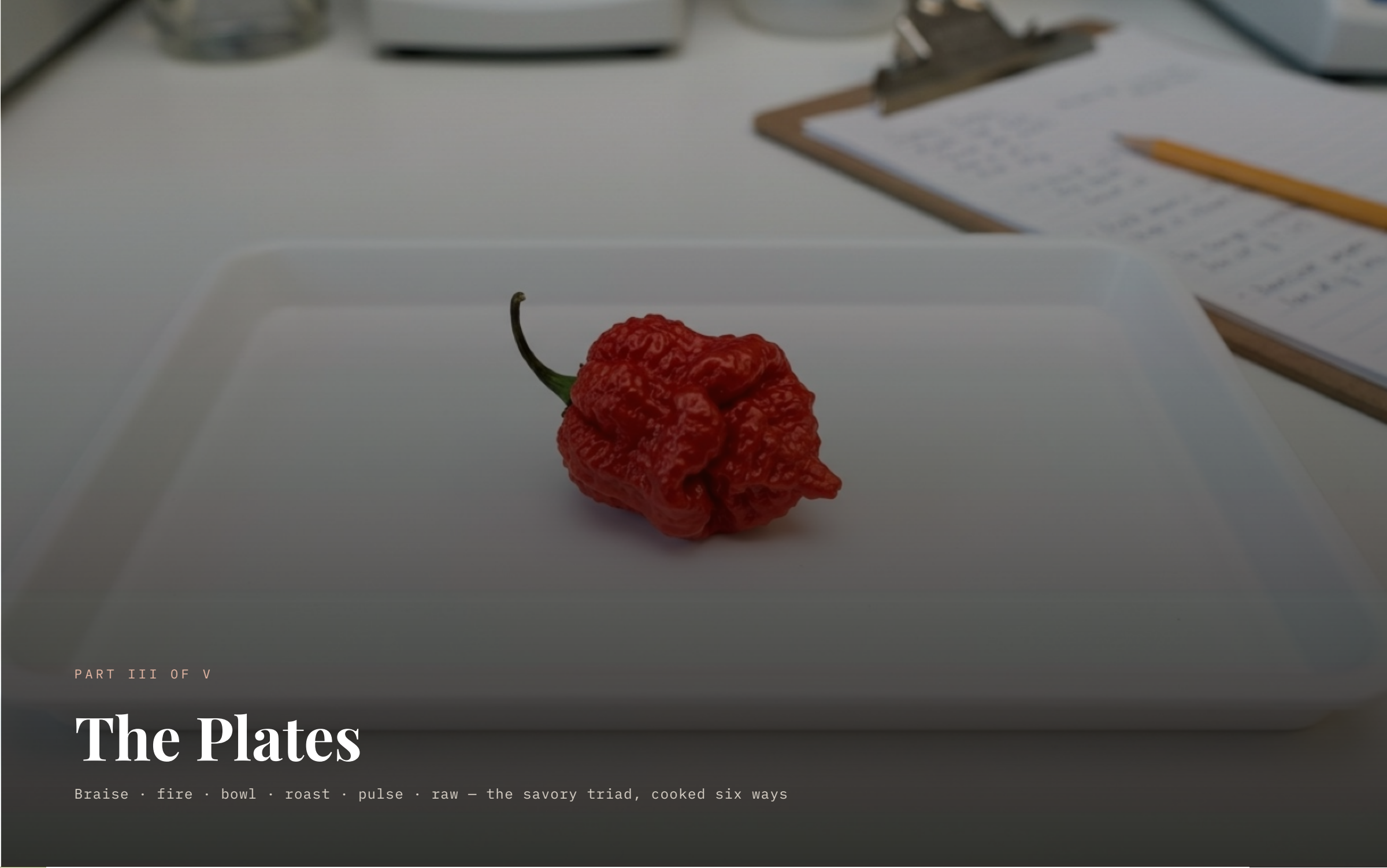


IFI-H		160
IFI-P		420
IFI-C		60
IFI-U		3,400
IFI-S		820
IFI-B		340
IFI-K		2,300
IFI-A		180

It eats like a serious, savory thing — because it *is* one, at the receptor, measured on the index — and not once did a vegetable have to pretend. The building blocks are complete. Stock, ferment, allium, mushroom: the four pillars. Now we cook the plates they hold up.



PART III OF V

The Plates

Braise · fire · bowl · roast · pulse · raw — the savory triad, cooked six ways

Chapter 8 · Braises — *long heat, no collagen, all depth.*

The braise is the dish the vegan cook is told cannot be done, because the braise is where meat's collagen melts to gelatin and gives a sauce its body and clinging richness. But unpack what a braise actually delivers to the tongue and collagen is only half of it; the other half, the half that makes a braise *taste* like a braise rather than merely feel like one, is the hours of low heat liberating free glutamate and building kokumi peptides and running a slow Maillard at the browned edges. That half is entirely ours.

The body that gelatin gives, we build from the plant kingdom's own thickeners, and it is worth being exact about how, because "it won't be as rich" is the objection and it is answerable. Gelatin gives a sauce two things: viscosity and a coating, lip-sticking mouthfeel. Viscosity we get from reduction — boiling off water concentrates everything, including the dissolved pectins and starches — and from the pectin that long-cooked vegetables and the skins of beans release. The coating mouthfeel we get from emulsified fat: a knob of the golden butter or a slick of garlic oil swirled into a reduced braise off the heat suspends in the liquid and clings exactly as gelatin-rich stock does. Between reduction, vegetable pectin, bean and lentil starch, and an emulsified finish, a vegan braise bodies up and clings without a gram of collagen. The sauce is not a thinner cousin of a meat braise. It is a differently-built version of the same cling.



The dark stock reduced and clinging — body built from reduction and pectin, not collagen.

A braise is a patience machine for the savory triad. You brown for Maillard, you add the glutamate base, you add the mushroom multiplier, you add the kokumi ferment, and then you give it the one thing fast food cannot buy: time, during which enzymes and heat keep freeing glutamate and building peptides. The scorecard of a good vegan braise climbs over its cooking hours exactly as a meat braise does, and for the same molecular reasons.

Mushroom & Butter-Bean Braise — *the Sunday pot, built on the multiplier.*

Mixed mushrooms	600 g (shiitake, oyster, cremini), torn
Dried porcini	15 g, soaked in 200 ml warm water
Butter beans	2 × 400 g tins, drained (or 350 g cooked)
Onion jam (Ch 6)	80 g
Confit garlic (Ch 6)	6 cloves
Dark stock (Ch 4)	600 ml
Tomato paste	30 g
Red wine (vegan)	150 ml
Multiplier powder (Ch 7)	2 tsp
Thyme, rosemary	a few sprigs
Golden butter (Ch 5)	30 g
Oil, salt, pepper	as needed

1. Soak the porcini; reserve both the softened mushrooms (chopped) and the soaking liquid (the dark, guanylate-rich water — strain off any grit).
2. Heat oil in a heavy casserole over high. Sear the torn fresh mushrooms in batches, hard and undisturbed, until deeply browned — crowd them and they steam, so work in batches and chase the Maillard color. Remove and reserve.
3. Lower the heat. Add the onion jam, confit garlic, chopped porcini, and tomato paste; cook two minutes until the paste rusts. Pour in the wine and scrape up every scrap of fond; reduce by half.
4. Return the mushrooms. Add the dark stock, the strained porcini water, the multiplier powder, and the herbs. Bring to a bare simmer, partly cover, and braise gently 45 minutes.
5. Stir in the butter beans and braise 15 minutes more, uncovered, until the sauce reduces and clings — the beans' own starch and the reduction give it body. Off the heat, swirl in the golden butter. Taste for salt; the kokumi will let you use less than you expect. Rest ten minutes before serving over mashed potato or the dark-stock rice.

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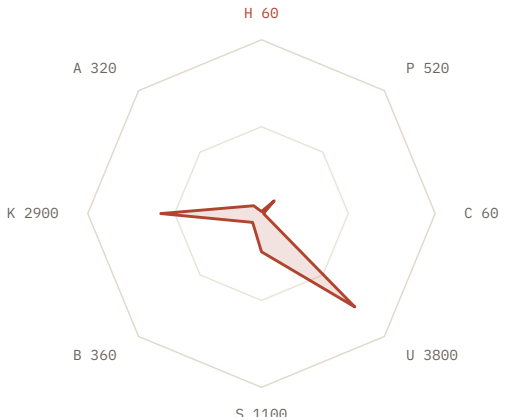


IFI-H	60
IFI-P	520
IFI-C	60
IFI-U	3,800
IFI-S	1,100
IFI-B	360
IFI-K	2,900
IFI-A	320

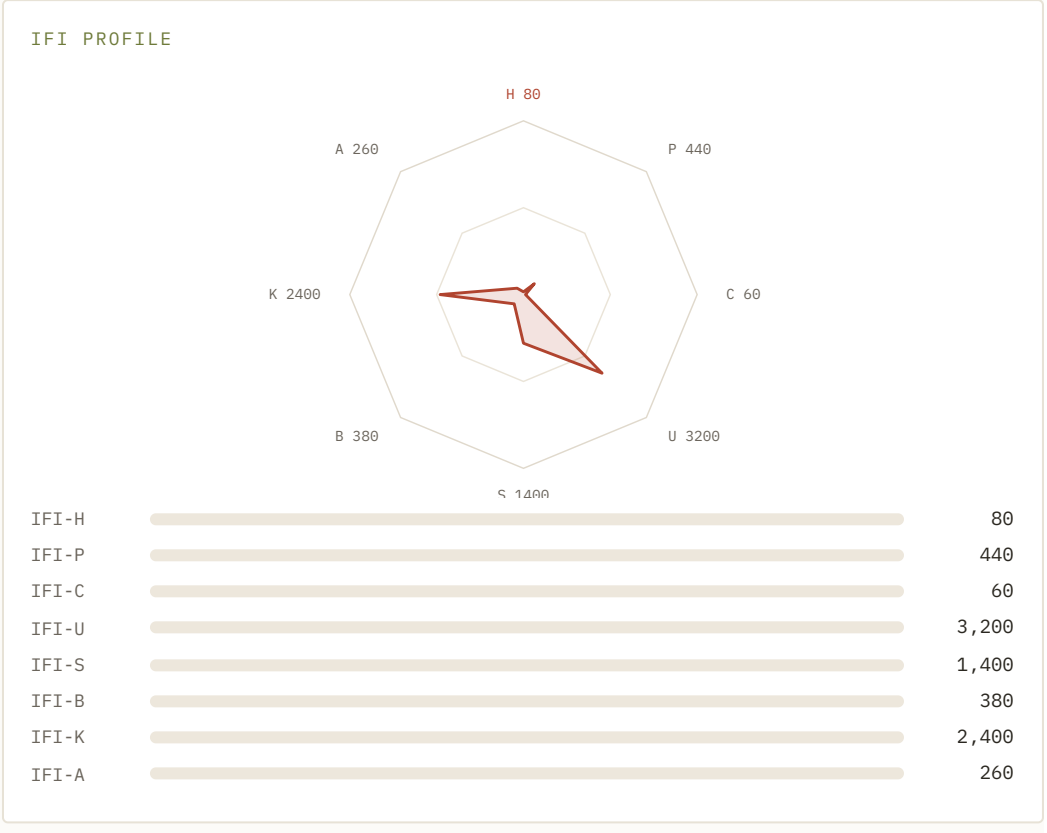
That is a braise by every measure that matters: IFI-U 3,800 from the triple convergence of mushroom guanylate, stock and tomato glutamate, and the multiplier powder; IFI-K 2,900 from onion jam, confit garlic, golden butter, and the hours of low heat; body from reduction and bean starch, not gelatin. Serve it to someone who eats meat and watch the question of what is missing simply fail to arise.

The second braise is quicker and brighter, built on eggplant, whose spongy flesh drinks a savory braise and whose skin, charred first, brings a smoky depth. Eggplant is a nightshade cousin of the tomato and pepper, and on our frontier roadmap sits a "Dark Matter" eggplant engineered for exactly this smolder; until that one is live, the char does the work.

Smoke-Charred Eggplant Braise — *fire first, then the slow savory soak.*

Eggplant	700 g (2 large), charred whole
Onion jam (Ch 6)	60 g
Confit garlic (Ch 6)	5 cloves
Ripe tomatoes	400 g, grated (or 1 tin chopped)
Dark stock (Ch 4)	300 ml
Shio koji (Ch 5)	20 g
Multiplier powder (Ch 7)	1 tsp
Smoked paprika	1 tsp
Cumin, coriander	1 tsp each, toasted and ground
Parsley, mint	to finish
Oil, salt	as needed

1. Char the whole eggplants directly over a flame (gas burner, grill, or under a hard broiler), turning, until the skin is blackened all over and the flesh collapses — 10 to 15 minutes. This is the smoke layer; do not rush it. Cool, peel off the blackened skin, and roughly chop the smoky flesh.
2. In a wide pan, warm oil and the onion jam and confit garlic over medium. Add the toasted spices and smoked paprika; bloom 30 seconds. Add the grated tomato and cook down 8 minutes until jammy and darkened.
3. Add the charred eggplant, dark stock, shio koji, and multiplier powder. Simmer gently 20 minutes, breaking the eggplant into the sauce, until thick and glossy. Finish with herbs and a thread of good oil. Eat with flatbread or over grain.



