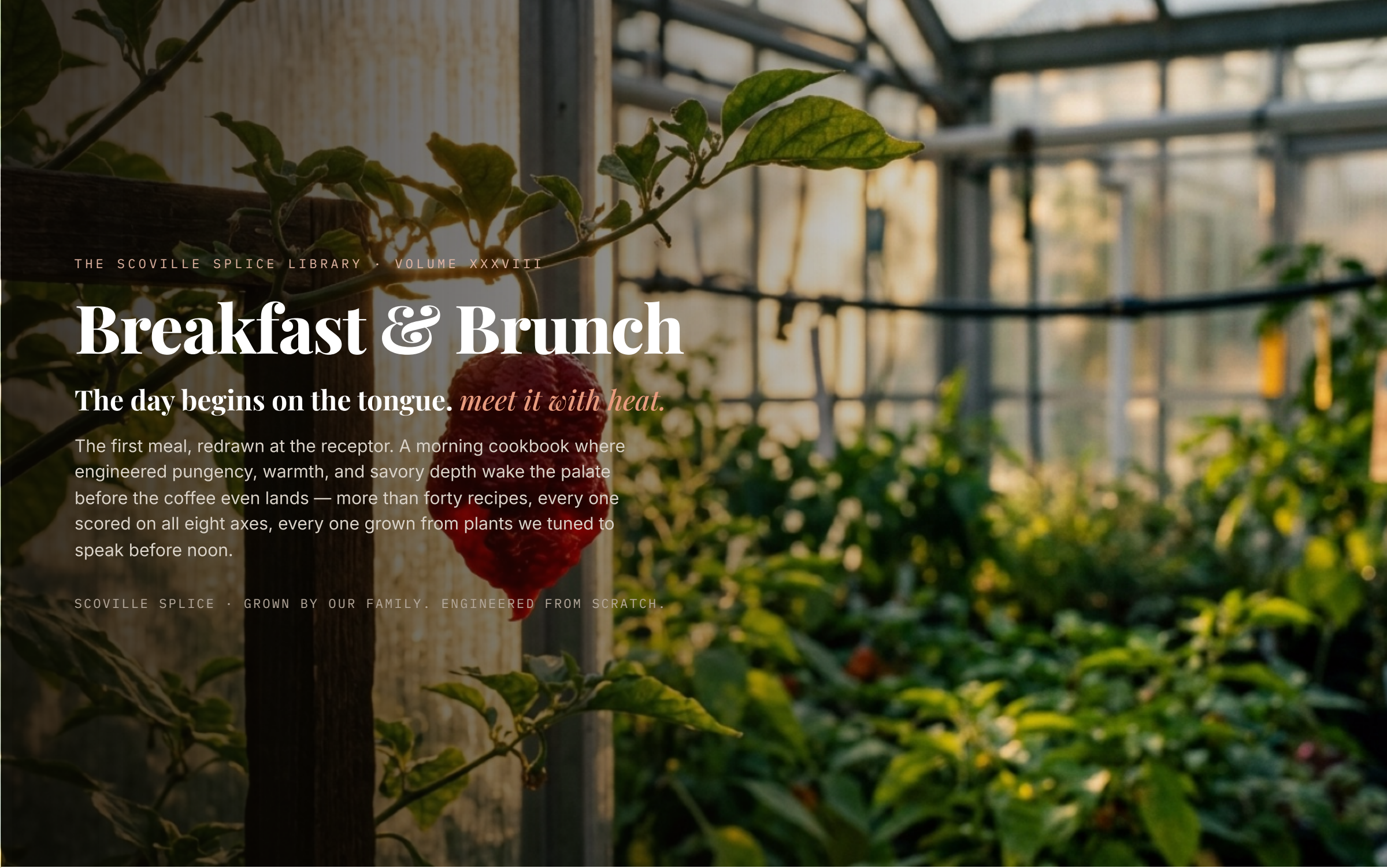


THE SCOVILLE SPLICE LIBRARY · VOLUME XXXVIII

Breakfast & Brunch

The day begins on the tongue. *meet it with heat.*

The first meal, redrawn at the receptor. A morning cookbook where engineered pungency, warmth, and savory depth wake the palate before the coffee even lands — more than forty recipes, every one scored on all eight axes, every one grown from plants we tuned to speak before noon.

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

Contents

01 Opening essay · The first fire of the day

02 Chapter 1 · The morning tongue — why dawn tastes different.

03 Chapter 2 · The pungent channel — the sharp way in.

04 Chapter 3 · Coffee, unbittered — the morning's oldest argument.

05 Chapter 4 · The egg, and the heat it was waiting for — six minutes, eight axes.

06 Chapter 5 · The pungent sauces — hollandaise, and its sharper kin.

07 Chapter 6 · Toast as a canvas — everything starts on bread.

08 Chapter 7 · Porridge, and the savory bowl — oats can hold a whole morning.

09 Chapter 8 · Pancakes, and the sugar-free syrup — sweet without the sugar.

10 Chapter 9 · French toast, and the custard axis — where richness is a receptor.

11 Chapter 10 · Fruit, bright and cooling — the cold that isn't cold.

12 Chapter 11 · Hash, and the Maillard morning — brown is a flavor.

13 Chapter 12 · Beans, tomato, and the slow savory — the pan that waits for you.

14 Chapter 13 · Breakfast proteins, with respect — plant first, all honored.

15 Chapter 14 · Smoothies, and the cooling glass — drink your morning.

16 Chapter 15 · The pungent drink — a bloody mary, rebuilt.

17 Chapter 16 · Composing the table — how eight axes share one plate.

18 Chapter 17 · The molecule behind the morning — gene to flavor, start to finish.

19 Closing · Breakfast, on purpose

Opening essay · The first fire of the day

In our house the kitchen wakes before anyone decides to. A kettle ticks as its element cools; the gas catches with that small blue cough; somewhere a knife finds a board and a clove of garlic gives up its skin. We have cooked a great many first meals at this counter, and we have come to believe the thing almost nobody says out loud — that breakfast is where taste is most awake and most ignored. We meet the sharpest, most receptive version of our own senses with the blandest food of the day, and we call it comfort.

This book is an argument against that trade, and it is written the way our family writes everything: with reverence for the plant on the board and no tolerance for hand-waving about what happens when you eat it. A tomato warm from the pan is a chemical event we can now read almost completely — the free glutamate loosening onto the tongue, the hum of ribonucleotides underneath it, the acid lifting the whole thing into focus. For ten thousand mornings nobody could say *how much*. We built a company so that we finally could.



The research greenhouse at first light — the hour this book keeps returning to.

The instrument under every page here is the Iyengar Flavor Index. Each of the eight axes is a single number anchored to the half-maximal activation of a receptor — not how much of a compound a food contains, but how *loudly* that compound speaks to the nerve.

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

EC_{50} is the concentration at which a stimulus drives its receptor to half of full response. Invert it against a fixed reference, scale by a thousand, and loudness becomes a score you can read a cup of coffee, a chili oil, and a spoon of porridge against on one page. The reason this matters at breakfast more than at any other meal is physiological: the morning palate is not the evening palate. Saliva is thinner and scarcer after a night's rest, so astringency reads louder

and sweetness reads a touch softer; the trigeminal channels that carry heat, pungency, and cold are rested and quick to answer. You are, chemically, wide open at seven in the morning. It seems a waste to hand that openness a beige bowl.

There is one more morning fact worth stating plainly, because it shapes half the recipes in this book: on waking, the nose is often its least useful. A night spent horizontal thickens the nasal passages a little in most of us, and flavor is mostly smell — the retronasal aroma rising from the back of the mouth is where the lion's share of what we loosely call *taste* actually lives. A half-congested morning nose reads that aroma faintly, which means breakfast leans harder than any other meal on what the *tongue and the trigeminal nerve* can carry unaided: the five tastes, and the heat, the pungency, the cool. It is no accident that the great breakfast flavorings of nearly every culture — chili and black pepper, mustard and ginger, strong coffee, salt — are precisely the loud, trigeminal, taste-forward ones. They are the flavors that still land when the nose is only half awake. This whole book is, in one sense, a study of those flavors, engineered to land louder still.

So we cook the other way. We reach for the pungent channel first — the sharp, electric *awake* of mustard and ginger and raw garlic and good black pepper — because it is the morning's natural key. We lean on umami and kokumi to give an egg or a bowl of oats the depth that usually takes a pot of stock and an afternoon. We debitter the coffee and the cocoa and the kale enough to let their better flavors through, never enough to make them lie. And we let heat be a pleasure rather than an assault, laddered precisely, because a morning chili should open the eyes, not close the throat.

A word on how this is grown, since it is the whole foundation and we would rather say it once than hide it. The platform underneath these recipes is **~19,500 product SKUs across 42 host organisms**, of which **1,000 are live and purchasable today**, designed to a batch-to-batch consistency specification of **≤7%** across **8 axes**. The computing fell to one pair of hands in our family; the questions, the tasting, the table, and the years belong to all of us. We grow each plant toward the fullest flavor — and the fullest nourishment — it can carry, and we mean that as an intention we hold, never a promise we make to your body. Food is something you give yourself with attention. Morning is the first chance of the day to do it well.

Cook from the front or cook from the middle; the recipes don't require each other. But read the first three chapters before you turn on a burner. They are the grammar. Everything after is the sentence.



PART I OF VII

The Waking Palate

the morning tongue · TRPA1 · the debittered cup

Chapter 1 · The morning tongue — *why dawn tastes different.*

Taste is not a constant you carry around unchanged. It drifts across the day on a tide you can feel if you pay attention — the orange juice that tastes flat after toothpaste, the wine that opens up only after dark, the fact that the first bitter sip of coffee is a different animal from the fourth. The morning palate has a character, and once you cook to it on purpose the whole meal changes shape.