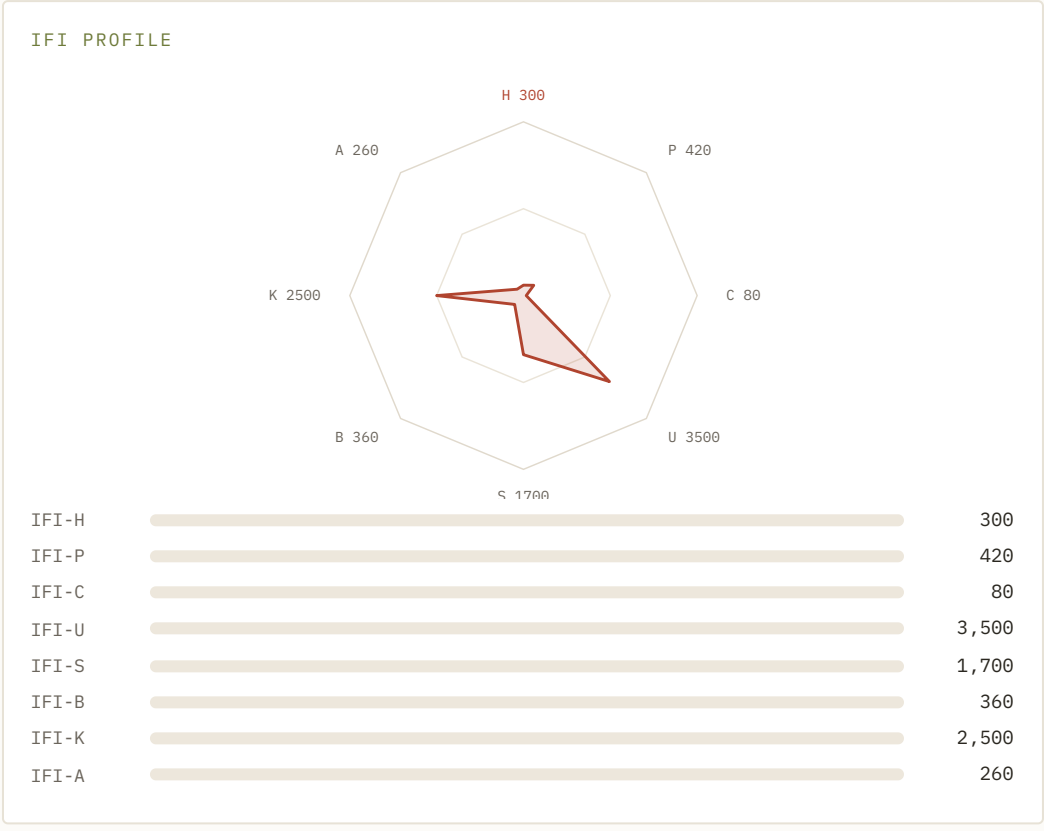
The third braise borrows from the Chinese red-cooking tradition — *hong shao* — where soy, sugar, and spice reduce around a dense ingredient to a dark, glossy, deeply savory lacquer. Daikon radish is

the vehicle: a watery, mild root that drinks a red-cooked braise and turns translucent, silky, and profound, with the mushrooms carrying the multiplier.

Red-Cooked Daikon & Shiitake — *the dark, glossy lacquer of a red braise.*

Daikon radish	800 g, peeled, in 3 cm chunks
Fresh shiitake	200 g, halved
Dried shiitake	15 g, soaked (reserve the water)
Dark stock (Ch 4)	500 ml + the shiitake soaking water
Shoyu / dark soy	50 ml
Shaoxing or dry sherry	40 ml
Rock sugar or date syrup	25 g
Ginger	30 g, sliced
Star anise, cinnamon, clove	a small sachet
Scallion, chili	to finish
Neutral oil	as needed

1. Blanch the daikon chunks 4 minutes in boiling water; drain. This softens them and removes any raw sharpness before the braise.
2. In a heavy pot, brown the fresh shiitake in a little oil until their edges catch color. Add the ginger and the spice sachet; let them sizzle 30 seconds.
3. Add the daikon, the sliced soaked shiitake, the dark stock and reserved soaking water, shoyu, Shaoxing, and sugar. Bring to a simmer, cover, and braise gently 40 minutes, until the daikon is translucent and tender.
4. Uncover, raise the heat, and reduce the liquid to a dark, glossy glaze that coats everything, basting as it thickens, 10 to 15 minutes. Finish with scallion and chili. Serve over rice; the daikon should be silky and the sauce deep enough to drink.



Three braises — deep and wintry, bright and smoky, dark and lacquered — all standing on the same four building blocks, all scoring like the meat dishes they quietly retire. The braise, it turns out, was never the animal's at all; it was always time and heat and the triad, and all three are ours.

Chapter 9 · Fire & char — *Maillard, smoke, and the browned edge.*

We have invoked the Maillard reaction in nearly every chapter, and now it gets its own, because direct fire is the one savory technique that owes nothing to genetics and everything to chemistry at the surface of the food. When an amino acid meets a reducing sugar above about 140 °C, they condense and rearrange through a cascade that ends in hundreds of new molecules: pyrazines (roasted, nutty, the smell of toasted bread and seared crust), thiophenes and thiazoles (the meaty, savory notes, built when sulfur-bearing amino acids join in), furanones (caramel, broth), and the brown melanoidin polymers that give char its color and bitterness. Strecker degradation, a side-branch, strips amino acids to aldehydes that smell of malt, cocoa, and honey. None of this is in the raw ingredient; all of it is made at the fire.

Two numbers govern the browned edge, and knowing them is the difference between a pale, steamed vegetable and a charred, savory one. The first is **140 °C** — the threshold below which the Maillard reaction barely proceeds and above which it accelerates sharply, roughly doubling in rate for every 10 °C further. The second is **100 °C** — the temperature at which water boils off, and the ceiling a wet surface is pinned to by evaporative cooling. As long as a vegetable's surface is wet, it cannot climb past 100 °C and cannot brown; the water must leave first. This is the whole technique of char in two facts: dry the surface (pat things dry, do not crowd the pan, let the water boil off before you expect color), and bring real heat (timid heat only ever reaches the steaming range). A brush of shio koji, rich in both sugar and amino acid, seeds the reaction and deepens every char.



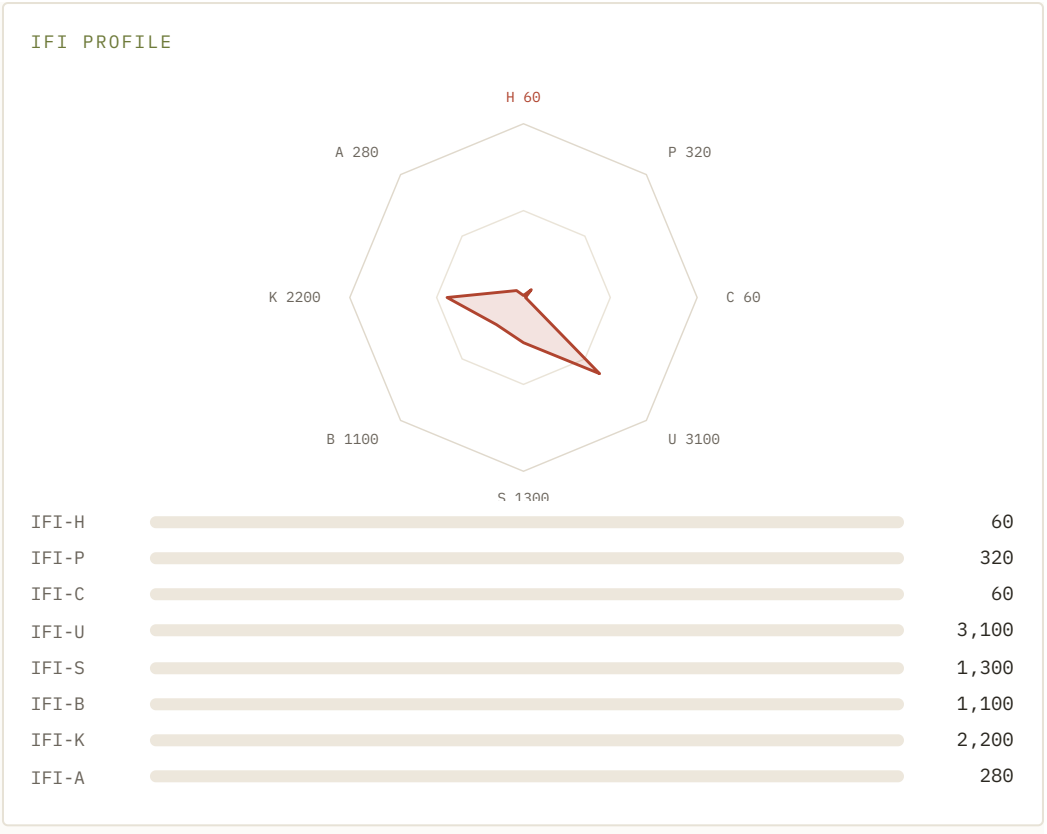
Live-fire char — the browned edge where amino acid meets sugar and the Maillard cascade writes a hundred roasted molecules.

For the plant cook this is liberating news, because the Maillard reaction does not care whether the amino acid came from muscle or from a mushroom. A cabbage wedge seared black at the edges, a carrot roasted until it blisters, a head of broccoli charred hard — each runs the same cascade a steak's crust runs, and each gains the same roasted, savory aromatics.

Blackened Cabbage Steaks, Koji-Brushed — *the humblest vegetable, charred to depth.*

Green or hispi cabbage	1 head, cut into 3 cm wedges through the core
Shio koji (Ch 5)	40 g
Neutral oil	30 ml
Golden butter (Ch 5)	30 g
Dark stock (Ch 4)	100 ml
Multiplier powder (Ch 7)	1 tsp
Lemon	to finish
Flaky salt, pepper	to finish

1. Heat oven to 220 °C and a heavy cast-iron pan on the stovetop until very hot. Brush the cut faces of the cabbage wedges with shio koji and a little oil.
2. Lay the wedges cut-side down in the hot pan and sear, undisturbed, 4 to 5 minutes, until the face is genuinely blackened at the edges and deep brown across — this char is the dish. Flip and blacken the second cut face.
3. Spoon over the dark stock and the multiplier powder, dot with golden butter, and transfer the pan to the oven. Roast 15 to 20 minutes, until the core is tender to a knife and the leaves have drunk the stock.
4. Finish with a hard squeeze of lemon, flaky salt, and pepper. The contrast of bitter char, sweet soft core, and savory glaze is the whole pleasure.

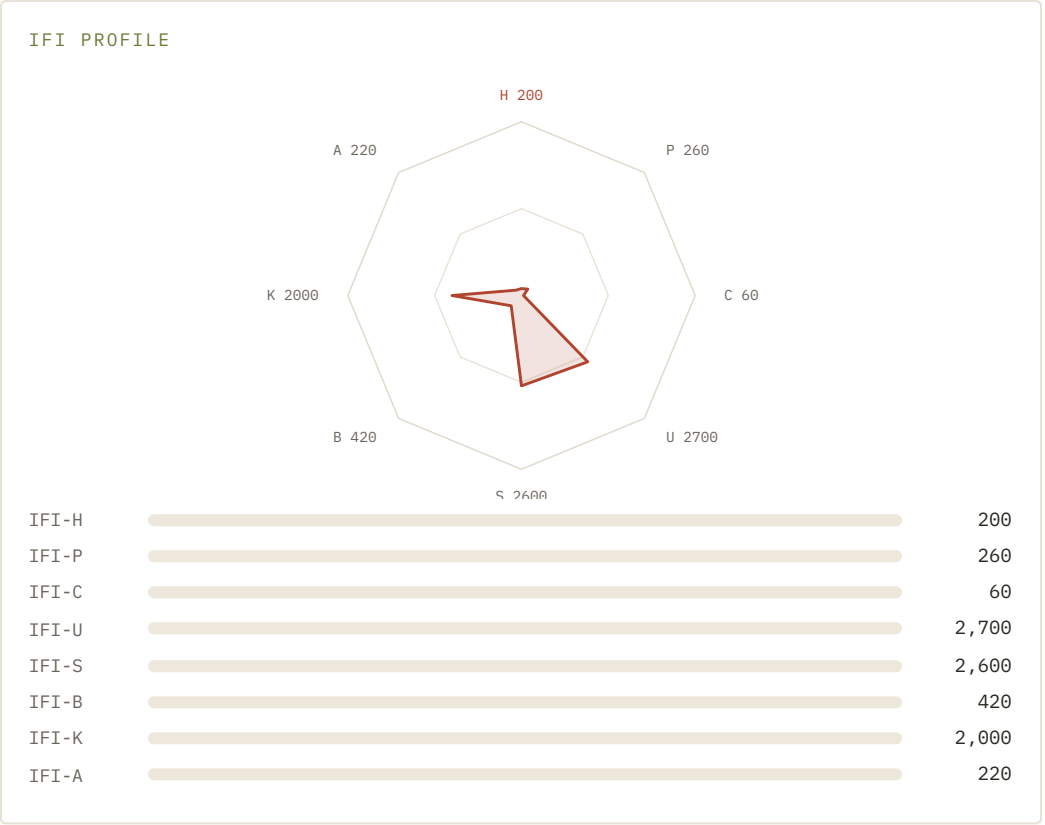


Note the IFI-B of 1,100 on that card — the zero-bitter axis. Cabbage is a brassica, carrying the glucosinolates that TAS2R38 reads as bitter, and the char adds its own melanoidin bitterness; our broccoli and brassica work (three hundred and eighty constructs on broccoli, signed B) is aimed at attenuating exactly that, and in a dish we lean on the sweet soft core and the kokumi glaze to balance what remains. A higher IFI-B here means *more* of the harsh bitterness tamed, letting the roasted, savory notes stand clear.

Grilled Carrots, Deep-Earth Style — *roots want fire and a long, patient sweetness.*

Carrots	600 g, whole or split, tops on if good
Shio koji (Ch 5)	30 g
Confit garlic oil (Ch 6)	30 ml
Cumin	1 tsp, toasted, ground
Multiplier powder (Ch 7)	1 tsp
Onion jam (Ch 6)	40 g
Dark stock (Ch 4)	80 ml
Herbs, chili to taste	to finish

1. Blanch the carrots 4 minutes in well-salted water to set the interior tenderness, then drain and dry thoroughly — dry surface, remember, or no Maillard.
2. Toss with koji, garlic oil, and cumin. Grill over a hot fire (or roast at 230 °C) turning until deeply charred and blistered in places, 15 to 20 minutes. The sugars in a carrot caramelize and Maillard beautifully; chase the color.
3. Warm the onion jam with the dark stock and multiplier powder to a glaze; toss the charred carrots through it off the heat. Finish with herbs and chili.



A carrot grilled this way is one of the sweetest, most savory things in the vegetable kingdom — IFI-S and IFI-U both high, the Maillard crust bridging them — and it points directly at our frontier: the "Deep Earth" carrot on the roadmap. The third fire recipe is the brassica's turn, charred hard to prove that our zero-bitter work and a hot grill together make a vegetable most people avoid into one they fight over.