Three things set the morning tongue apart, and all three are mechanical rather than mystical. The first is saliva. Through the night the parasympathetic drive that keeps the mouth wet idles down; you wake with less of it and thinner. Saliva is not a passive rinse — it is the medium every taste molecule has to cross to reach a receptor, and it carries the proline-rich proteins (PRPs) that tannins bind and precipitate. With less of them present, astringency arrives sharper and drier, which is exactly why a strong black tea or an underripe fruit *bites* harder before breakfast than after it. We will use that, not fight it.

Saliva does far more than wet the mouth. It buffers acid, so a dry morning mouth reads sourness and the brightness of citrus a touch sharper; it carries amylase, which begins cleaving starch into sugar even as you chew, which is why a slowly chewed mouthful of plain toast turns faintly sweet by the end; and it holds the whole flavor event in suspension for the second or two the receptors need to read it. A thin morning saliva is a less generous solvent and a quicker one — flavors arrive fast and clear and leave fast. That rewards dishes built with a long tail of kokumi and umami to hold the finish open, and it punishes anything that relied on a slow, rich, well-watered mouth to carry it. The morning does not forgive a one-note dish; it simply lets the single note fade before you have finished the bite.

The second is temperature and the trigeminal channels that read it. Heat (TRPV1), pungency (TRPA1), and cooling (TRPM8) are not taste receptors at all; they are channels on the trigeminal nerve endings that report touch, temperature, and chemical irritation. They are rested in the morning and quick to fire, which makes dawn the natural hour of the pungent — the clean electric sharpness that mustard, horseradish, raw allium, and ginger all deliver. A morning dish built around that channel does not sit on the stomach; it opens the face.



Ginger, cross-cut — 6-gingerol concentrated in the resin canals, the morning's gentlest way onto the sharp channel.

The third is the body's own clock, and here we are careful, because it is easy to overclaim. There is good evidence that sensitivity to the five classical tastes shifts on a circadian rhythm — that the thresholds you cross to *detect* sweet, sour, and bitter are not identical at breakfast and at midnight. We treat this as a reason to design, not a reason to promise anything. The practical upshot is simple and testable at your own table: sweetness has to work a little harder in the morning to read as generous, and bitterness and astringency need a gentler hand. A pancake that tastes perfectly sweet at nine at night can read thin at seven in the morning. The fix is not more sugar. The fix is a louder sweetness — a molecule that speaks to TAS1R2·TAS1R3 at a lower concentration — which is precisely what the sweetness library is for.

Temperature is the quiet fourth variable, and breakfast is the meal most governed by it. Warmth drives volatility, so a hot dish releases far more aroma than the same dish cold — which is part of why coffee and a fresh griddle smell like morning itself and a cold leftover smells like nothing. Warmth also moves the receptors directly. TRPV1, the heat channel, is literally a thermometer that capsaicin tricks; a warm chili therefore reads hotter than a cold one of identical capsaicin load, because the heat of the food and the heat of the molecule are summed by the same channel. TRPM8, the cold channel, works in mirror: menthol's cooling is loudest against a warm tongue, faint against a cold one. This is why one chili oil is a gentle hum on cold avocado and a genuine heat stirred into hot oats, and why a mint garnish does more on a warm plate than a chilled one. We cook with the thermometer in mind — heat where the dish is already hot and the eater already warm, cooling held back for the warm plates that have something to cool against.

Here is the map we cook from. Every axis has a morning home, and the pungent channel — the accent of this whole book — is the one we reach for first because it is the one the waking tongue answers fastest.

AXIS	RECEPTOR	WHERE IT LIVES AT BREAKFAST	MORNING READ
IFI-P · Pungency	TRPA1	mustard, ginger, garlic, black pepper, cinnamon	loud, welcome, the key
IFI-H · Heat	TRPV1	chili oil, shakshuka, hot sauce, breakfast tacos	quick to fire, use a pinhead
IFI-U · Umami	mGluR1 / TAS1R1·R3	tomato, mushroom, miso, a cured fish	the depth that reads as "made with care"
IFI-K · Kokumi	CaSR	yolk, butter, aged cheese, long-cooked allium	richness; the glue of a good plate
IFI-C · Cool-Burn	TRPM8	mint, a cold melon, a cucumber	reads strong on a warm face
IFI-S · Sweetness	TAS1R2 / TAS1R3	fruit, syrup, pancakes, pastry	runs soft early; needs a louder molecule
IFI-B · Zero-Bitter	TAS2R family	coffee, cocoa, grapefruit, kale	louder before noon; the one we attenuate
IFI-A · Astringency	salivary PRPs	tea, blueberry, pomegranate	sharpest on a dry morning mouth

Read the table as a set of levers, not a set of rules. A great breakfast is rarely one axis shouting; it is two or three in tune, pitched for a tongue that is more awake than it will be all day. The chapters that follow take the levers one and two at a time, hand you the recipes that pull them, and show the mechanism in the same breath — because at our table the wonder and the number were never two different things.

Chapter 2 · The pungent channel — *the sharp way in.*

If this book has a signature axis it is this one, and it is worth meeting the receptor properly, because once you understand *how* pungency works you stop treating it as a weaker cousin of heat and start using it as the precise, bright, morning-shaped tool it is.

Pungency is read by **TRPA1** — Transient Receptor Potential Ankyrin 1 — a cation channel sitting on the same trigeminal endings that carry heat and cold. It is often called the irritant receptor, and that is nearly right but misses the beauty of it. TRPA1 is a *chemical* alarm: it detects reactive, electrophilic molecules, and it detects them not by a lock-and-key fit but by being chemically attacked. Agonists like allyl isothiocyanate — the molecule that makes mustard and wasabi and horseradish go straight up the nose — form covalent bonds with specific cysteine residues on the channel's intracellular N-terminus (in the human receptor, the much-studied Cys621, Cys641, and Cys665, with a lysine, Lys710, assisting). The bond pulls the gate open. This is why wasabi pungency is a flash and not a build: it is a reaction, fast and then spent, cleared as the modified channel resets — nothing like the slow, fatty cling of capsaicin on TRPV1.

That difference is the whole reason pungency belongs to the morning. Heat lingers and accumulates; pungency arrives, blooms in the sinuses, and clears. It wakes you and then it lets you keep eating.

The channel itself is worth a closer look, because its architecture explains its behavior at the table. TRPA1 is a tetramer — four identical subunits around a central pore — and each subunit carries, on its intracellular side, a long stack of ankyrin repeats, the protein motif the receptor is named for, which acts as a kind of spring. The reactive cysteines sit at the base of that spring; when an electrophile like allyl isothiocyanate bonds to them, the spring is loaded and the gate pulled open. Because this is a covalent event and not a reversible fit, the sensation has a distinctive shape: a fast onset as the reaction fires, a bloom as more channels are hit, and then a clean fade as the modified channels are internalized and replaced. It is also why pungency does not stack the way heat does — you cannot easily "build" an isothiocyanate burn across a meal, because each hit is spent, where each dose of capsaicin finds a TRPV1 population still sensitized from the last. TRPA1 has a second job, too, as a cold and irritant alarm, which is part of why a hard hit of wasabi can read as almost cold-sharp at its peak before it turns to warmth. For the cook, the lesson is timing: pungency is a punctuation mark, best deployed fresh and late, grated or stirred in at the end, where its flash is sharpest and its fade is a feature.



Garlic in cross-section — alliin and alliinase held apart in separate cells until the knife introduces them.

The plants that speak this axis do so through three families of molecule, and each one is a small engineering story.

The isothiocyanates — mustard, horseradish, wasabi, watercress, radish. In *Brassica* and kin, the pungency is manufactured only on injury. The leaf or seed stores a glucosinolate — in black mustard, *sinigrin* — in one cell compartment and the enzyme *myrosinase* in another. Intact, the tissue is quiet. Crush it, chew it, or grind it with water, and the two meet: myrosinase hydrolyzes sinigrin, the unstable product rearranges, and out comes **allyl isothiocyanate (AITC)**, the mustard-oil bomb. White mustard runs the same machine on a different substrate, *sinalbin*, yielding *p*-hydroxybenzyl isothiocyanate — heavier, less volatile, so its pungency is slower and lingers on the palate rather than rushing the nose. Our black mustard library is deep for exactly this reason: at **2,790 constructs** it is one of the most engineered non-pepper organisms we keep, tuned across the glucosinolate-to-myrosinase ratio so that a prepared mustard can be dialed from a nasal flash to a long warm hum.

The thiosulfinates — garlic and onion. Garlic stores *alliin* and the enzyme *alliinase* apart; the knife introduces them and **allicin** is born within seconds, a reactive thiosulfinate that is itself a potent TRPA1 agonist before it decays into the diallyl di- and trisulfides that carry garlic's cooked, mellow depth. This is why raw-garlic pungency is sharp and fleeting while roasted garlic is sweet and round — you have let the reactive molecule spend itself. Our garlic (**560 constructs**) is engineered on both ends of that reaction, which is what lets it carry two axes at once: pungency when raw, and the kokumi of Chapter 9 when slow-cooked.

The others — ginger, cinnamon, thyme, oregano. Ginger's **6-gingerol** hits both TRPA1 and TRPV1, which is why ginger reads as *warm* rather than merely sharp; dry or cook it and gingerol dehydrates to the hotter **6-shogaol**, the reason dried ginger bites harder than fresh. Cinnamon's **cinnamaldehyde** is a clean TRPA1 agonist — and, pleasingly, a molecule that branches off the very same phenylpropanoid trunk (PAL → cinnamic acid → cinnamaldehyde) that our whole platform is built on, a point we return to in the last chapter. Thyme and oregano work through **thymol** and **carvacrol**, which open TRPA1 without the covalent attack — a softer, aromatic pungency that is why herbs feel gentle where mustard feels violent.