Charred Broccoli with Burnt-Garlic Crumbs — *the brassica, bitterness tamed, char embraced.*

Broccoli	2 heads (500 g), in large florets with stem
Confit garlic oil (Ch 6)	40 ml
Shio koji (Ch 5)	20 g
Multiplier powder (Ch 7)	1 tsp
Golden butter (Ch 5)	20 g
Breadcrumbs	60 g
Garlic	2 cloves, minced
Chili flakes, lemon	to finish

1. Toss the broccoli (stems split so they cook through) with garlic oil and shio koji. Spread on a scorching tray or grill, cut faces down, and char hard — 10 to 15 minutes at 240 °C — until blackened at the edges and tender at the stem. Do not crowd; char wants space.
2. Meanwhile toast the breadcrumbs with the minced garlic in a little oil until deep gold and crisp, then let the garlic go just past gold to a "burnt" (not acrid) nuttiness. Season with salt and chili.
3. Toss the charred broccoli with the multiplier powder and a knob of golden butter off the heat. Pile on a platter, shower with the garlic crumbs, finish with lemon. The char and the burnt-garlic crumbs stack two layers of Maillard savor on a vegetable engineered to meet you halfway.

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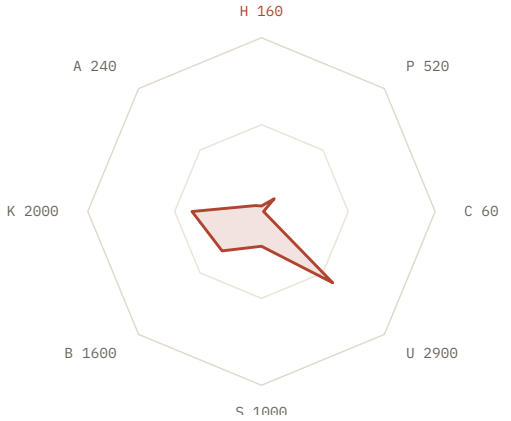

IFI-H	160
IFI-P	520
IFI-C	60
IFI-U	2,900
IFI-S	1,000
IFI-B	1,600
IFI-K	2,000
IFI-A	240

The IFI-B of 1,600 is the highest in the book — the most bitterness tamed — because the dish combines engineered attenuation with the sweetening the char brings, so the broccoli's green depth reads clean and savory. Three ways with fire: the humble cabbage, the sweet carrot, the tamed brassica, each proving that char is a universal savory engine with no animal required.

Chapter 10 · Noodles & broth bowls — *the bowl as a receptor experiment.*

A bowl of noodles in broth is, if you look at it through the index, the cleanest receptor experiment in all of cooking: a clear liquid whose entire pleasure is dissolved savor, nothing hiding behind texture or char. It is where the synergy of Chapter 2 is most nakedly on display, and where a thin broth is most mercilessly exposed. It is also, not by accident, the dish that the great savory cultures of the world — the ramen counter, the pho cart, the dan dan stall — built their deepest umami craft around, almost always on an animal bone. We build it on kombu, shiitake, and ferment, and the bowl does not know the difference, because the bowl is only receptors.



The broth bowl, backlit — a clear liquid whose only pleasure is dissolved savor, the synergy laid bare.

The architecture of a great bowl has three layers, and naming them makes the bowl designable. The *base* is the glutamate-and-nucleotide broth — our dark or clean stock, carrying the synergy. The *tare* is a concentrated seasoning paste, usually ferment-based, stirred into the bottom of the bowl: this is where the kokumi and the salt live, and where you tune the dish to the eater. The *aroma oil* is a fat infused with allium or chili, floated on top, carrying the volatile top-notes the nose reads first. Base for umami, tare for kokumi and salt, oil for aroma: three layers, three roles, each scorable. A great

creamy bowl, the tonkotsu style, adds a fourth trick — emulsification, where hard-boiled fat and the broth's dissolved thickeners whip into an opaque, clinging liquid; we get the same opacity by hard-blending a little of the broth with the golden butter and a spoon of cooked potato or soy milk, so the bowl coats the noodle exactly as a pork-bone broth does, from plants. Build all four and a vegan bowl reaches a depth that embarrasses most meat ones, because most meat bowls lean on the bone and forget the kokumi and the aroma. We forget nothing, because the index will not let us.

Shiitake-Kombu Ramen — *the synergy in a bowl, three layers deep.*

```
— BASE —
Dark stock (Ch 4)          1.2 L
Clean golden broth (Ch 4)  400 ml
Multiplier powder (Ch 7)   1 tsp

— TARE (per bowl, ~3 tbsp) —
White miso                 40 g
Shoyu / tamari             20 ml
Shio koji (Ch 5)           10 g
Confit garlic (Ch 6)       2 cloves, mashed
Golden butter (Ch 5)       15 g

— AROMA OIL —
Neutral oil                60 ml
Scallion, ginger, garlic   handful, sliced
Chili flakes               to taste

— TO SERVE —
Fresh ramen noodles        4 portions
Seared king oyster (Ch 7)  sliced
Charred corn, greens, nori, scallion, soft-marinated mushroom
```

1. **Aroma oil:** warm the oil gently with scallion, ginger, and garlic until fragrant and the aromatics are pale gold, 5 minutes; add chili off the heat. Strain or leave rustic.
2. **Tare:** whisk the miso, shoyu, shio koji, and mashed garlic to a smooth paste. Divide among four warmed bowls, a heaped tablespoon each, with a knob of golden butter.
3. **Base:** combine the two stocks with the multiplier powder and bring to just below a boil. Taste — it should be deeply savory before any salt; if short, another pinch of multiplier powder. For a

creamy bowl, blend a ladle of base with an extra knob of butter and a spoon of cooked potato until opaque, then whisk back in.

4. Cook the noodles in separate water to the second of al dente. Ladle a little hot base into each bowl and whisk to loosen the tare. Lift the drained noodles in, pour over the rest of the base, and stir once from the bottom so tare, base, and butter emulsify.
5. Top with sliced king oyster, charred corn, greens, nori, scallion, and a spoon of aroma oil. Eat immediately, loud.

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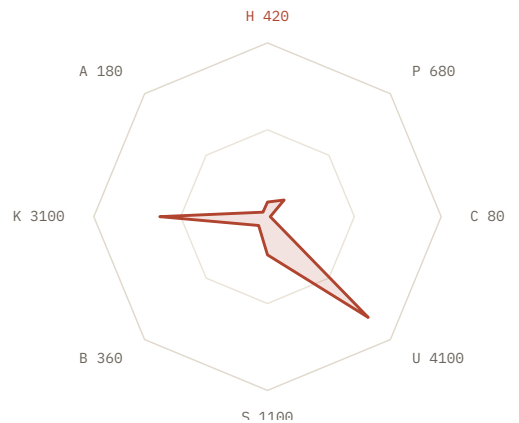


IFI-H	420
IFI-P	680
IFI-C	80
IFI-U	4,100
IFI-S	1,100
IFI-B	360
IFI-K	3,100
IFI-A	180

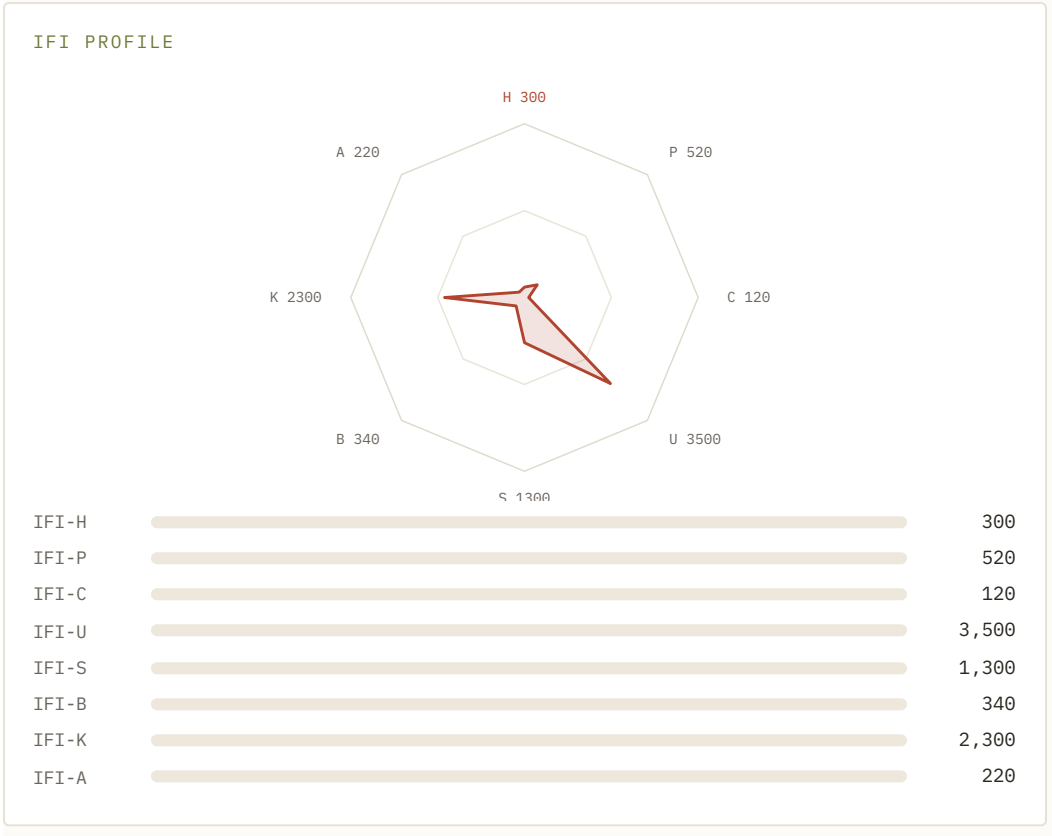
An IFI-U of 4,100 is near the top of the axis, and it is built entirely from kombu glutamate, shiitake and multiplier guanylate, and fermented-soy glutamate, converging in a clear broth where the synergy has nowhere to hide and everything to gain. The kokumi of 3,100 — miso, koji, garlic, butter — gives it the long, clinging finish of a tonkotsu without a gram of bone. This is, we think, the single most convincing dish in the book for the skeptic, because the broth bowl is where meat was supposed to be undefeatable, and it simply is not.

Smoky Tomato & Charred Onion Pho-Style — *bright savor over the long dark stock.*

Dark stock (Ch 4)	1.5 L
Onion	1 large, charred whole
Ginger	60 g, charred whole
Ripe tomatoes	300 g, charred
Star anise, clove, cinnamon, coriander	a whole-spice sachet
Shoyu, shio koji	to season
Rice noodles	4 portions
Herbs: thai basil, mint, coriander; lime, chili, bean sprouts	to serve

1. Char the onion, ginger, and tomatoes directly over a flame until blackened in patches — this smoky layer is the soul of the broth. Add to the dark stock with the toasted whole-spice sachet.
2. Simmer gently 40 minutes; the spices and char infuse the stock with the warm, aromatic backbone pho is known for. Season with shoyu and shio koji to a savory, faintly sweet balance. Strain.
3. Soak the rice noodles, divide among bowls, and pour over the strained broth. Serve with a mountain of herbs, lime, chili, and sprouts for each eater to build their own bowl — the raw herbs are

the aroma layer, added at the table.



The third bowl trades broth for a clinging sesame-chili sauce — the dan dan style — where a crisp, savory mushroom mince stands in for the traditional pork, and the "soup" is really an emulsion of sesame paste, chili oil, and a little stock that coats each noodle.

Dan Dan-Style Noodles, Mushroom Mince — *the clinging, nutty, numbing bowl.*

```
— MINCE —
Mixed mushrooms        300 g, finely chopped
Shoyu, shio koji       15 ml each
Multiplier powder (Ch 7)  1 tsp
Five-spice             ½ tsp
Neutral oil            as needed

— SAUCE (per bowl) —
Tahini or sesame paste 20 g
Shoyu                  12 ml
Laddered chili oil (Ch 14)  to taste
Sichuan pepper, ground 1 pinch (the numbing tingle)
Black vinegar          5 ml
Dark stock (Ch 4), hot 60 ml

— TO SERVE —
Wheat noodles          4 portions
Scallion, peanuts, greens, more chili oil
```

1. **Mince:** fry the chopped mushrooms hard in oil until browned, crisp at the edges, and dry — 10 to 12 minutes, chasing the Maillard. Season with shoyu, shio koji, multiplier powder, and five-spice; cook until sticky and savory. This is the savory, crumbly topping.
2. **Sauce:** in each bowl, whisk the tahini, shoyu, chili oil, Sichuan pepper, and black vinegar, loosening with the hot stock to a pourable, clinging sauce.
3. Cook the noodles, drain, and pile into the bowls. Toss from the bottom so every strand is coated. Top with the crisp mushroom mince, scallion, crushed peanuts, and greens. The Sichuan

pepper adds a cool-tingling IFI-C note against the chili's heat — the málà balance — and the sesame carries a nutty richness.

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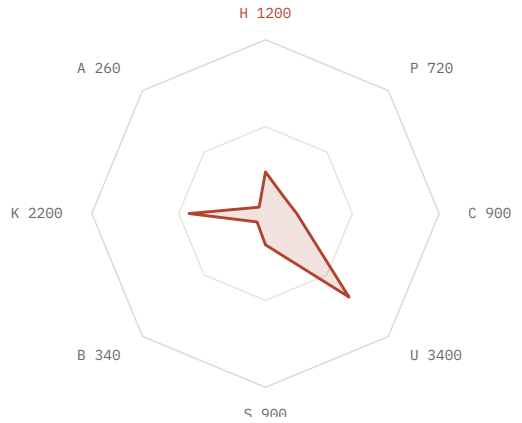

IFI-H	1,200
IFI-P	720
IFI-C	900
IFI-U	3,400
IFI-S	900
IFI-B	340
IFI-K	2,200
IFI-A	260

That IFI-C of 900 is the Sichuan pepper's doing — not menthol's cooling but a related tingling the trigeminal nerve reads alongside the chili's heat, the numbing-hot *málà* sensation that is its own small receptor experiment. Three bowls, three architectures — the clear ramen, the aromatic pho, the clinging dan dan — and all of them prove the same point: in a bowl, where only receptors judge, the plant kitchen wins.

Chapter 11 · The roast — *a centerpiece that needs no animal at its center.*

The hardest psychological hurdle in plant-based cooking is the center of the table. A braise can be ladled, a bowl is personal, but the roast is the communal object — the thing carried out whole, carved, shared — and for most of culinary history that object has been an animal. We want to make the case, and then make the dish, for a vegetable centerpiece that earns the center not by imitating a roast bird or joint but by being, in its own right, a glorious, lacquered, savory thing that a table gathers around.



The roast as centerpiece — lacquered, dark, built to be carried out whole.

A roast's savor comes from three places, and all three are ours. The Maillard crust on the exposed surface — pyrazines and melanoidins, the dark lacquer. The glutamate and kokumi driven into the interior by a savory brine or glaze. And the basting — the repeated painting of a reducing, savory liquid that builds layer on layer of flavor and sheen. The brine deserves a word of science, because it is doing more than seasoning. Salt in a brine moves by diffusion down its own concentration gradient, drawing dissolved savor with it into the vegetable's cells over hours, while the koji's enzymes, working at that same leisurely pace, free glutamate *inside* the vegetable — a cold, slow version of the aging that deepens meat. Give a cauliflower all three — a koji brine for the interior, a hard initial blast and a long finish for the crust, a dark-stock glaze basted again and again — and it comes out burnished and deep, carving into tender, savory flesh that has drunk the triad to its core.

Whole Roasted Cauliflower, Koji-Brined & Lacquered — *the centerpiece, carved at the table.*

```
— BRINE —
Cauliflower            1 large, whole, leaves trimmed
Water                  2 L
Salt                   50 g
Shio koji (Ch 5)       60 g

— GLAZE —
Dark stock (Ch 4)      300 ml
Onion jam (Ch 6)       50 g
Miso                   30 g
Multiplier powder (Ch 7)  2 tsp
Shio koji (Ch 5)       20 g
Golden butter (Ch 5)   40 g
Confit garlic oil (Ch 6)  30 ml

— TO FINISH —
Toasted seeds, herbs, lemon, chili
```

1. **Brine:** dissolve the salt in the water, whisk in the shio koji, and submerge the whole cauliflower (weight it under a plate). Brine 4 to 8 hours in the refrigerator; the salt seasons to the core and the koji enzymes lightly tenderize and deepen.
2. Lift out, drain well, and pat dry. Heat oven to 240 °C.
3. **Glaze:** simmer the dark stock, onion jam, miso, multiplier powder, and shio koji together, whisking, until reduced by a third and syrupy; off the heat whisk in the golden butter and garlic oil. You want a glossy, savory lacquer.
4. Set the cauliflower in an oiled ovenproof pan, brush all over with glaze, and roast 15 minutes at 240 °C to set a crust. Lower to 190 °C and roast 45 to 55 minutes more, basting with glaze every 12 to 15 minutes, until a knife slides to the core with no resistance and the surface is dark, blistered, and lacquered.
5. Rest 10 minutes. Carry it out whole, spoon over the last of the glaze, scatter toasted seeds, herbs, lemon, and chili, and carve into wedges at the table.

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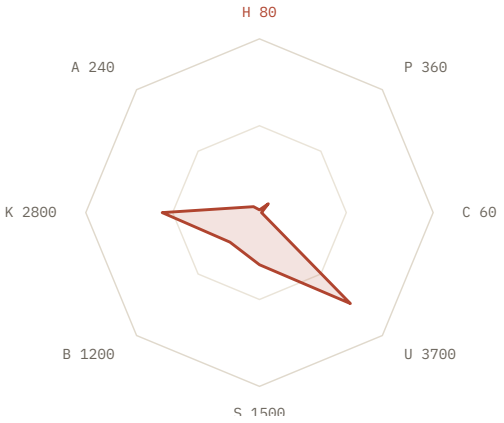

IFI-H	80
IFI-P	360
IFI-C	60
IFI-U	3,700
IFI-S	1,500
IFI-B	1,200
IFI-K	2,800
IFI-A	240

That is a centerpiece by the numbers and on the plate: IFI-U 3,700 and IFI-K 2,800 driven to the core by brine and repeated basting, a dark Maillard crust, an IFI-B of 1,200 as the glaze and our brassica

work tame the cauliflower's native bitterness so the savor reads clean. It carves with a little ceremony, it feeds six, and the question of the empty center never comes up.

Miso-Glazed Roast Squash — *sweet gourd, savory lacquer, twenty minutes of hands-on.*

Winter squash	1 kg (kabocha, delicata, or crown prince), in wedges
Miso	40 g
Maple or date syrup	20 ml
Shio koji (Ch 5)	15 g
Confit garlic oil (Ch 6)	30 ml
Multiplier powder (Ch 7)	1 tsp
Chili, sesame, scallion	to finish

1. Heat oven to 210 °C. Whisk miso, syrup, shio koji, garlic oil, and multiplier powder to a glaze.
2. Toss the squash wedges in half the glaze and roast 25 minutes on a lined tray. Brush with the rest of the glaze and roast 10 to 15 minutes more, until caramelized at the edges and tender through.
3. Finish with chili, toasted sesame, and scallion. The miso's glutamate and the squash's sweetness are a classic, honest pairing — savory and sweet balanced on one wedge.

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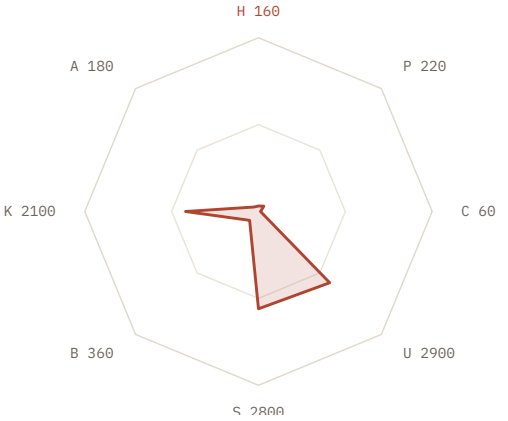

IFI-H	160
IFI-P	220
IFI-C	60
IFI-U	2,900
IFI-S	2,800
IFI-B	360
IFI-K	2,100
IFI-A	180

The third roast is pure theater: a whole celeriac baked in a salt crust, which seals it like a kiln, seasons it gently through the skin, and steams-roasts the dense root to a silky, savory, almost custardy center — then cracked open and carved at the table for a gasp.

Salt-Baked Celeriac — *a root baked in its own kiln, cracked at the table.*

Celeriac	1 large (1 kg), scrubbed, whole
Coarse salt	1.5 kg
Plain flour	200 g
Water	~200 ml, to a paste
Thyme, rosemary	chopped, a handful
Shio koji (Ch 5)	20 g, rubbed on the celeriac
Glaze: dark stock (Ch 4) + miso + golden butter (as Ch 11 glaze)	

1. Heat oven to 200 °C. Mix the salt, flour, herbs, and enough water to a thick, spreadable paste. Rub the celeriac with shio koji.
2. Pack the salt paste all over the celeriac in a 1 cm shell, sealing it completely, and set on a tray. Bake 2 to 2.5 hours; inside the sealed crust the root roasts and steams at once, cooking to a silky core while the salt seasons gently through the skin.
3. Let it rest 15 minutes, then crack the hardened crust open at the table and lift out the celeriac — it will be tender enough to spoon. Brush with the warm savory glaze, or slice thick and sear the slices for a Maillard edge.
4. Serve with the mushroom conserva (Ch 7) and greens. The flesh is sweet, deep, and faintly nutty, and the ceremony of cracking the crust makes it a centerpiece as surely as any roast.

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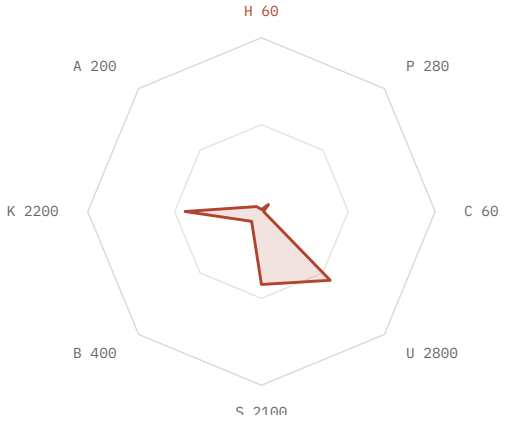


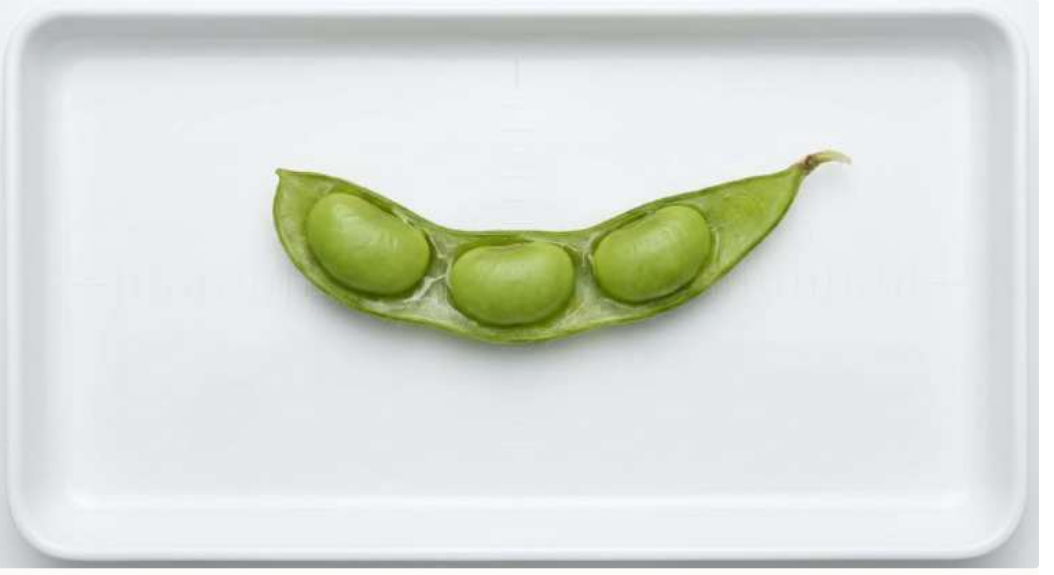
IFI-H	60
IFI-P	280
IFI-C	60
IFI-U	2,800
IFI-S	2,100
IFI-B	400
IFI-K	2,200
IFI-A	200

Three roasts — the lacquered cauliflower, the sweet squash, the salt-kilned celeriac — each a thing a table gathers around, none of them an animal, none of them an apology. The center of the table was never the animal's by right, only by habit.

Chapter 12 · Beans & pulses — *protein, and the glutamate that makes it sing.*

Now the question the vegan cook is asked most and answers worst: protein. We want to reframe it entirely, because "protein" in the nutritional sense and "savor" in the receptor sense are different problems that get tangled together, and untangling them is the key to cooking beans that satisfy. Protein, the macronutrient, is abundant in pulses and does its quiet work regardless of flavor. But *savor* — the taste that makes a pot of beans feel like a meal rather than a worthy obligation — is the triad, and beans, left plain, are low on all three axes. They bring body and background but little glutamate, no nucleotide, and modest kokumi. The art is to lend them the triad from the pantry, so the pulse brings the substance and the seasoning brings the savor, and the bowl satisfies on both counts at once.

A fact worth having, offered as biology and not as a health claim: pulses and grains are complementary in their amino acids. Legumes are generous in lysine and short on the sulfur amino acid methionine; grains are the reverse. Eaten across a day — beans and rice, dal and roti, hummus and bread — they cover each other, which is why nearly every traditional plant-based cuisine pairs a pulse with a grain without anyone having to think about it. We mention it only so the "protein question" can be set down: the traditions already solved it, deliciously, long before anyone counted an amino acid.



Soybean in cross-section — the one pulse that carries the savory triad in its own tissue, glutamate and kokumi both.

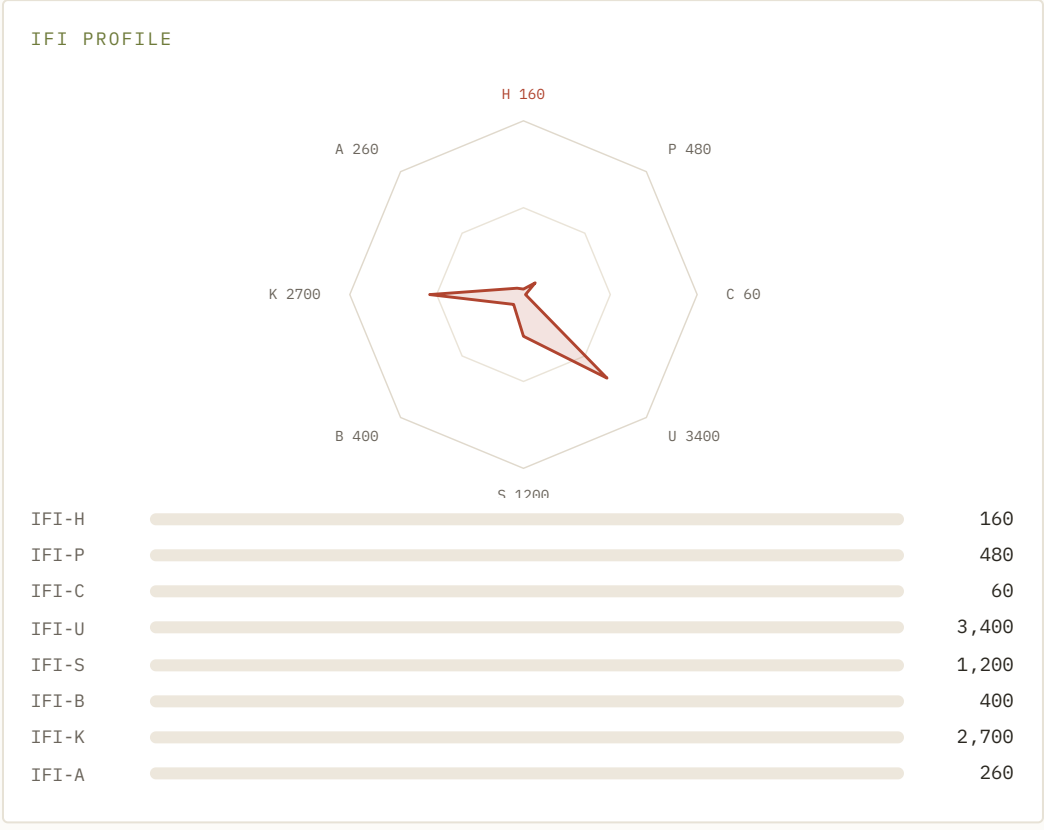
The soybean is the exception that proves the savor rule, and the reason it anchors so much of this book: it carries both U and K in its own tissue, glutamate and kokumi together, three hundred and sixty constructs built on exactly that savory signature. It is why fermented soy is the most efficient savory ingredient a vegan owns, and why edamame, tofu, and tempeh reward savory treatment more than any other pulse. But every bean — the butter bean, the chickpea, the lentil — becomes a serious savory thing when cooked *in* the triad rather than cooked plain and seasoned after. The difference is

enormous: beans simmered in dark stock with a strip of kombu and a few dried shiitake drink the glutamate and guanylate into their centers, so the savor is *in* the bean, not just on it.