ORGANISM	CONSTRUCTS	PUNGENT PRINCIPLE	HOW IT REACHES TRPA1
Black Mustard	2,790	allyl isothiocyanate	covalent; fast nasal flash
White Mustard	200	*p*-hydroxybenzyl ITC	covalent; slow, lingering
Garlic	560	allicin → diallyl sulfides	covalent; sharp raw, round cooked
Watercress	120	phenethyl isothiocyanate	covalent; green, peppery
Ginger	120	6-gingerol / 6-shogaol	covalent + TRPV1 warmth
Thyme	120	thymol	non-covalent; aromatic
Oregano	40	carvacrol	non-covalent; aromatic
Cinnamon	40	cinnamaldehyde	covalent; warm, sweet-adjacent

Now the number. On the Index, IFI-P is anchored so that a reference pungent stimulus sits at 1,000. The score is the usual inversion: a preparation whose effective agonist reaches half-activation of TRPA1 at a *lower* concentration scores higher, because it speaks louder for less material. Take the convention reference of 2.1 µM — the IFI-P stated convention, analogous to how the Scoville scale is defined by dilution-to-threshold, not derived from a measured literature value — and an engineered prepared mustard whose milled, hydrated paste delivers an effective EC_{50} of 2 µM: IFI-P = 1000 × 2.1/2 = **1,050**. Double the effective agonist concentration a preparation achieves and you double its IFI-P; it is a loudness scale, not a dose scale, which is the whole reason it travels between a mustard, a ginger, and a clove of garlic that share nothing but the receptor they shout at.

One practical digression, because it is the most useful thing to know about this axis in a home kitchen: the isothiocyanate reaction is something *you* trigger, and you control it with water and time. Mustard powder is inert until you wet it — grinding the seed does nothing until the myrosinase enzyme meets the sinigrin substrate in water. Mix mustard powder with cold water and wait ten minutes and the reaction runs hot and sharp; the AITC generated is volatile and will mellow over the next hour as it escapes. Mix it instead with an acid — vinegar, lemon — or with hot liquid, and you arrest the enzyme early, locking in a milder, more stable, longer-keeping heat. This is the single lever behind the difference between a nose-clearing fresh English mustard and a mellow jarred Dijon, and it means a cook can tune the pungency of the same engineered powder across a wide range with nothing but the choice of liquid and the patience to wait. The platform sets the ceiling; the cook sets where on the curve the dish actually lands.

The point of engineering the glucosinolate ratio, then, is not to make a mustard that scalds — it is to raise and steady that ceiling, and to put the loudness exactly where you want it on the time axis: a flash for a soft-boiled egg, a lingering warmth for a sausage, a background hum folded into a sauce. Pungency is the morning's most controllable pleasure. The rest of Part I shows you how to aim it.

Chapter 3 · Coffee, unbittered — *the morning's oldest argument.*

No flavor is argued over more at breakfast than coffee's bitterness, and no flavor is more misunderstood. People who say they love coffee bitter and people who drown it in cream are usually responding to the same thing: a cup carries *two* bitternesses, and only one of them is worth keeping.

Coffee's bitterness is not caffeine's doing, or mostly not — caffeine contributes perhaps fifteen percent of the bitter signal, and an espresso with the caffeine removed is still unmistakably bitter. The weight comes from the roast. Green coffee is loaded with **chlorogenic acids**, a family of bright, astringent, mildly bitter phenolics. Apply heat and they degrade along two roads. The first produces **chlorogenic acid lactones**, which taste pleasantly, roundly bitter — this is the "good" bitterness, the one a medium roast is prized for. Push the roast darker and you cross onto the second road, which produces **phenylindanes**, harsh and lingering and flatly, aggressively bitter. That is the burnt, scorched note that makes a dark roast read as *bitter* in the pejorative sense. The two are produced by the same reaction at different intensities, which is why roast level is the single biggest bitterness lever a roaster has — and why it is such a blunt one.



Coffee, cross-cut — the chlorogenic acid load of the green seed is the raw material of every bitterness to come.

These bitter molecules are read by the **TAS2R** family — the roughly twenty-five human bitter receptors, of which several (TAS2R7, TAS2R10, TAS2R43, TAS2R46) answer to coffee's compounds. On the Index this axis is the Zero-Bitter axis, IFI-B, anchored to TAS2R38, and the platform's lever is deliberately upstream of the tongue: rather than mask bitterness in the cup, we lower the concentration of the bitter ligand the bean produces in the first place, retuning the chlorogenic-acid pool so that roasting yields the round lactone bitterness and far less of the harsh phenylindane. Our model predicts attenuation of **20 to 65%**, and the reason we give a

range rather than a single figure is honesty: how far you can pull bitterness down without hollowing the cup depends on the bean and the roast, and past a point you are no longer improving coffee, you are erasing it. Our coffee library is small and hard-won — **40 constructs**, every one a Hard engineering problem — precisely because the goal is attenuation, not deletion.

The arithmetic of the cup is worth seeing. If a reference bitter ligand half-activates its TAS2R at concentration C, and we engineer the bean to deliver 40% less of it, the receptor now sees 0.6 C and the perceived bitterness falls accordingly — not linearly, because receptor response is sigmoidal, but enough to move a cup from "needs sugar" to "needs nothing." What you taste in the gap is everything bitterness was shouting over: the fruit, the florals, the cocoa, the actual coffee.

Extraction is the cook's own lever on bitterness, and it multiplies with the engineering rather than replacing it. When water meets ground coffee it pulls compounds out in a rough order: the bright acids and fruit first, the sugars and body next, and the heavy, drying, bitter molecules last. Under-extract — too coarse a grind, too brief a contact, too cool a water — and you get sourness without depth; over-extract — too fine, too long, too hot — and you drag out that bitter tail on top of whatever the roast already built in. The target a careful brewer aims for is an extraction yield near 18–22% of the grounds' mass dissolved, at a strength around 1.2–1.4% total dissolved solids for filter coffee. Starting from a debittered bean widens the safe margin at both ends: with the harsh phenylindanes pulled back at the plant, a slightly long extraction no longer tips into punishment, so the cup forgives a clumsy, half-awake morning. Good beans and good technique are not alternatives — they are the same lever pulled twice.

BITTER SOURCE	FORMED BY	CHARACTER	OUR LEVER
Chlorogenic acid lactones	medium roast	round, pleasant bitter	keep
Phenylindanes	dark roast	harsh, lingering bitter	lower the precursor pool
Caffeine	native alkaloid	clean, ~15% of bitterness	retain

Three ways to put it in a cup, from plainest to most indulgent.

The honest pour-over

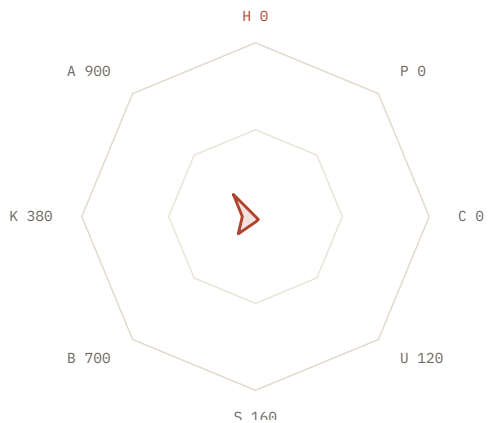
Serves 1 · 4 min · a filter cone

> 22 g debittered coffee (SS-library), medium roast, coarse-ground
> 360 g water at 96 °C

1. Rinse the paper filter with hot water and discard it — this removes the paper taste and pre-warms the cone.
2. Add the grounds; make a small well in the center.
3. Pour 50 g water to wet all the grounds and wait 35 seconds for the bloom to rise and settle.
4. Pour the remaining water in slow concentric circles over the next 2 minutes, keeping the bed level.

5. Let it draw down; the whole brew should finish near 3 minutes. Drink it black, at least the first cup. With the phenylindanes pulled back, there is nothing to hide from.

IFI PROFILE



IFI-H	0
IFI-P	0
IFI-C	0
IFI-U	120
IFI-S	160
IFI-B	700
IFI-K	380
IFI-A	900

The high B score here is the *attenuated* reading — a loud Zero-Bitter axis means bitterness has been turned down far, letting the native astringency (A) and a whisper of roast sweetness (S) stand clear.

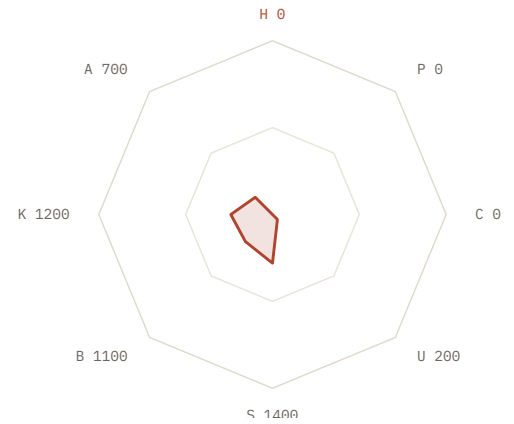
The morning mocha, debittered twice

Serves 2 · 10 min · small saucepan

```
2 shots espresso from debittered coffee (SS-library)
300 ml oat or whole milk
20 g debittered cocoa (cacao, SS-library)
8 g engineered sugarcane or stevia (SS-library), to taste
pinch fine salt
scrape of engineered vanilla (SS-library)
```

1. Warm the milk with the cocoa, salt, and sweetener, whisking until no cocoa dust remains.
2. Pull or brew the espresso.
3. Add the vanilla to the milk off the heat.
4. Combine espresso and cocoa-milk; froth with a whisk or wand.
5. The mocha's whole problem is usually double bitterness — coffee's and cocoa's — fighting the sugar. With both plants debittered, the sweetener does less work and the chocolate reads as chocolate, not as a bitter thing being covered up.