Brothy Butter Beans in Dark Stock — *beans cooked in the triad, not seasoned after.*

Dried butter beans	300 g, soaked overnight (or 2 tins, see note)
Dark stock (Ch 4)	1 L
Kombu	1 strip
Dried shiitake	4 caps
Onion jam (Ch 6)	60 g
Confit garlic (Ch 6)	6 cloves
Multiplier powder (Ch 7)	1 tsp
Golden butter (Ch 5)	30 g
Greens (kale, chard)	200 g, shredded
Lemon, chili, good oil	to finish

1. Drain the soaked beans. Combine with the dark stock, kombu, shiitake, onion jam, and confit garlic in a heavy pot. Bring to a bare simmer — hard boiling blows beans apart — and cook gently, partly covered, 60 to 90 minutes, until the beans are creamy to the center. Add water only if they threaten to dry out; you want them brothy, not soupy. Salt only in the last 15 minutes (early salt can toughen skins).
2. Fish out the kombu (slice it thin and return it if you like) and the softened shiitake (slice and return). The beans have now cooked *in* the synergy; taste one and feel the savor in its center.
3. Stir in the multiplier powder and the greens; cook 5 minutes until the greens wilt. Off the heat, swirl in the golden butter.
4. Serve in wide bowls with lemon, chili, and a thread of good oil, over toast or alone. (With tins: skip the long simmer; warm the beans in the stock-and-aromatics 25 minutes to let them drink the savor.)

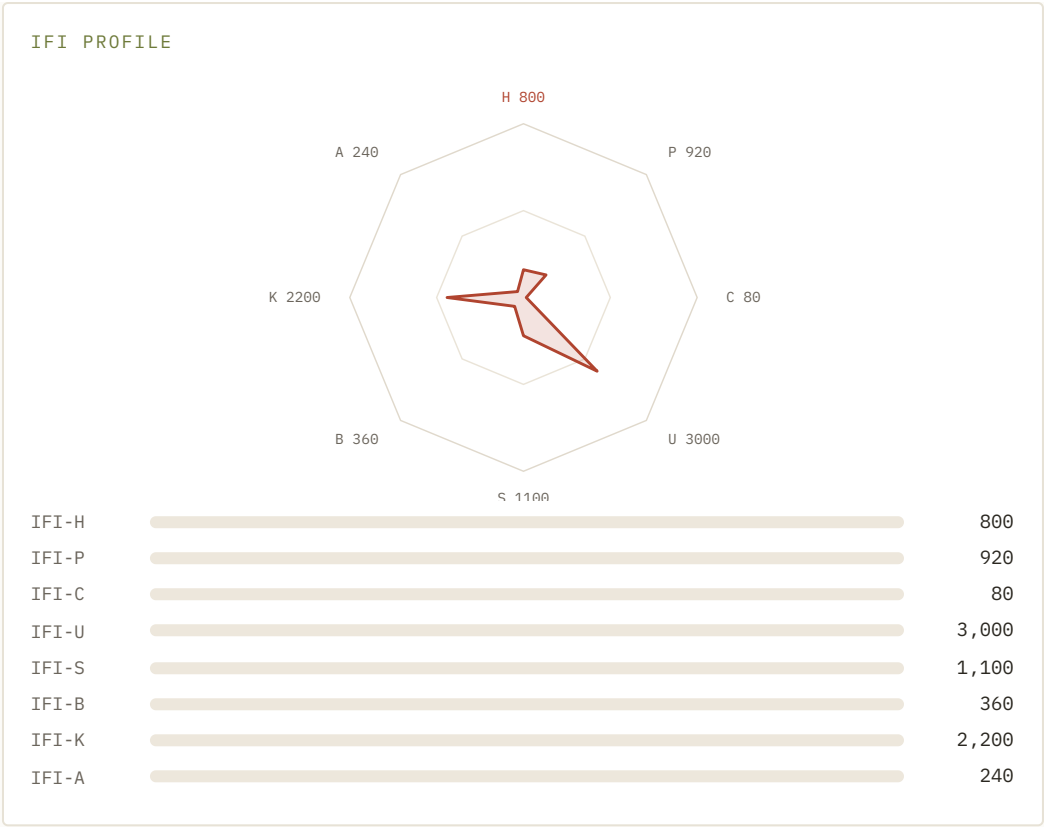


A bowl of these eats like a meal and nothing like a side — IFI-U 3,400 and IFI-K 2,700 cooked *into* the bean — and it is, by the macronutrient measure everyone frets about, a serious plate of protein. The savor and the substance arrive together, which is the whole point.

Red Lentil Dal, Heat Laddered — *the vegetarian-first cuisine, where the ethos sings.*

Red lentils	300 g, rinsed
Dark stock (Ch 4)	900 ml + water as needed
Onion jam (Ch 6)	80 g
Confit garlic (Ch 6)	6 cloves
Ginger	30 g, grated
Tomatoes	300 g, grated
Multiplier powder (Ch 7)	1 tsp
Ground turmeric, cumin, coriander	1 tsp each
Chili: see heat ladder (Ch 14)	to taste
Tempering: oil, mustard seed, curry leaf, dried chili, asafoetida	
Coriander, lime	to finish

1. Simmer the lentils in the dark stock and water with turmeric until collapsed and soft, 20 to 25 minutes, skimming. Whisk to the consistency you like, loosening with water.
2. In a separate pan, warm the onion jam, confit garlic, and ginger; add cumin and coriander and bloom. Add the grated tomato and cook to a dark paste, 8 minutes. Stir this masala and the multiplier powder into the lentils; simmer 10 minutes to marry. Season.
3. **Tadka:** heat oil until shimmering, add mustard seed until it pops, then curry leaf, dried chili, and a pinch of asafoetida; pour the sizzling temper over the dal. Finish with coriander and lime. Set the heat with your chosen chili from Chapter 14's ladder — a little Ember for warmth, a breath of Phoenix for those who chase the edge.



The dal is the dish where this book's values are most at home, because the vegetarian-first cuisines of the world — Indian chief among them — have always built deep savor from plants without apology, and our engineering only joins a tradition that was already right. The third pulse recipe is silken tofu braised in a savory sauce, a study in how little a mild protein needs to become deeply satisfying when the triad is strong around it.

Miso-Braised Silken Tofu — *the mild protein, carried by a strong savory sauce.*

Silken or soft tofu	500 g, in thick slabs
Dark stock (Ch 4)	300 ml
White miso	25 g
Shoyu	15 ml
Multiplier powder (Ch 7)	1 tsp
Confit garlic (Ch 6)	3 cloves, mashed
Ginger	20 g, grated
Cornstarch	1 tbsp, slurried (for cling)
Golden butter (Ch 5)	15 g
Scallion, chili oil (Ch 14), sesame	to finish

1. Warm the dark stock with the miso, shoyu, multiplier powder, garlic, and ginger to a gentle simmer; the mushroom and miso make a sauce far more savory than the tofu alone could be.
2. Slide in the tofu slabs and braise very gently 8 to 10 minutes, spooning sauce over; silken tofu is fragile, so baste rather than stir.
3. Stir the cornstarch slurry into the sauce around the tofu and let it thicken to a glossy cling — the plant thickener standing in for body. Swirl in the golden butter off the heat.
4. Finish with scallion, a spoon of chili oil, and sesame. Serve over rice. The tofu stays silky and mild; the sauce does all the savory work, which is exactly the division of labor a mild protein wants.

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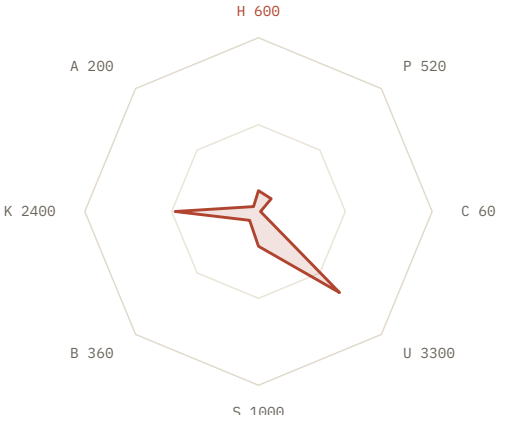


IFI-H	600
IFI-P	520
IFI-C	60
IFI-U	3,300
IFI-S	1,000
IFI-B	360
IFI-K	2,400
IFI-A	200

Three pulses — the brothy butter bean, the laddered dal, the braised tofu — each a complete, satisfying plate of protein *and* savor, the substance and the taste arriving together. We make no nutritional claim beyond the obvious: a pulse cooked to taste this good is a pulse you will actually eat, and often, and gladly.

Chapter 13 · Raw & cured — *koji time, and savor without heat.*

We end the plates where cooking seems least able to help — the raw plate — because the raw plate is where engineering and fermentation most clearly do what fire cannot. A raw vegetable has only the glutamate and kokumi it grew with; no Maillard, no reduction, no browning will deepen it, because you have forsworn the heat that drives all three. And yet the rawest dishes in this book score among the most savory, because two tools reach raw food that fire cannot: *genetics*, which builds the savor in before the plant is ever picked, and *curing*, which uses salt, time, and koji's enzymes to deepen a vegetable at room temperature the way aging deepens flesh.



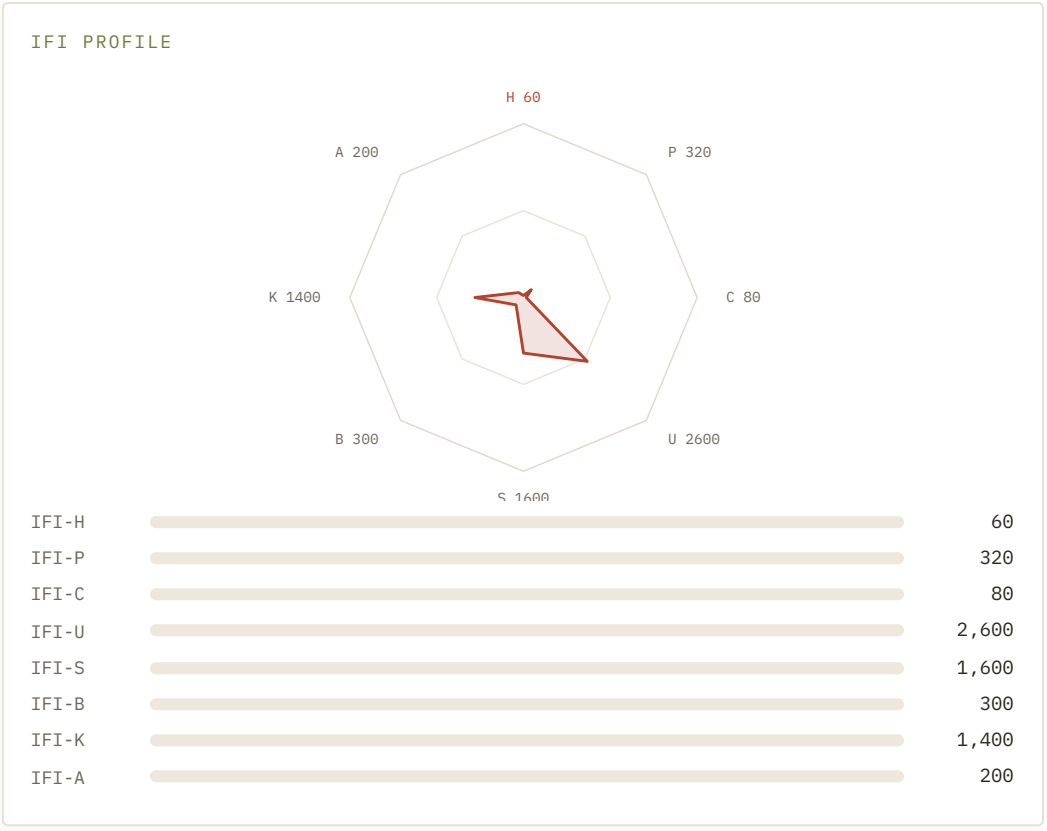
The engineered tomato whole — raw savor built in at the gene, IFI-U 2,600 with no heat at all.

The engineered tomato is the hero of the raw plate. A supermarket tomato eaten raw scores near IFI-U 300 — thin, watery, the loss the shelf inflicts. Our cultivar, its glutamate metabolism retuned across two thousand constructs, eats at IFI-U 2,600 raw, no cooking required, the savor grown in. That single fact rewrites the raw course: a dish that was a garnish becomes a centerpiece, because the tomato finally tastes, uncooked, the way a slow-roasted one used to.

Engineered Tomato Tartare — *the raw plate the cultivar makes possible.*

Ripe engineered (or best vine-ripe) tomatoes	500 g	
Shio koji (Ch 5)	15 g	
Confit garlic oil (Ch 6)	20 ml	
Shoyu	5 ml	
Capers, cornichon, shallot		finely diced, 2 tbsp total
Dijon or kokumi mustard	1 tsp	
Chive, tarragon		chopped, to taste
Flaky salt, pepper		to finish
Good bread or crisps		to serve

1. Score, briefly blanch, and peel the tomatoes; halve, seed (reserve the savory seed-jelly for a dressing), and dice the flesh into a fine, even brunoise — knife-cut, never processed, for the right clean texture.
2. Gently fold the diced tomato with the shio koji, garlic oil, shoyu, capers, cornichon, shallot, mustard, and herbs. Let it sit 10 minutes for the koji and salt to draw the savor forward.
3. Mold into a neat round, finish with flaky salt, pepper, and a thread of garlic oil, and serve cold with bread or crisps. It is bright, savory, and clean — and it is a raw tomato, doing the work.