IFI PROFILE



IFI-H	0
IFI-P	0
IFI-C	0
IFI-U	200
IFI-S	1,400
IFI-B	1,100
IFI-K	1,200
IFI-A	700

Contains: milk (or oat). The cocoa and coffee here are engineered cultivars from the live library.

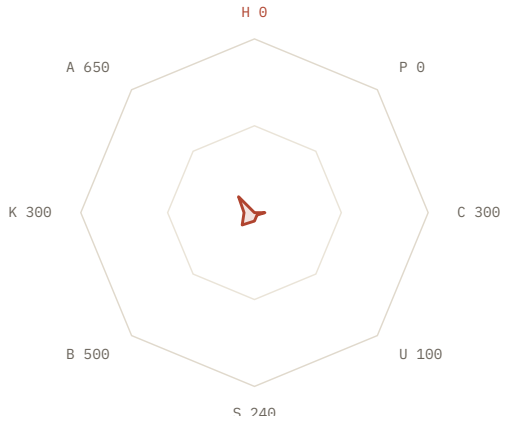
Overnight cold brew, for the slow morning

Makes ~1 L concentrate · 16 h · a jar

> 120 g debittered coffee (SS-library), coarse-ground
> 1 L cold filtered water

1. Stir grounds and water in a large jar until fully wetted.
2. Cover and leave at room temperature 14–16 hours.
3. Strain through a paper filter set in a sieve; do not press the bed.
4. Store the concentrate cold up to a week; cut 1:1 with water or milk over ice.
5. Cold extraction already dodges most of the harsh bitterness heat creates; starting from a debittered bean takes it almost all the way, which is why this reads clean and almost sweet without a grain of sugar.

IFI PROFILE



IFI-H	0
IFI-P	0
IFI-C	300
IFI-U	100
IFI-S	240
IFI-B	500
IFI-K	300
IFI-A	650

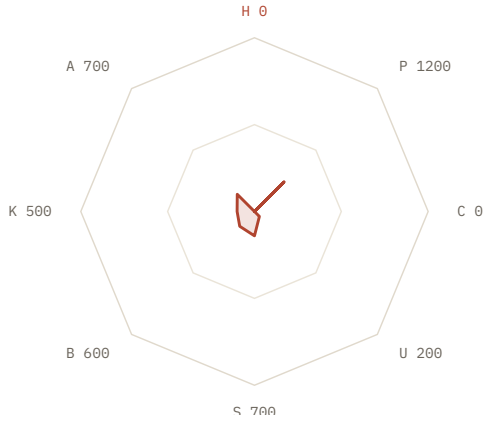
Cardamom coffee, the slow spiced pot

Serves 2 · 10 min · small pot

```
2 cups brewed debittered coffee (SS-library), hot
4 green cardamom pods, cracked
1 small piece cinnamon (SS-library)
2 slivers ginger (SS-library)
milk and engineered sweetener to taste (SS-library)
```

1. Warm the brewed coffee gently with the cracked cardamom, cinnamon, and ginger — do not let it boil, which would pull out fresh bitterness.
2. Steep 5 minutes off direct heat so the aromatics infuse.
3. Strain; add milk and a little sweetener.
4. The cardamom and ginger lay a warm pungency over the coffee that reads as "spiced" and lets you use even less sweetener — the spice fills the space sugar usually occupies. This is the cup for a cold morning and a slow one.

IFI PROFILE



IFI-H	0
IFI-P	1,200
IFI-C	0
IFI-U	200
IFI-S	700
IFI-B	600
IFI-K	500
IFI-A	700



PART II OF VII

The Egg

shakshuka · chili crisp · the pungent sauces

Chapter 4 · The egg, and the heat it was waiting for — *six minutes, eight axes.*

An egg is the most forgiving canvas in the kitchen and the most revealing. Forgiving because its own flavor is quiet and generous — it will carry almost anything you put beside it. Revealing because that quietness means there is nowhere for a bad idea to hide. Cook an egg well and season it badly and you taste the bad seasoning exactly.

The yolk is the secret, and the secret is kokumi. A yolk is rich in phospholipids and in the peptides — including glutathione, the γ-glutamyl tripeptide — that activate the calcium-sensing receptor, CaSR, which the Index reads as the Kokumi axis, IFI-K. Kokumi compounds have almost no taste alone; what they do is lengthen and thicken everything else, pulling a flavor from a flash into something continuous and mouth-filling. This is why a sauce enriched with yolk tastes *rounder*, why a custard feels like it coats, why a soft yolk broken over toast turns two plain things into one good one. When we build an egg dish we are really building a frame around that native kokumi, then choosing which other axes to wake.

The other half of egg cookery is physics, and a cook who understands it is never at the mercy of a rubbery scramble again. An egg is a suspension of proteins that unfold and bond — coagulate — as they heat, and the two parts set at different temperatures: the white's proteins begin firming around 62–65 °C, the yolk's a little higher, near 65–70 °C. The whole art of a soft-boiled egg, a custard, a soft scramble, a hollandaise lives in the gap between those numbers — setting the white while the yolk still flows, thickening a custard without letting it cross into scramble. Push the proteins too far or too fast and they bond too tightly and wring out the water they were holding; that is precisely what a dry, weeping scramble or a broken hollandaise *is* — protein that overcooked and squeezed itself dry. Low heat, constant motion, and an early exit from the pan are the entire discipline. And salt, added before cooking rather than after, slightly loosens the protein network for a more tender set — a small, free improvement most cooks skip.

At breakfast the answer is almost always heat and pungency — but a *calibrated* amount, and here a warning that runs through this whole book. The flagship cultivars of the Scoville Splice library are not breakfast food. They are proof-of-concept designs, engineered to show how far the platform reaches in computational design scope and axis activation, and our model predicts they top out somewhere no morning should go.

CULTIVAR	SKU	PREDICTED SHU	IFI-H	AXES
Ember	SS-0087	~866K	1,570	2/8
Blaze	SS-0091	~1.72M	2,630	4/8
Firestorm	SS-0094	~2.47M	3,490	6/8
Phoenix	SS-0096	~2.95M	4,200	8/8

Our model predicts a whole Phoenix pod carries a heat of approximately three million Scoville units; it is designed to register on all eight axes at once, not to go in your eggs. When a recipe in this book calls for one of the flagships it calls for a *pinhead* — a sliver the size of a match-head infused into oil, then the pod removed — and we say so each time. Morning heat should open the eyes. The measure of a good breakfast chili is that you reach for a second forkful, not a glass of water.



Engineered tomato, cross-cut — the free-glutamate load in the locular jelly is the umami spine of every shakshuka.

Shakshuka, the morning's great one-pan dish

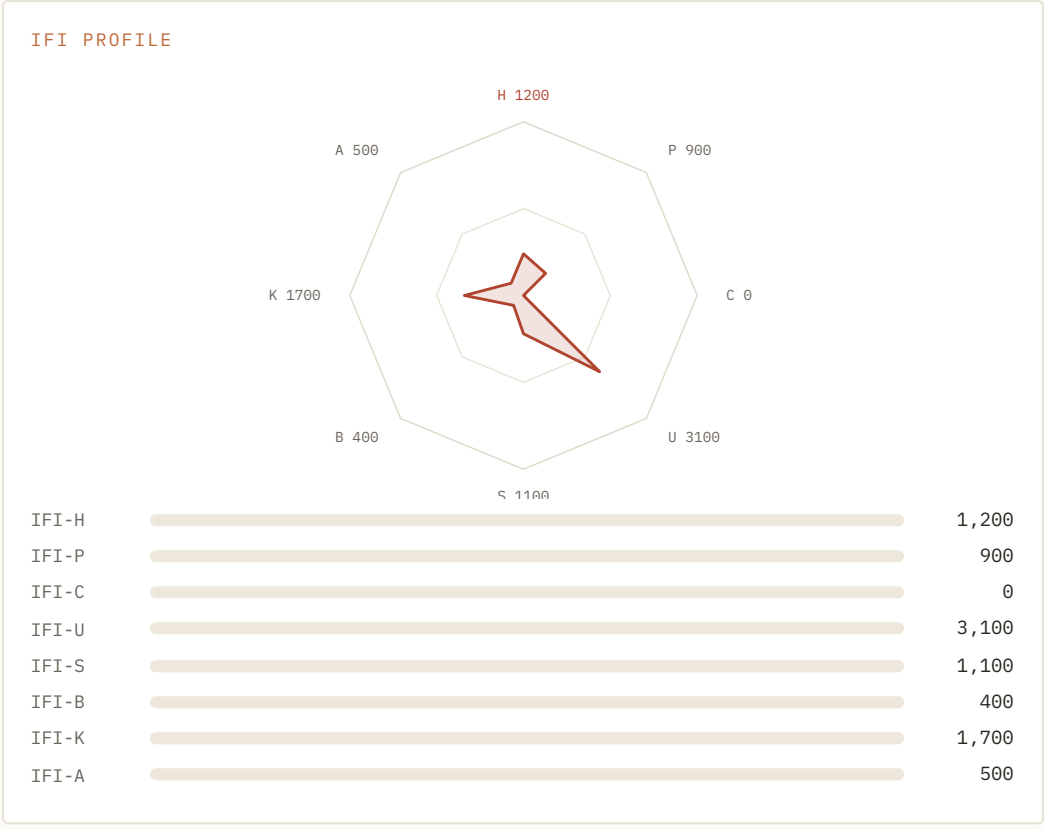
Serves 2–3 · 30 min · one wide pan

> 2 tbsp olive oil
> 1 onion (SS-library), diced
> 3 cloves garlic (SS-library), sliced
> 1 red pepper, diced
> 1 tsp cumin seed, toasted and ground
> 1 tsp sweet paprika
> chili oil infused with a pinhead of Blaze (SS-0091) — see note
> 700 g engineered tomato (SS-library, 2,040 constructs), crushed
> 4–6 eggs
> salt; a handful of soft herbs; crumbled feta (optional)

1. Warm the oil; soften the onion slowly, 8 minutes, until sweet and translucent.

2. Add garlic, pepper, cumin, and paprika; cook 3 minutes until fragrant and the pan smells like a spice market.
3. Add the crushed tomato and a careful teaspoon of the infused chili oil. Simmer 12–15 minutes until thick enough to hold a spoon-track.
4. Taste for salt and heat. The engineered tomato brings its own loud umami and a restored sweetness, so you will need far less sugar-correcting than a supermarket tin demands.
5. Make wells with the back of the spoon; crack an egg into each. Cover and cook 6–8 minutes, until whites set and yolks stay loose.
6. Scatter herbs and feta. Bring the pan to the table; break the yolks into the sauce there, at the table, so the kokumi loosens into the whole dish at once.

Note on the chili oil: warm 60 ml oil to barely steaming, drop in one match-head sliver of a flagship pod, steep 10 minutes off the heat, discard the sliver. You now have a calibrated heat you can pour by the teaspoon.



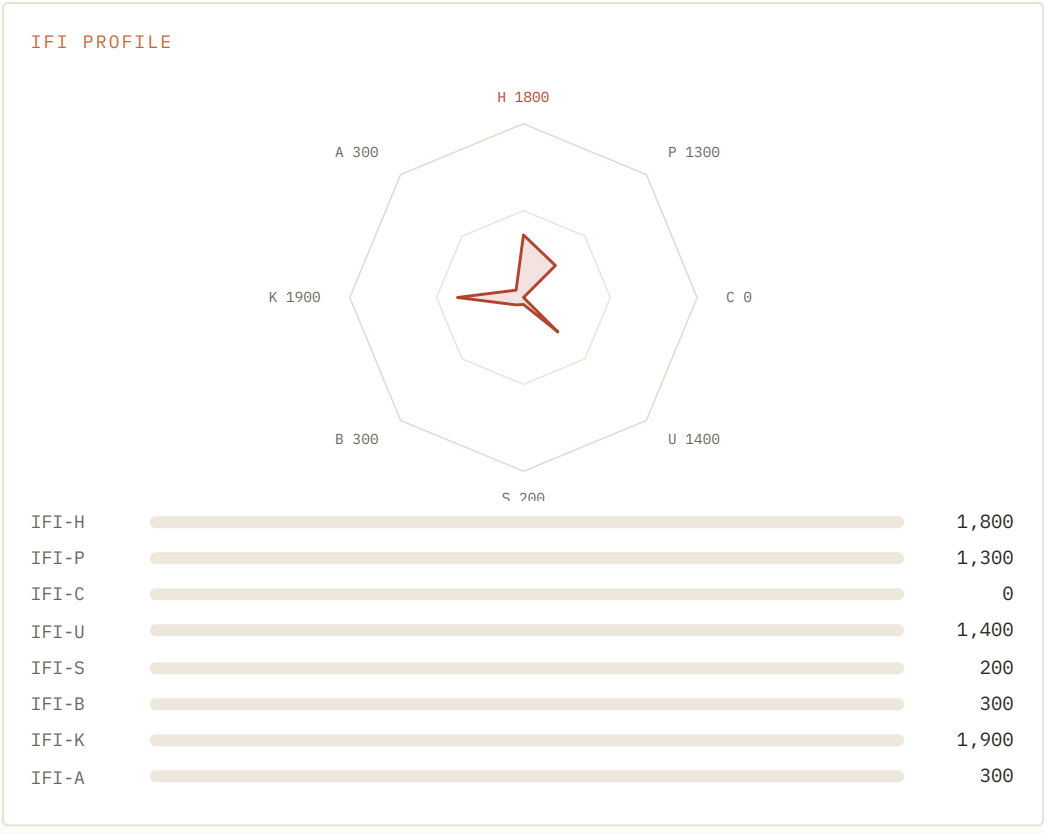
Contains: egg, dairy (optional feta).

Chili-crisp fried eggs

Serves 1 · 5 min · a small skillet

```
2 eggs
2 tbsp neutral oil
1 tbsp engineered chili crisp (see Ch. 15 method, or jarred)
flaky salt
1 slice toast, buttered
```

1. Heat the oil until it shimmers — hotter than most people fry eggs.
2. Crack the eggs in; the edges should bubble and lace immediately.
3. Baste the whites with the hot oil, tipping the pan, until the edges are crisp and brown but the yolk is still liquid.
4. Lift onto the toast. Spoon the chili crisp over the set white, never the raw yolk — you want the crunch and heat to meet the firm part, the yolk to stay a soft river.
5. Salt and eat at once, while the contrast of crisp lace and loose yolk is at its sharpest.



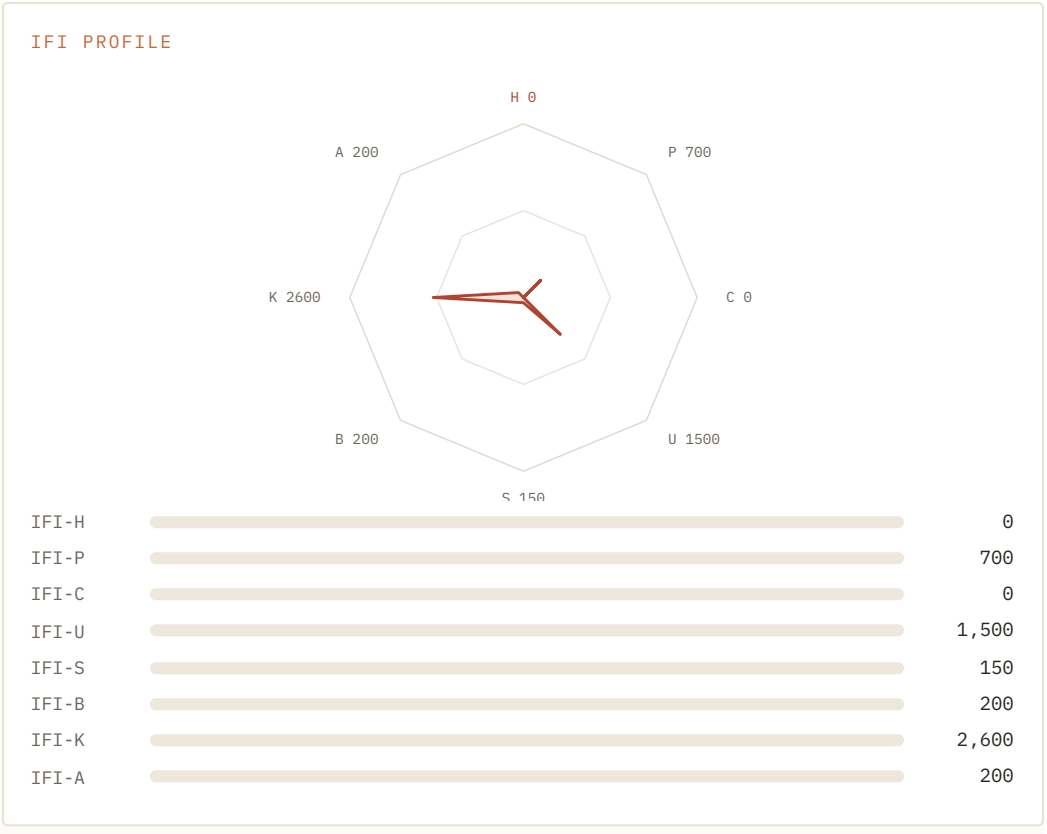
Contains: egg, dairy (butter).

The soft scramble, built on kokumi

Serves 2 · 8 min · nonstick pan, low heat

> 5 eggs
> 20 g cold butter, cubed
> 1 small clove garlic (SS-library), grated to a paste
> 2 tbsp finely chopped chives or scallion
> salt; a few grinds of black pepper

1. Beat the eggs smooth with a pinch of salt. Do not add milk — you want the eggs' own richness, not dilution.
2. Melt half the butter over low heat; add the eggs and the grated garlic.
3. Stir constantly with a spatula, pulling the setting curds off the base. Keep the heat low; this should take four or five patient minutes.
4. When they are still glossy and barely set, pull the pan off the heat and fold in the cold butter and the chives — the cold fat stops the cooking and lifts the kokumi to its fullest.
5. Serve immediately, soft and spoonable. The raw-grated garlic gives a clean pungent lift against all that richness; cooked garlic would go sweet and lose the point.



Contains: egg, dairy.

Masala omelet

Serves 1 · 7 min · a small skillet

```
3 eggs
1/2 small onion (SS-library), minced
1 green chili, minced (or 1 tsp calibrated chili oil)
2 tbsp chopped cilantro
1/2 tsp grated ginger (SS-library)
pinch turmeric; salt
ghee or oil for the pan
```

1. Beat the eggs with salt and turmeric.
2. Stir through the onion, chili, ginger, and cilantro.
3. Heat the ghee until a drop of egg sizzles; pour in the mix.
4. Lift the edges as they set, tilting the pan so the raw egg runs under, until just set with a soft center.
5. Fold and slide onto the plate. The ginger and raw onion put two pungent molecules — gingerol and allium thiosulfinates — onto TRPA1 at once; the result is a flat, bright *awake* that no amount of black pepper alone can match.