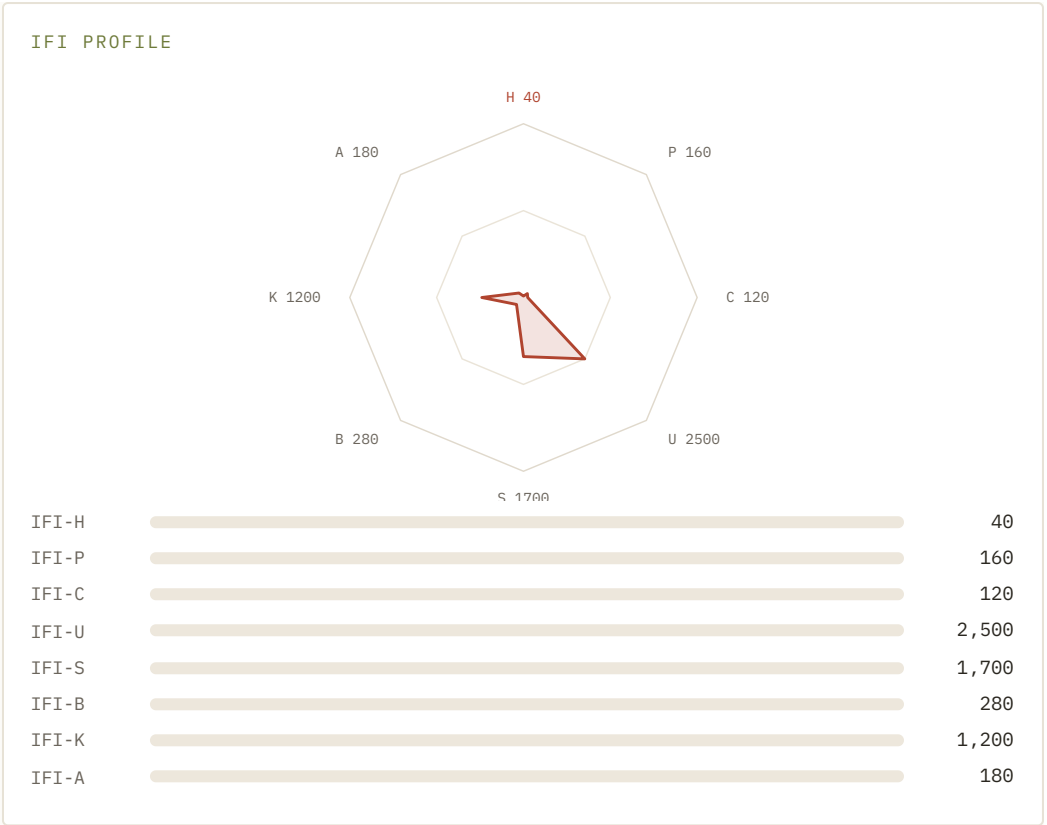


Read that card and remember the supermarket tomato's 300: this is the same fruit, raw, at IFI-U 2,600, because the savor was built in at the gene rather than coaxed out by heat the dish does not use. The second raw dish presses that savor into a liquid — a clear tomato "consommé," the essence strained out and served cold, the purest possible reading of what the cultivar carries.

Clear Tomato Water — *the essence, strained, a cold savory broth.*

```
Ripe engineered (or best) tomatoes   1 kg, very ripe
Flaky salt                6 g
Shio koji (Ch 5)          10 g
Basil or shiso            a few leaves
(optional: a few drops of good oil, to serve)
```

1. Blend the tomatoes with the salt, shio koji, and herbs to a rough purée. Taste; it should be vividly savory and bright.
2. Line a sieve with a clean cloth over a deep bowl and pour in the purée. Let it drip, undisturbed and refrigerated, 4 to 12 hours. Do not press it, or it clouds — gravity alone pulls a crystal-clear, intensely savory liquid from the pulp.
3. Serve the clear tomato water cold in small glasses or as the base of a chilled soup, with a drop of oil and a torn herb. It looks like water and tastes like the concentrated soul of a tomato — a party trick that is really a demonstration of engineered raw savor.



The third recipe uses curing — the room-temperature deepening that koji and salt perform — to turn a beet into something with the silk, salt, and savor of cured fish, by the same logic that lets dry-curing deepen meat without cooking it. We call it beet "lox," with the quotation marks doing honest work: it is not pretending to be salmon; it is a beet, cured, and glorious on its own terms.

Koji-Cured Beet "Lox" — *curing does to a root what aging does to flesh.*

Beets	600 g, medium, scrubbed
Salt	40 g
Sugar	20 g
Shio koji (Ch 5)	40 g
Kombu	2 strips
Dill, caraway	to taste
Dark stock / shoyu glaze	for finishing
Good oil, lemon, dill	to serve

1. Roast the whole beets in foil at 200 °C until tender, 50 to 70 minutes. Cool and slip off the skins.
2. Mix salt, sugar, and shio koji. Lay a bed of it in a dish, sit the peeled beets on top with the kombu and dill/caraway, and pack the rest of the cure over them. Cover and refrigerate 24 to 48 hours, turning once; the salt and koji draw moisture and drive savor in, the kombu lends glutamate, exactly as a cure deepens fish.
3. Rinse off the cure, pat dry, and slice very thin on a mandoline or sharp knife. Brush with a little shoyu glaze or garlic oil.
4. Serve as you would cured fish — on rye with a cashew cream, capers, dill, red onion, and lemon — silky, savory, salt-deep, unmistakably beet and all the better for it.

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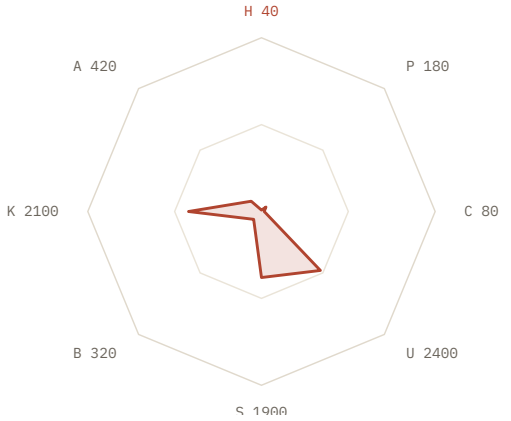


IFI-H	40
IFI-P	180
IFI-C	80
IFI-U	2,400
IFI-S	1,900
IFI-B	320
IFI-K	2,100
IFI-A	420

The cure has done to the beet what weeks in salt do to flesh: driven savor and kokumi to the center (IFI-U 2,400, IFI-K 2,100) and given it a silk and depth no raw beet has, all at room temperature, all enzymes and salt and time. Raw, strained, and cured — three faces of the no-heat plate — and all score like dishes that cooked for hours, because the depth was built in by genetics and by patience rather than by fire. The plates are complete. Now the two chapters that finish them: heat, and the aromatic last gram.



PART IV OF V

Depth & Heat

The ten flagships · the finishing kitchen · the aromatic layer — the last, loudest grams

Chapter 14 · Heat, laddered — *the ten flagships, and where they belong on a plant.*

A plant-based book carries heat differently than a meat one, and better, because heat and savor share no receptor and therefore never compete — capsaicin speaks to TRPV1, glutamate to the umami heterodimer, and the two signals ride side by side, so a dish can be as hot as you like and lose none of its depth. We think heat belongs in the vegan kitchen with particular joy, because a plant plate laddered with real, clean heat is a complete sensory event: savor for depth, kokumi for length, and capsaicin for the bright, warming thrill that makes a meal feel alive. This chapter is the heat, and it is where the company's origin — superhot chili engineering — meets the savory table.



Phoenix in the controlled chamber — 2,937,948 Scoville, the first cultivar engineered to register on all eight axes at once.

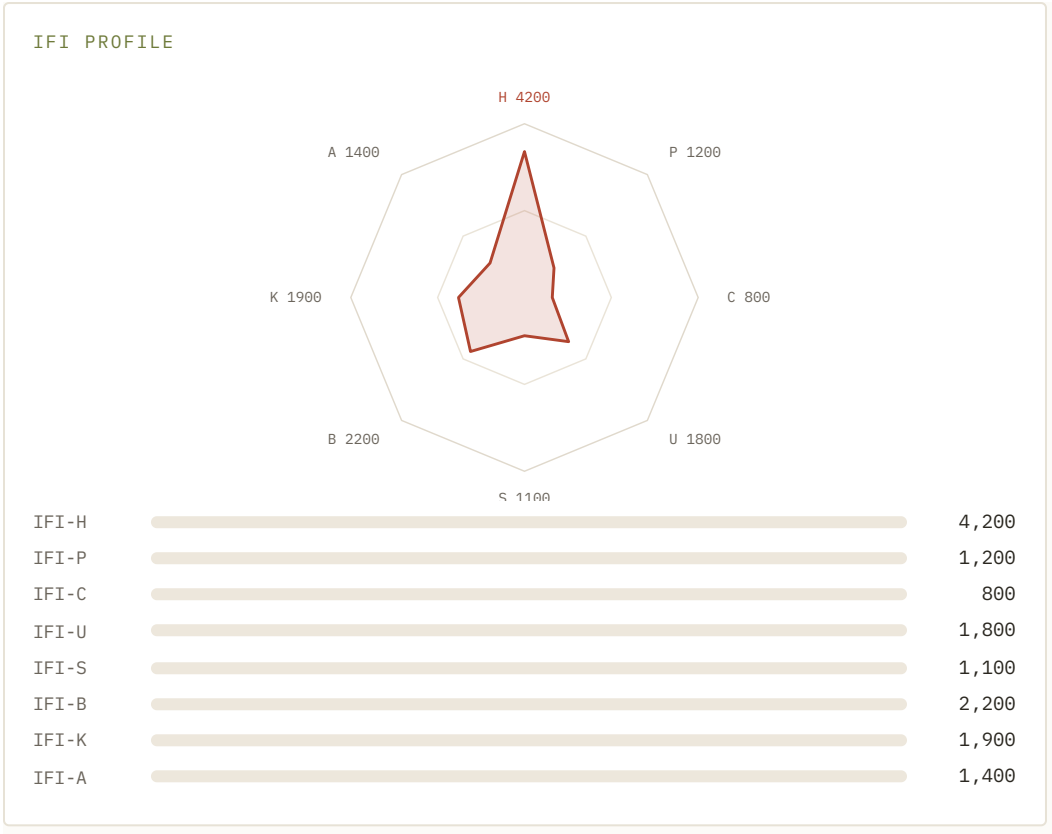
Capsaicin binds TRPV1, a non-selective cation channel on the trigeminal nerve endings of the tongue — the same receptor gated by temperatures above 43 °C and by acidity. The molecule does not warm the tissue; it lowers the channel's thermal threshold, so the body reports a fire that is not there. Capsaicin is built where the universal phenylpropanoid branch — PAL → C4H → 4CL — hands off to four pepper-specific enzymes: pAMT, which makes vanillylamine from vanillin; a branched-chain fatty-acid route through BCAT and KAS; and Pun1/CS, the capsaicin synthase, an AT3 acyltransferase

that condenses vanillylamine with an 8-methyl branched-chain acyl group to make the molecule itself. The length and saturation of that acyl chain sets the ratio of the capsaicinoids — capsaicin and dihydrocapsaicin make up the great majority, with nordihydrocapsaicin and others as minor players — and that ratio sets the *shape* of the burn, whether it blooms sharp at the front of the mouth or creeps slow up the back of the throat.

Scoville Heat Units measure capsaicinoid concentration; IFI-H measures receptor loudness, the half-activation of TRPV1, which is why the two track together but are not the same number. Our ten flagship superhots are a ladder, each a known rung on both scales, so you can set a dish's heat with precision rather than hope. These are real cultivars with real, locked values; a plant-based cook uses them exactly as a dose, a measured spark, from the gentle warmth of the lowest rung to the measured edge of Phoenix

CULTIVAR	SKU	SHU	IFI-H	AXES	ON A PLANT PLATE
Ember	SS-0087	866K	1,570	2/8	everyday warmth; dal, beans
Cinder	SS-0088	1.05M	2,290	3/8	a bright kick in oils
Kindle	SS-0089	1.25M	2,000	3/8	salsas, char
Flare	SS-0090	1.48M	—	4/8	ferment heat
Blaze	SS-0091	1.72M	2,630	4/8	chili crisp
Wildfire	SS-0092	1.96M	2,930	5/8	serious oils
Scorch	SS-0093	2.21M	3,220	5/8	the edge, respected
Firestorm	SS-0094	2.47M	3,490	6/8	for the devoted
Solara	SS-0095	2.72M	3,980	6/8	a trace, no more
Phoenix	SS-0096	2.95M	**4,200**	**8/8**	a breath; the full-spectrum pepper

Phoenix is the exception on that ladder, and a landmark: the first cultivar we engineered to register on all eight axes at once — not only the heat of 4,200 but a built profile across the whole index, heat and pungency and kokumi and the rest in one fruit.



That full-spectrum profile is why a shaving of Phoenix does more to a dish than heat alone — it brings a whole chord. It took three AI-designed mutations to the Pun1 enzyme to reach it, substitutions no breeder had ever combined, scored by a protein language model and confirmed by a flux-balance model before a single edit was made.

EDIT	EFFECT	ΔΔG
S39L	binding affinity ↑ (N-term)	−2.1
L345G	steric relief, active-site cleft	−1.8
C175S	disulfide-misfold prevention	−0.9

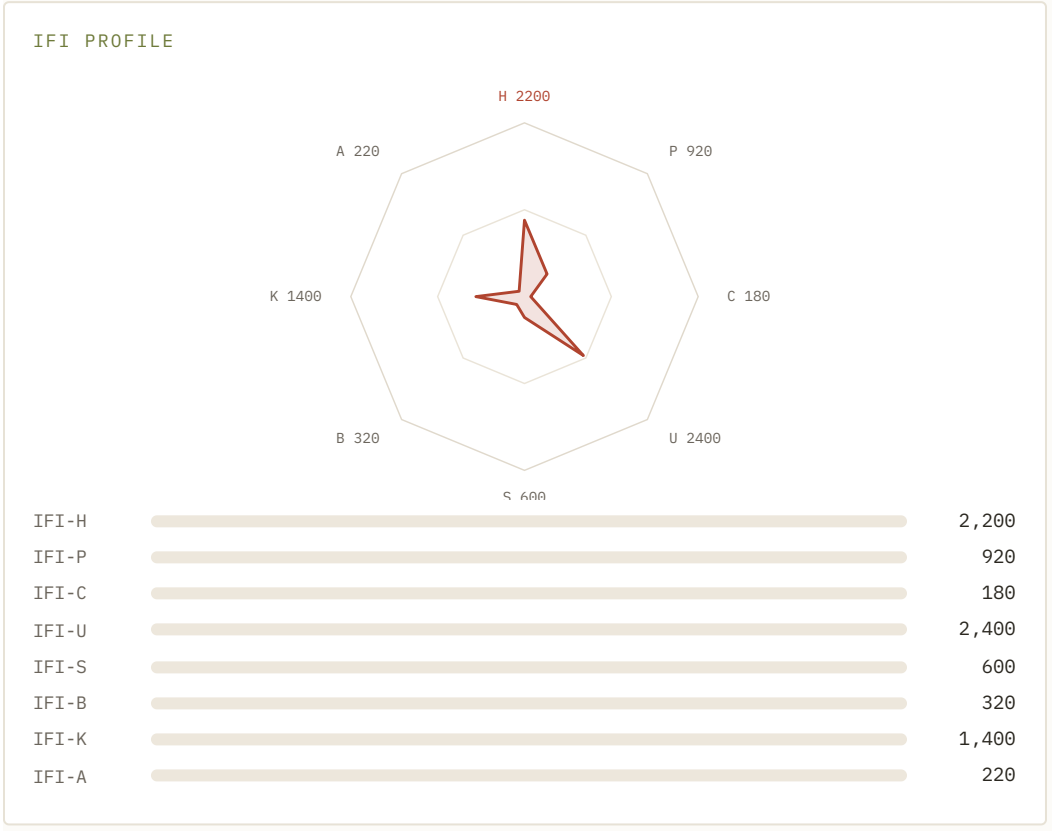
Those two Pun1 substitutions lift peak output to 2,937,948 Scoville at a batch-to-batch consistency of seven percent or better, against forty-two percent in the wild type — which matters more to a cook than the raw number, because it means a measured dose of heat lands the same every time. Here is the ladder in a usable form: a chili oil you make once at the heat you choose, and dose everywhere.