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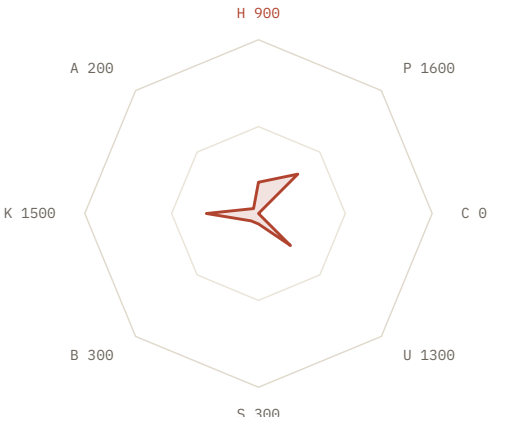

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IFI-P	1,600
IFI-C	0
IFI-U	1,300
IFI-S	300
IFI-B	300
IFI-K	1,500
IFI-A	200

Contains: egg, dairy (ghee).

Çılbır — poached eggs over garlic yogurt

Serves 2 · 15 min · a pot for poaching

```
2 eggs, very fresh
200 g thick yogurt
1 small clove garlic (SS-library), grated to a paste
50 g butter
1 tsp Aleppo-style chili flakes or calibrated chili oil
1/2 tsp dried mint (SS-library)
salt; a splash of vinegar for the poaching water
```

1. Beat the garlic and a pinch of salt into the yogurt; let it sit at room temperature so the fridge-chill comes off — cold yogurt kills the dish.
2. Bring a wide pot of water to a bare simmer and add a splash of vinegar. Swirl the water, slip in each egg, and poach 3 minutes until the white sets and the yolk stays liquid.
3. Meanwhile melt the butter until it foams and just begins to brown; off the heat, stir in the chili and the dried mint.
4. Spread the garlic yogurt across two plates; lift the drained eggs on top; spoon the warm chili butter over.
5. One of the great brunch dishes and a near-perfect axis lesson: raw garlic's pungency carried through the cool kokumi of yogurt, the poached yolk adding its own kokumi, the browned chili butter laying heat and a nutty Maillard depth across the top. Serve with warm bread to drag through all of it.

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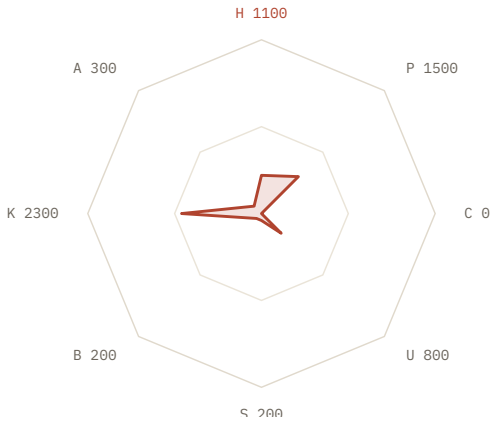

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IFI-P	1,500
IFI-C	0
IFI-U	800
IFI-S	200
IFI-B	200
IFI-K	2,300
IFI-A	300

Contains: egg, dairy.

Chapter 5 · The pungent sauces — *hollandaise, and its sharper kin.*

A brunch is made or broken by its sauces, and almost all the great brunch sauces are emulsions — hollandaise and its family — which means they are all, structurally, the same trick: fat suspended in a water phase, held apart by the emulsifiers in egg yolk so that butter and acid become one glossy thing instead of a broken slick. The yolk's lecithin does the mechanical work; the yolk's kokumi peptides do the flavor work, which is why a good hollandaise tastes *long* and rich in a way that butter alone never does. On the Index a classic hollandaise is a kokumi-forward sauce (IFI-K leading) with a bright acid top note.

An emulsion is a truce between two things that do not want to mix — fat and water — brokered by a molecule with a foot in each camp. Lecithin, the phospholipid abundant in egg yolk, is exactly that broker: one end loves water, the other loves fat, so it wraps each droplet of butter and holds it suspended in the lemon-and-yolk water phase instead of letting it pool out. The reason a good hollandaise feels so luxurious is, quite literally, droplet size — whisk the butter in slowly and you shear it into millions of tiny droplets, and a fine emulsion of small droplets reads as silky and thick, where a coarse one reads as greasy or splits outright. Add the fat too fast, or too cold, or let the sauce overheat, and the broker is overwhelmed: the droplets coalesce, the water is released, and the sauce "breaks" into a greasy slick. Every fix follows from the physics — a broken sauce is rebuilt by whisking it drop by drop into a fresh yolk or a spoon of warm water, giving the emulsion a new, intact scaffold to climb back onto. Knowing it is droplets and not magic is what lets you rescue it with a calm hand instead of pouring it down the drain. Our contribution is to run a pungent axis straight through it.

The reason this works so well is chemical opposition. Richness and pungency sit on different systems entirely — CaSR for the kokumi, TRPA1 for the sharpness — so they do not compete; they stack. A fat-heavy sauce can take a surprising amount of mustard heat before it reads as hot, because the fat coats and slows delivery while the pungent molecule still fires its channel. The effect is a sauce that is simultaneously plush and electric, and it is the single most useful idea in morning cooking.



Garlic, whole — the raw clove is a pungent sauce's fastest route to a clean, bright edge.

Engineered-mustard hollandaise

Makes ~250 ml · 12 min · blender or bowl and whisk

```
3 egg yolks
1 tbsp lemon juice
1 tsp prepared engineered mustard (Black Mustard, SS-library)
120 g butter, melted and hot
salt; a little cayenne or calibrated chili oil
2 tsp cold water
```

1. In a blender or a bowl set over barely-simmering water, whisk the yolks with the water, lemon, and mustard until pale and thickened.
2. If using a bowl, keep it moving and never let it get hot enough to scramble — pull it off the heat whenever the whisk leaves a lasting track.
3. Stream in the hot butter very slowly, whisking or blending constantly, until thick and glossy.
4. Season with salt and a breath of cayenne. Taste: the mustard should read as a clean sharp lift under the richness, not as "mustard sauce."
5. Keep warm, not hot, until serving. Over poached eggs, over asparagus, over a split biscuit — anywhere you want richness with a spine.

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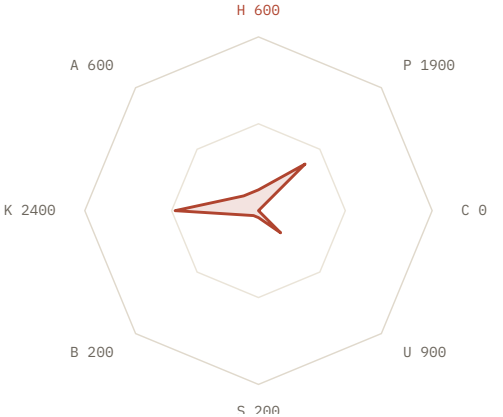

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IFI-P	1,900
IFI-C	0
IFI-U	900
IFI-S	200
IFI-B	200
IFI-K	2,400
IFI-A	600

Contains: egg, dairy, mustard (allergen).

Green-chili and herb hollandaise

Makes ~250 ml · 15 min · blender

```
3 egg yolks
1 tbsp lime juice
1 roasted green chili (mild), peeled and seeded
small handful cilantro and parsley
120 g butter, hot
1 small clove garlic (SS-library)
salt
```

1. Blend the yolks, lime, roasted chili, herbs, and garlic until smooth and green.
2. With the blender running, stream in the hot butter until emulsified and thick.
3. Season. The roasted chili gives a low, rounded heat (roasting converts some of the sharp edge to sweetness) while the raw garlic keeps a pungent top.
4. Spoon over huevos, over a breakfast tostada, over grilled vegetables. This is the sauce that makes a plate of eggs taste like a place with sun.

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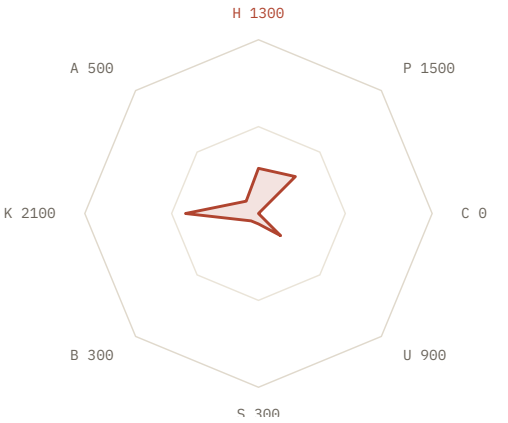

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IFI-P	1,500
IFI-C	0
IFI-U	900
IFI-S	300
IFI-B	300
IFI-K	2,100
IFI-A	500

Contains: egg, dairy.

Whipped chili butter, for everything else

Makes ~120 g · 5 min · a bowl

```
100 g soft butter
1 tbsp calibrated chili oil (see Ch. 4 note)
1 tsp honey or engineered sweetener
1/2 tsp smoked paprika
flaky salt
```

1. Beat the butter until pale and light.
2. Fold in the chili oil, sweetener, paprika, and salt.
3. Whip 30 seconds more until fluffy.
4. Melt a knob over pancakes, waffles, cornbread, a baked sweet potato, or the first warm toast of the morning. Not an emulsion and not a sauce — just the fastest way to put heat, a little sweet, and a lot of richness onto anything, all at once.