Laddered Chili Oil — *set the rung, and keep the savor underneath.*

```
Neutral oil            300 ml
Dried chili of chosen rung (Ch 14 ladder), de-seeded   20–40 g
Confit garlic (Ch 6)   4 cloves
Shallot                1, sliced
Multiplier powder (Ch 7)  2 tsp
Shiitake, dried        2 caps, crushed
Sichuan pepper (optional, for tingle)   1 tsp
Shoyu                  10 ml
Salt                   to taste
```

1. Grind or crush the dried chili of your chosen rung — Ember for a warm everyday oil, a mere trace of Solara for the devoted. Handle the high rungs with gloves and respect; a little goes a long way, and the measured CV means your dose is repeatable.
2. Gently warm the oil with sliced shallot and confit garlic to 140 °C until the aromatics are pale gold; do not scorch.

3. Off the heat (the oil will still be hot enough), pour over the chili, multiplier powder, crushed shiitake, and Sichuan pepper in a heatproof bowl. It will sizzle and bloom. Stir in the shoyu and salt.
4. Cool, then jar. The oil carries heat *and* savor — the multiplier powder and shiitake keep umami under the burn — so a spoonful seasons and ignites at once.



Note that even an oil built for heat keeps IFI-U at 2,400: we never let the burn hollow out the savor, because capsaicin and glutamate share no receptor and so there is no reason to trade one for the other. The second heat recipe is the Mexican *salsa macha* — a toasted, nutty, seedy chili oil-relish that is as much texture as heat, and that proves the same principle: build the depth under the burn.

Salsa Macha — *the toasted, nutty chili relish, savor beneath the fire.*

Dried chilis (mixed, your rung)	30 g, stemmed, seeded
Garlic	6 cloves, sliced
Peanuts or pumpkin seeds	60 g
Sesame seeds	20 g
Multiplier powder (Ch 7)	1 tsp
Neutral oil	250 ml
Cider vinegar	15 ml
Salt, a little sugar	to taste

1. Warm the oil over medium-low and gently fry the garlic until just gold; scoop out. Fry the nuts and seeds until toasted and fragrant; scoop out. Finally, off the heat, bloom the dried chilis in the hot oil 30 seconds — do not burn them, or they turn acrid.
2. Pulse the chilis, garlic, nuts, and seeds with the multiplier powder in a food processor to a coarse, textured relish — not a paste. Stir back into the oil with the vinegar, salt, and a pinch of sugar.
3. Jar and keep cold. Spoon over the roasts, the beans, the tofu, or anything that wants a crunchy, nutty, savory heat. The multiplier powder keeps a savory floor under the fire.

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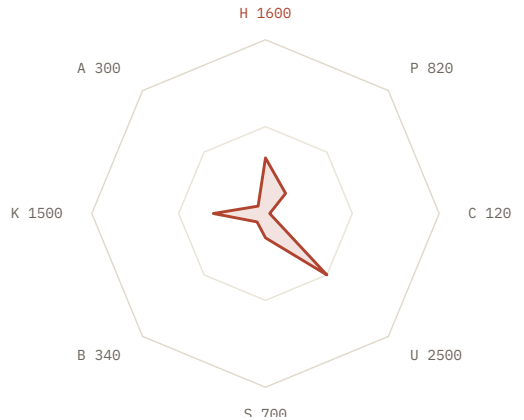

IFI-H	1,600
IFI-P	820
IFI-C	120
IFI-U	2,500
IFI-S	700
IFI-B	340
IFI-K	1,500
IFI-A	300

That is the whole philosophy of heat in this book — laddered, precise, repeatable, and always sitting on a bed of depth. Set the rung to the eater and the dish, and let the two signals, fire and savor, ride together.

Chapter 15 · The finishing kitchen — *chili crisp, kokumi butter, the last gram.*

The difference between a good plate and a great one is often a single finishing gram — the condiment, the flake, the spoonful swirled in off the heat — and the index makes clear why: a finishing element is a concentrated hit of one or two axes, applied where the dish is thin, tuning the final scorecard without recooking anything. This is the cook's equivalent of our engineering: a precise, targeted adjustment to a specific receptor. A great finishing kitchen is a rack of such adjustments — pure kokumi here, pure heat-and-crunch there, a bright pungent lift, a sweet-hot drizzle — each one a vial of a particular axis you can add to the plate at the last second.



The finishing rack as a set of targeted adjustments — each condiment a concentrated hit of one or two axes.

We will give you the finishers to build the rack around: a mushroom "XO" that is a savory bomb of pure umami and kokumi; a savory finishing salt that seasons and multiplies at once; a kokumi butter; and a sweet-hot drizzle that proves heat and sweetness, two axes that share no receptor, can be stacked without muddying either. Between them they can lift almost any plate in the book from correct to thrilling.

Mushroom XO — ***a savory bomb, pure umami and kokumi in a jar.***

Dried shiitake	40 g, rehydrated and minced
Dried mushrooms (mixed)	20 g, minced
Shallot	3, minced
Garlic	1 head, minced
Fermented black bean	30 g, rinsed and chopped
Chili of chosen rung (Ch 14)	to taste
Neutral oil	300 ml
Shoyu, shio koji	20 ml each
Multiplier powder (Ch 7)	2 tsp
Sugar	1 tsp

1. Squeeze the rehydrated mushrooms very dry and mince fine; mince the dried mushrooms, shallot, and garlic. The texture is the soul of XO — all small, even dice.
2. Warm the oil over medium and cook the shallot and garlic slowly until just gold, 8 minutes. Add all the mushrooms and the black bean; cook patiently, stirring, 20 to 25 minutes, until everything is deeply browned, crisp at the edges, and the oil runs red-brown — this long, slow Maillard is what makes XO taste of so much.
3. Add the chili to your chosen rung, the shoyu, shio koji, multiplier powder, and sugar; cook 5 minutes more. Cool and jar under its oil. Keeps a month cold. A teaspoon remakes a bowl of plain noodles, rice, or greens.

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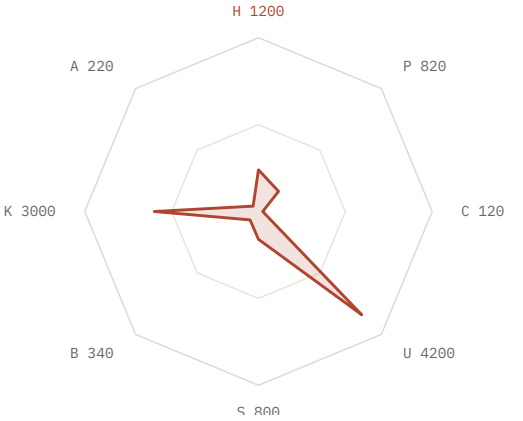


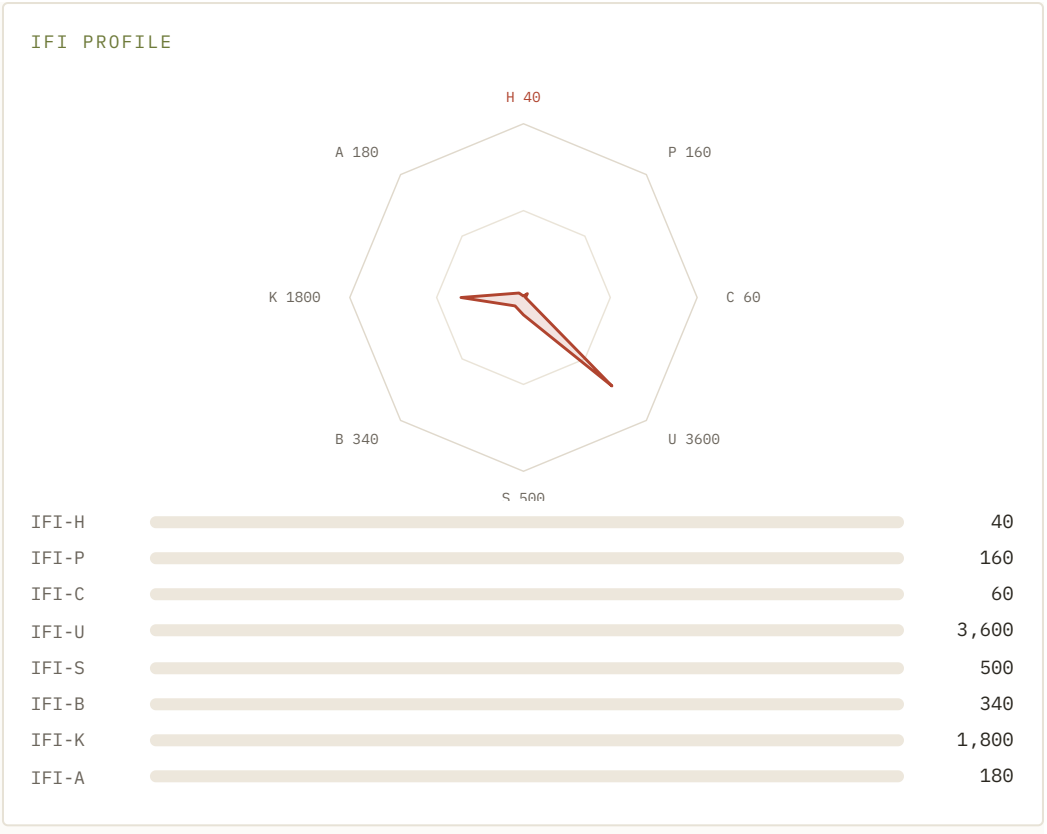
IFI-H	1,200
IFI-P	820
IFI-C	120
IFI-U	4,200
IFI-S	800
IFI-B	340
IFI-K	3,000
IFI-A	220

An IFI-U of 4,200 and IFI-K of 3,000 in a jar: this is the single most concentrated savory object in the book, a spoonful of which carries the whole triad. It exists to be added at the end, to the plate that tastes nearly there.

Umami Salt & Mushroom Furikake — *season and multiply in one shake.*

Flaky salt	80 g
Dried shiitake / porcini	30 g
Kombu	15 g
Nori	10 g, toasted
Toasted sesame	20 g
Dried tomato	15 g (optional, for sweetness)

1. Grind the dried mushrooms, kombu, nori, and dried tomato to a coarse powder; keep some texture for a furikake, grind fine for a pure seasoning salt.
2. Stir through the flaky salt and toasted sesame. Store airtight.
3. Use it wherever you would use salt but want the savor doubled: on the roasts, over rice, on the tomato tartare, rimming a savory cocktail. Because it carries glutamate and nucleotide alongside the sodium, it seasons and multiplies in one motion — the kokumi it raises means you reach for less of it than plain salt.



Kokumi Finishing Butter & Sweet-Heat Drizzle — *two vials for the rack.*

```
— KOKUMI BUTTER (see Golden Butter, Ch 5, plus) —
Golden butter (Ch 5)   120 g
γ-rich additions: extra miso 10 g, yeast extract 5 g, black garlic (Ch 6)
2 cloves mashed

— SWEET-HEAT DRIZZLE —
Agave or date syrup    120 ml
Chili of chosen rung (Ch 14)   to taste
Cider vinegar          20 ml
Shio koji (Ch 5)       10 g
Salt                   a pinch
```

1. **Kokumi butter:** mash the extra miso, yeast extract, and black garlic into the golden butter for an even deeper, aged-tasting finishing fat; a knob off the heat rounds any savory plate. Black garlic, aged slowly, is nearly pure kokumi — its proteins and sugars Maillard over weeks into a sweet, dark, peptide-rich clove.
2. **Sweet-heat drizzle:** warm the syrup gently with your chosen chili rung, the vinegar, shio koji, and salt until just combined; do not boil hard or it stiffens. Strain or leave rustic. This is the "hot honey" of the plant kitchen — agave standing in for the bee — and it stacks heat (TRPV1) on sweetness (TAS1R2·R3), two axes with no shared receptor, so each stays clean.

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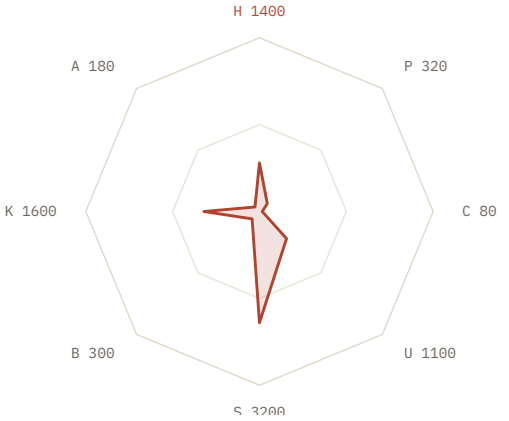

IFI-H	1,400
IFI-P	320
IFI-C	80
IFI-U	1,100
IFI-S	3,200
IFI-B	300
IFI-K	1,600
IFI-A	180

That drizzle's scorecard — IFI-H 1,400 and IFI-S 3,200 standing side by side, neither muddying the other — is a small proof of the index's deepest lesson: because flavor is read by separate receptors, a cook can stack sensations that seem opposed, hot and sweet, savory and bright, and have each arrive clean and whole. The finishing rack is where you compose that final chord. Keep it stocked, and no plate in this book is ever more than a gram from great.