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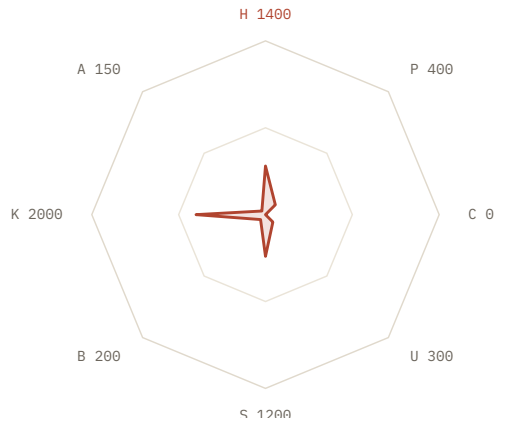

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IFI-P	400
IFI-C	0
IFI-U	300
IFI-S	1,200
IFI-B	200
IFI-K	2,000
IFI-A	150

Contains: dairy.

Salsa macha, the oil that goes on everything

Makes ~250 ml · 20 min · small pot + blender

```
120 ml neutral oil
3 tbsp mild-to-medium dried chili flakes
2 cloves garlic (SS-library)
30 g peanuts or almonds
2 tbsp sesame seeds
1 tsp engineered sweetener (SS-library); 1 tsp salt
1 tbsp cider vinegar
```

1. Warm the oil gently; fry the garlic and nuts until just gold, then add the sesame for a final minute.
2. Off the heat, stir in the chili flakes, salt, and sweetener and let them bloom in the residual heat.
3. Cool slightly, then pulse to a coarse, spoonable salsa; stir in the vinegar.
4. A Mexican oil-salsa and the brunch condiment that improves everything it touches — eggs, avocado, beans, a hash. The nuts give kokumi and body, the garlic a pungent base, the chili a rounded heat; the vinegar at the end keeps it bright. It keeps for weeks and gets better for the first few days.

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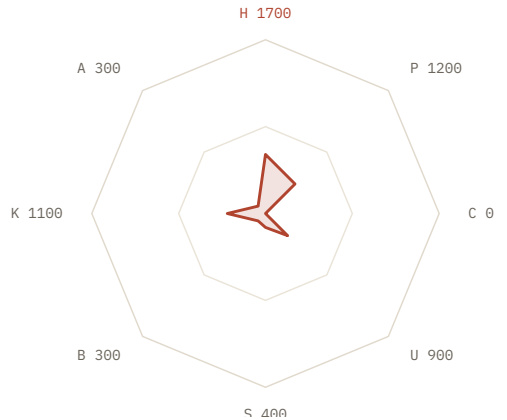

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IFI-P	1,200
IFI-C	0
IFI-U	900
IFI-S	400
IFI-B	300
IFI-K	1,100
IFI-A	300

Contains: peanuts or tree nuts, sesame.



PART III OF VII

Grain & Fire

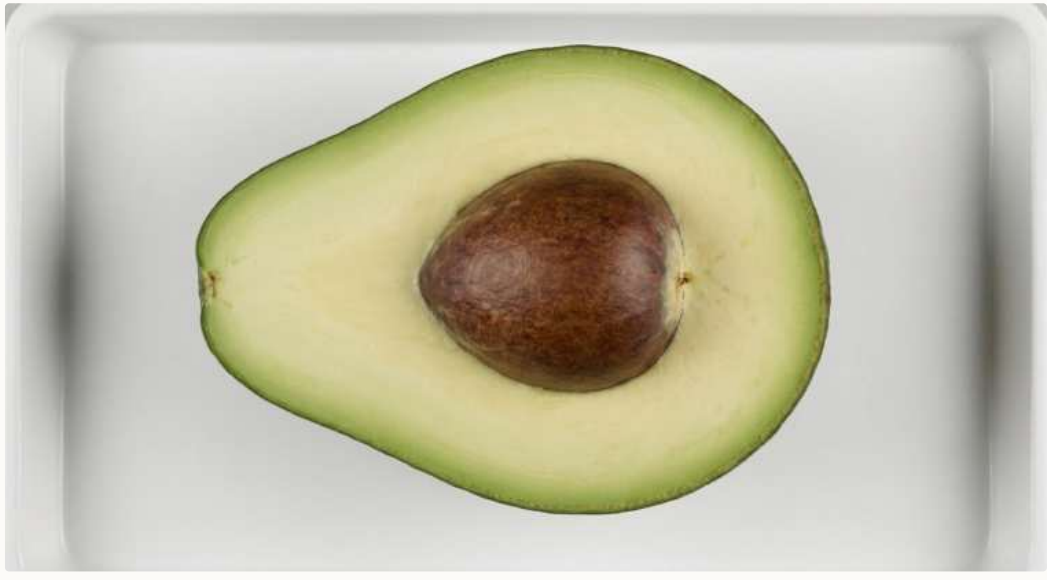
toast · porridge · the savory bowl

Chapter 6 · Toast as a canvas — *everything starts on bread.*

There is no humbler or more complete breakfast than a good thing on toast, and there is no better demonstration of how axes combine. Toast itself is a flavor, not a neutral platform — the crust is a sheet of Maillard chemistry, the browning reaction between the bread's amino acids and its reducing sugars that generates hundreds of roasty, nutty, faintly bitter compounds and the pyrazines that smell like *toasted*. That base note of warm bitterness and savor is why buttered toast is satisfying on its own and why it carries toppings so well: it is already giving you two axes before you add a thing.

It pays to be precise about what toasting does, because the same reaction governs the hash, the bacon, the waffle, and the coffee roast — it is the most important flavor-making process in the whole breakfast repertoire. The Maillard reaction is a cascade, not a single step: a reducing sugar and the free amino group of a protein condense into an unstable intermediate — the Amadori product — which then fragments and recombines down dozens of branching roads into pyrazines (roasted, nutty), furans (caramel, bready), thiophenes and thiols (meaty, savory), and finally the brown nitrogenous polymers called melanoidins that give a crust its color and its faint, pleasant bitterness. It needs heat above roughly 140 °C, a surface dry enough to reach that heat — water caps a surface at 100 °C, which is why steamed bread never browns — and a little time. It is distinct from caramelization, which is sugar browning *alone*, without the amino partner; the two often run together on one crust, but Maillard is the savory one, and it is why toast tastes of far more than warm sugar. Control it with the three dials it answers to: surface dryness, temperature, and time. A darker toast is not a burnt toast until the melanoidins tip over into acrid — the line a good cook learns to stop just short of.

The craft of a toast is axis choice. Pick a topping that completes the bread rather than fighting it, pitch two or three axes in tune, and finish with one sharp or bright element to keep it from going heavy. Below are four that have been on our table a thousand mornings.



Avocado, cross-cut — the fat that makes it the perfect kokumi-adjacent canvas for a loud chili oil.

Chili-oil avocado toast

Serves 1 · 6 min · toaster and a fork

```
1 thick slice sourdough
1/2 ripe avocado
1 tbsp calibrated chili oil (Ch. 4 note)
1/2 lime
flaky salt; a few cilantro leaves
```

1. Toast the bread dark — you want a real crust for the structure.
2. Mash the avocado roughly with a squeeze of lime and a pinch of salt right on the toast.
3. Spoon the chili oil over in a slow line so every bite finds some.
4. Finish with flaky salt and cilantro. The avocado's fat is doing a kokumi-adjacent job, coating and softening, so the chili oil can be loud without becoming harsh — richness and heat on two different receptors, stacking, never fighting.

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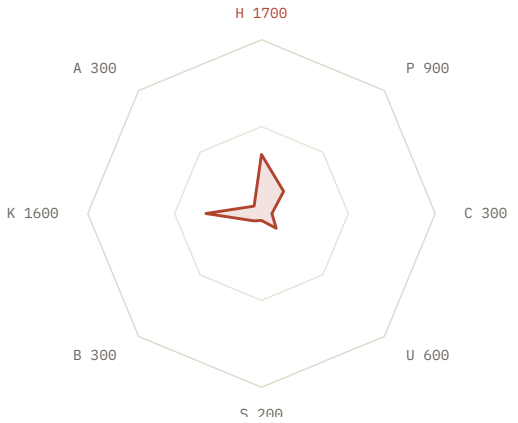

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IFI-P	900
IFI-C	300
IFI-U	600
IFI-S	200
IFI-B	300
IFI-K	1,600
IFI-A	300

Pan con tomate, the engineered version

Serves 2 · 10 min · a box grater

```
4 slices country bread
2 very ripe engineered tomatoes (SS-library, 2,040 constructs)
1 clove garlic (SS-library), halved
good olive oil
flaky salt
```

1. Toast or grill the bread until crisp.

2. While hot, rub each slice with the cut face of the garlic — the rough crust grates the clove and leaves a ghost of raw allium pungency.
3. Halve the tomatoes and grate the cut sides on a box grater into a bowl, discarding the skins; you will have a loose, seedy pulp.
4. Spoon the tomato pulp generously over the toast, drizzle with oil, and salt heavily.
5. This is a four-ingredient dish that lives or dies on the tomato, which is exactly why we engineered ours — a supermarket tomato gives you water and acid; the restored free-glutamate load here gives you the deep savory *tomato-ness* that the whole dish is supposed to be about.