Chapter 16 · The aromatic layer — *pungency, cooling, and the pathways behind them.*

The last layer of a plate is the one the nose reads before the tongue — the aromatic top-note, the volatile lift, the sensation that is technically not taste at all but trigeminal and olfactory, and that completes a dish the way a high note completes a chord. Two axes beyond the savory triad live here, and both deserve a cook's understanding: pungency, IFI-P, the sharp channel of mustard and ginger and raw garlic; and cool-burn, IFI-C, the menthol coolness that can finish a hot dish with a startling, refreshing contrast. Neither feeds the depth of a plate, but both frame it, and a savory cook who ignores them leaves the top of the chord empty.



Onion, whole — the allium's pungency and kokumi are two signals from one bulb, read by two different receptors.

Pungency and the TRPA1 channel. The sharp, sinus-clearing hit of mustard, wasabi, horseradish, raw garlic, fresh ginger, and cinnamon is not heat — it is a different receptor, TRPA1, and a different mechanism. The pungent molecules are electrophiles: reactive compounds that do not merely dock in a binding pocket but chemically *bond* to specific cysteine residues on the inside of the TRPA1 channel protein — the residues biochemists label Cys621, Cys641, and Cys665 in the human channel — forcing it open through covalent modification rather than a lock-and-key fit. Allicin from

crushed garlic, allyl isothiocyanate from mustard and wasabi (made when the enzyme myrosinase meets a glucosinolate on cutting), gingerol and shogaol from ginger, cinnamaldehyde from cinnamon — all of them are electrophiles, all of them open TRPA1, all of them are fragile and volatile, which is why their lift is a *finishing* sensation, added raw or late. Our garlic (K and P) and the broader pungency roster — black mustard, white mustard, ginger — are built to carry this channel cleanly, and in the kitchen you deploy it with a grating of fresh ginger over a bowl, a smear of mustard under a roast, a scatter of raw allium at the end.

Cool-burn and the TRPM8 channel. At the opposite pole, menthol and its relatives open TRPM8, the receptor gated by cold, so the tongue reports a chill that is not there — the mirror image of capsaicin's false fire. A cooling finish can be extraordinary against heat and savor: a mint oil over a spicy dal, a cucumber-mint relish beside a charred plate. The menthol itself is the product of a beautiful seven-step pathway in the mint plant, which we tune across more than two thousand constructs in our peppermint, and which is worth drawing because it is the cleanest example of a flavor built step by enzymatic step.

STEP	ENZYME	PRODUCT
1	limonene synthase	(−)-limonene
2	limonene-3-hydroxylase	(−)-trans-isopiperitenol
3	isopiperitenol dehydrogenase	(−)-isopiperitenone
4	isopiperitenone reductase	(+)-cis-isopulegone
5	isopulegone isomerase	(+)-pulegone
6	pulegone reductase	(−)-menthone
7	menthone reductase	(−)-menthol

Seven enzymes, geranyl diphosphate to menthol, each step a single chemical move — and the final molecule a cooling top-note you can finish a plate with. For the vegan savory cook, cooling is a rare tool, deployed sparingly: a few drops of mint or cucumber brightness to cut through a heavy, savory, laddered-hot dish, the high cool note over the deep warm chord.

Herb & Cooling Finish — *the top-note that completes the plate.*

Fresh mint, coriander, dill	large handful, chopped
Cucumber	½, finely diced
Fresh ginger	15 g, grated (pungent lift)
Green chili (low rung)	to taste
Lime	juice of 1
Shio koji (Ch 5)	5 g
Good oil	30 ml
Salt	to taste

1. Combine herbs, cucumber, grated ginger, and chili. Dress with lime, shio koji, oil, and salt just before serving — raw and late, so the volatile pungent and cooling notes stay sharp.

2. Spoon over any heavy savory plate in this book — the braises, the dal, the roasts — as the bright, cool, pungent top-note that frames the depth beneath. It feeds no axis of savor and completes every one.

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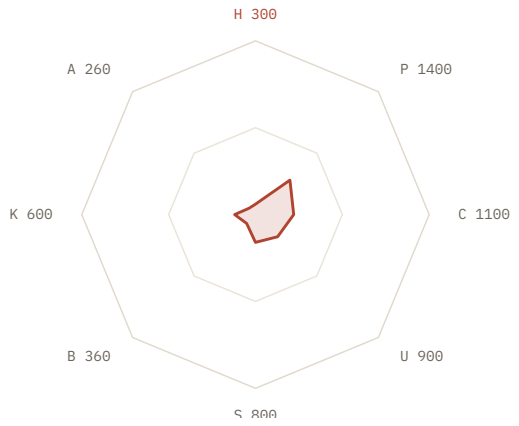


IFI-H		300
IFI-P		1,400
IFI-C		1,100
IFI-U		900
IFI-S		800
IFI-B		360
IFI-K		600
IFI-A		260

That scorecard is the inverse of everything before it — low on the savory axes, high on pungency and cool — because its job is not depth but contrast, the high bright frame around the deep savory picture. With it, the plate is complete: triad for depth, heat for thrill, aromatic for lift, each axis doing its own work at its own receptor. The composition is whole. One part remains, and it is the one the whole book has been quietly about.



PART V OF V

The Nourishment

What the plant carries, and why depth and nourishment turned out to be one act

Chapter 17 · What the plant carries — *depth and nourishment as one act.*

We have spent sixteen chapters on savor, and now, at the end, we want to say the quiet thing out loud — once, carefully, and then let it go back to being a hum beneath the cooking, which is where it belongs. The thing is this: everything we did to build flavor into these plants turned out, again and again, to also build nourishment into them, because the molecules of savor and the molecules of sustenance are so often the same molecules, and because a plant grown to carry the most of what it can carry carries more of everything at once.



The grown plant at dusk — tuned to hold the most it can, of savor and of sustenance together.

Consider the glutamate at the center of this whole book. It is the savory signal, yes — the thing the tomato's two thousand constructs amplify, the thing the kombu and the ferment deliver. It is also a proteinogenic amino acid, a building block of protein, a node in the plant's nitrogen economy and in ours. When we retuned the tomato to hold more free glutamate, we were not adding an empty flavor; we were asking the plant to hold more of a molecule that is, in every sense, substance. The kokumi peptides are γ-glutamyl compounds built around glutathione — the cell's own master antioxidant, the tripeptide that keeps a plant's tissues and our own from oxidative wear — so a plant built to carry more kokumi is, by the same stroke, a plant built to carry more glutathione. The savor and the sustenance are not in tension. They are the same tuning, read two ways.

This is why we say, and mean, that designing flavor and designing nourishment are one act. The platform's forward roadmap — the sixty-four concept organisms, the frontier beyond the forty-two we grow today — points squarely at this convergence: a "deep earth" carrot built for mineral depth that is both a flavor and a mineral load; a tomato whose savor and whose lycopene rise together because the pathways overlap; the whole long project of growing food that holds the most it can hold. We will not tell you this food is medicine. It is not; it is food, and we make no claim that it cures or detoxifies or

heals anything, because that would be a lie dressed as a kindness, and this book has tried very hard never to lie to you. What we will say is smaller and truer: that a plant grown with intention, tuned to carry the fullest flavor and the fullest substance it can, and then cooked with care and eaten with pleasure, is a good way to feed a body. That is not a health claim. It is just what we believe about dinner.

And it changes, a little, how you cook from this book. The restraint the index taught us in Chapter 4 — that a kokumi-rich dish needs less added salt, because the kokumi amplifies what salt is there — is of a piece with this whole ethos: build the savor into the plant and the preparation, and you lean less on the cellar, less on the additive, less on the processed shortcut, because the depth is already there, grown in. A food that carries its own savor asks less of everything you would otherwise pile on top of it. We find that a kind of grace, and we cook toward it: the fullest plate from the cleanest means, the deepest flavor from the plant itself, turned up to say what it was always trying to say.

That is the hum under every recipe here, and we will let it go quiet again now. There is no sermon at the end of this book, and no program to follow, and nothing to buy to be well. There is only a pantry of ten tuned organisms, four building blocks, a set of plates that reach the depth of meat without an animal in them, and a way of thinking — receptor by receptor, axis by axis — that lets you compose savor on purpose. What you do with it is yours. We only grew the plants, and wrote down what they can do, and set the table. The last chapter sets it fully: a week of cooking from everything above, to show the book as a life rather than a reference.

Chapter 18 · A week at our table — *the book, cooked.*

A cookbook proves itself not in any single dish but in a week — in whether its parts compose into the ordinary rhythm of feeding people, weeknight and weekend, fast and slow. So we end with ours: a week built entirely from the chapters above, the building blocks made once on Sunday and spent across seven days, the way we actually cook. This is the book as a life, and the proof that a plant-based kitchen built on the triad is not a special occasion but a default — deep, various, and easy, once the foundations are in the refrigerator.



The research tray as a week's mise en place — the building blocks made once, spent across seven days.

Sunday — the foundation day. Make the dark stock (Chapter 4), a jar of onion jam and a jar of confit garlic (Chapter 6), the golden glutamate butter (Chapter 5), and the triple-mushroom multiplier powder (Chapter 7). If you planned ahead, your shio koji (Chapter 5) is already ten days old and your black garlic (Chapter 6) has been warm for weeks. This is two hours of mostly unattended work — things roasting, things simmering, things softening in oil — and it is the whole week's savor, banked. Cook the week's centerpiece tonight: the whole roasted cauliflower (Chapter 11), carried out and carved, with the brothy butter beans (Chapter 12) alongside.

Monday — the leftover bowl. Yesterday's cauliflower and beans, reheated, become tonight's shiitake-kombu ramen (Chapter 10): the base from your dark stock, the tare from miso and your golden butter, the leftovers as toppings. Fifteen minutes, and a bowl that scores IFI-U above 4,000.

Tuesday — the fast night. Plain noodles or rice, a spoonful of mushroom XO (Chapter 15), a scatter of herb-and-cooling finish (Chapter 16). Ten minutes, because the XO did all the work weeks ago.

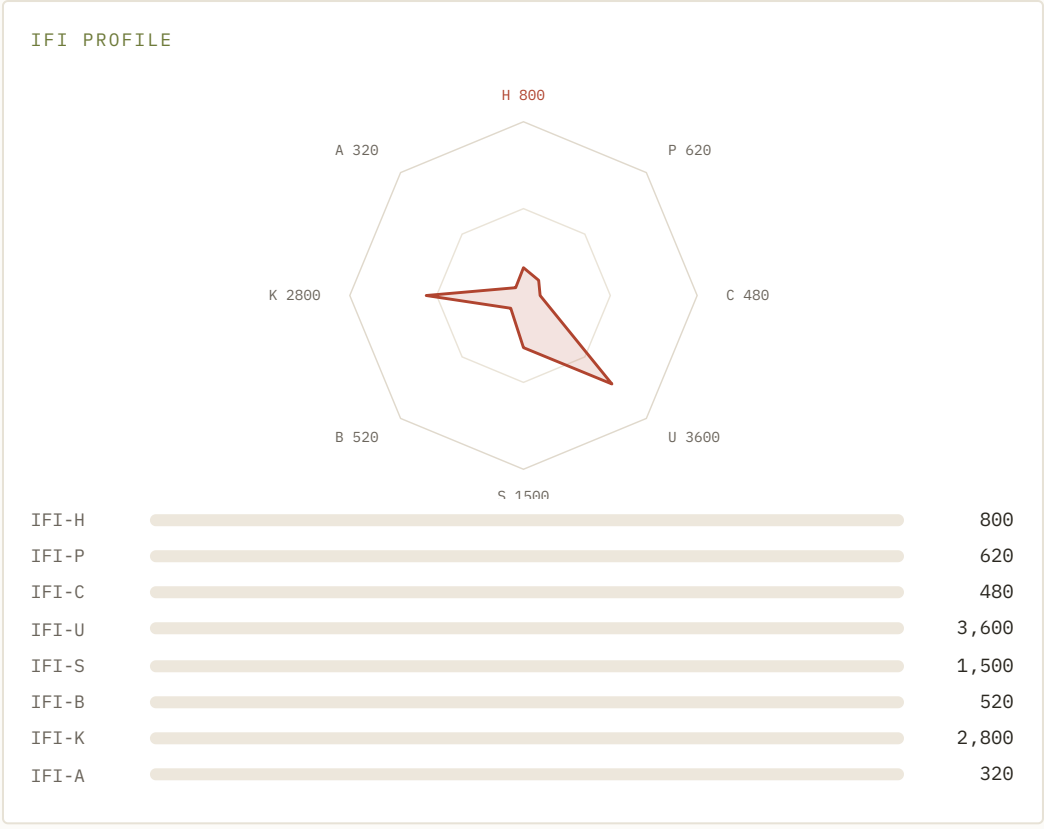
Wednesday — the braise. The mushroom and butter-bean braise (Chapter 8), mostly hands-off, over mashed potato. Make a double batch; Thursday will thank you.

Thursday — the second life. Wednesday's braise, reduced further and piled onto toast rubbed with confit garlic, under a blistered handful of greens. The braise deepens overnight as the kokumi peptides settle; it is better the second day, as the best savory things always are.

Friday — the fire. Blackened cabbage steaks and grilled deep-earth carrots (Chapter 9), laddered chili oil (Chapter 14) at whatever rung the table wants, the sweet-heat drizzle (Chapter 15) for those who stack hot on sweet. A plate of char and glaze and controlled fire, for the end of a week.

Saturday — the slow pleasure. The dal, heat-laddered (Chapter 12), simmered unhurried, with the tempering poured over sizzling at the table and the cooling herb finish on top. Or, if friends are coming and you want to astonish them, the engineered tomato tartare (Chapter 13) to start and the smoke-charred eggplant braise to follow — a raw plate and a fire plate, bookending a meal that happens to contain no meat and that no one at the table will think to mention, because nothing is missing.

Here is that Saturday dinner, scored as a whole — the composition the book has been teaching, read on one card:



Deep umami and kokumi carrying the plate, a measured warmth of heat, a lift of pungency and cool at the top, everything else in balance — a complete sensory event, composed axis by axis, from plants alone. That is the week, and that is the book: ten tuned organisms, four building blocks, the savory triad understood at the receptor, and a stove. We revere what we grow, and we grew these plants to give you their fullest savor and their fullest substance at once, and then we wrote down how to cook them. The rest is yours. Set the table; the plants will do the talking.

These are computational designs; Scoville Splice's cultivars and constructs have not been experimentally validated in a laboratory.