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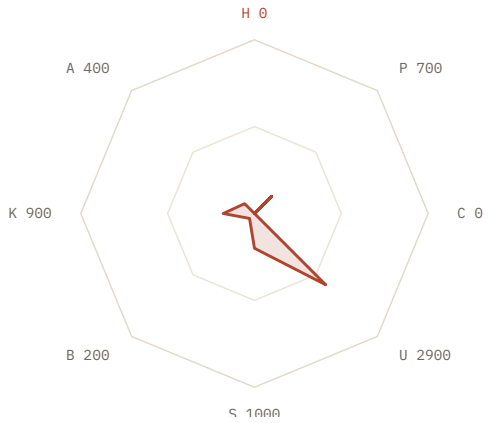

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IFI-P	700
IFI-C	0
IFI-U	2,900
IFI-S	1,000
IFI-B	200
IFI-K	900
IFI-A	400

Mushroom-umami toast

Serves 2 · 15 min · a wide skillet

```
300 g mixed mushrooms, torn
2 tbsp butter; 1 tbsp oil
2 cloves garlic (SS-library), sliced
1 tsp fresh thyme (SS-library)
1 tbsp soy or engineered koji paste (SS-library)
4 slices toast; parsley; black pepper
```

1. Heat the pan hot; add the oil and mushrooms in one layer and *do not stir* for 3 minutes — let them brown before they release water.
2. Toss, add butter, garlic, and thyme, and cook until deep gold.
3. Off the heat, stir in the koji or soy paste; it will glaze the mushrooms in savory depth.
4. Pile onto buttered toast, finish with parsley and a hard grind of pepper.
5. Mushrooms carry GMP, a ribonucleotide that synergizes with glutamate so strongly that umami multiplies rather than adds — pairing them with koji's free glutamate is the loudest savory move in the whole book, and it comes from fungus and a slice of bread.

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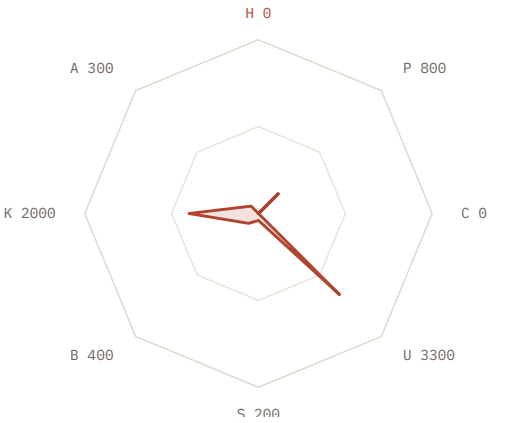

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IFI-P	800
IFI-C	0
IFI-U	3,300
IFI-S	200
IFI-B	400
IFI-K	2,000
IFI-A	300

Contains: soy (if using soy), gluten.

Sweet-heat ricotta toast

Serves 2 · 8 min · a bowl

```
250 g ricotta
zest of 1 lemon
4 slices toast
2 tbsp hot honey (engineered sweetener + calibrated chili oil + honey)
handful raspberries or sliced fig
flaky salt
```

1. Beat the ricotta smooth with the lemon zest and a pinch of salt.
2. Spread thickly on warm toast.
3. Drizzle the hot honey over; scatter the fruit.
4. Finish with flaky salt. Here sweetness, a low heat, the cheese's gentle kokumi, and the fruit's slight astringency land together — four axes, no single one loud, the definition of balance. It eats like dessert and belongs at breakfast.

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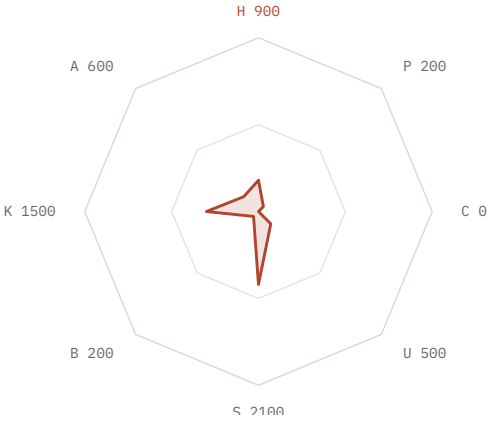


IFI-H	900
IFI-P	200
IFI-C	0
IFI-U	500
IFI-S	2,100
IFI-B	200
IFI-K	1,500
IFI-A	600

Contains: dairy, gluten.

Chapter 7 · Porridge, and the savory bowl — *oats can hold a whole morning.*

Porridge is the oldest breakfast there is and the most unfairly maligned, because most people have only met the sweet, thin version. A bowl of oats is a near-perfect vehicle: it is bland in the best sense, a soft neutral starch that will take on whatever flavor you build into it, and it is warm, which means it releases aroma and carries heat beautifully. We cook oats in two directions — savory and sweet — and the savory bowl is the one that converts people.



Oats — the quiet, generous base that will carry any axis you teach it.

The grain itself has a mild, almost dairy sweetness and, when toasted first, a nutty Maillard depth. Everything after that is your choice of axes. Savory oats want umami and kokumi and a pungent lift; sweet oats want a louder sweetness and warm spice. The engineering that matters most here is on the quiet end — the debittered, the deepened, the sweetened — because in a bowl this plain there is nothing to hide an off note.

The creaminess of a good porridge is starch doing physics. Oats are rich in a soluble fiber, beta-glucan, that dissolves into the cooking water and thickens it to that particular silky body porridge has and water does not; meanwhile the starch granules swell and gelatinize, bursting to release still more thickening. Both want time, gentle heat, and a little agitation — which is why a porridge stirred often over a low flame turns creamy while one blasted hot and left alone turns to glue on the bottom and water on top. Salt matters more than people expect: added at the start it seasons from within and firms the grain slightly, and a single pinch is the difference between oats that taste of something and oats that taste of wet. And toasting the dry grain first, as several of these recipes ask, runs a shot of Maillard through the oat before any liquid arrives — a nutty depth that survives all the way to the bowl and gives even a sweet porridge a savory floor to stand on.

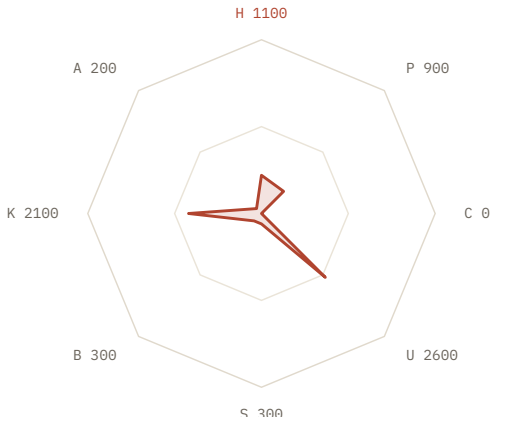
Savory oatmeal with egg and chili crisp

Serves 1 · 15 min · small pot

```
50 g rolled oats
250 ml water or light stock
1 tbsp engineered koji or miso (SS-library)
1 soft-boiled egg
1 tbsp chili crisp
1 scallion, sliced; toasted sesame
salt
```

1. Toast the dry oats in the pot for 2 minutes until they smell nutty.
2. Add the water and simmer, stirring, 8–10 minutes until creamy.
3. Off the heat, stir in the koji or miso — never boil it, which dulls the living savor.
4. Pour into a bowl; top with the halved soft egg, chili crisp, scallion, and sesame.
5. Break the yolk through. You now have a bowl running umami (koji), kokumi (yolk), and a clean pungent heat (chili crisp) over a warm neutral base — congee's idea, oats' ease.

IFI PROFILE



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IFI-B	300
IFI-K	2,100
IFI-A	200

Contains: egg, soy (miso/koji), sesame.

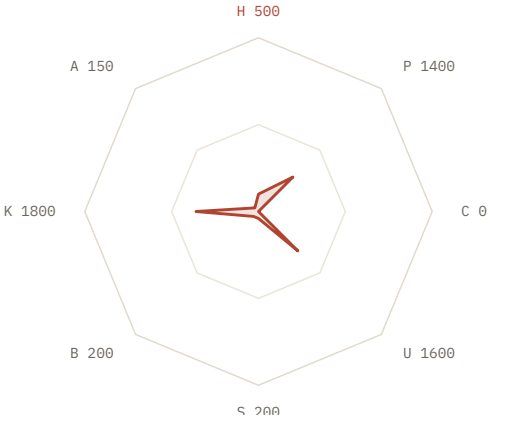
Ginger congee, the slow bowl

Serves 2 · 50 min · a heavy pot

```
100 g short-grain rice (SS-library)
1.5 L water or stock
a thumb of ginger (SS-library), sliced
2 cloves garlic (SS-library), smashed
white pepper; salt
to finish: scallion, soy, chili oil, a jammy egg
```

1. Rinse the rice; bring it to a boil with the water, ginger, and garlic.
2. Drop to the lowest simmer and cook 45 minutes, stirring now and then, until the grains collapse into a loose, silky porridge.
3. Season with salt and white pepper.
4. Ladle into bowls; let each person finish their own with scallion, a few drops of soy, chili oil, and a jammy egg.
5. The ginger infuses the whole pot with gingerol — a slow, warming pungency quite unlike a sharp raw hit — and the long cook pulls kokumi from the garlic. This is the gentlest way the pungent channel comes to the table, and the most comforting.

IFI PROFILE



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IFI-B	200
IFI-K	1,800
IFI-A	150

Contains: soy, egg (optional).

Cinnamon-and-fruit sweet oats

Serves 1 · 12 min · small pot

```
50 g rolled oats
200 ml milk or oat milk
1/2 tsp ground cinnamon (SS-library)
1 tsp engineered sweetener (stevia or sugarcane, SS-library)
pinch salt
to top: grated apple, toasted walnuts, a scrape of vanilla
```

1. Simmer the oats with the milk, cinnamon, salt, and sweetener, stirring, until thick and creamy.
2. Stir in the vanilla off the heat.
3. Top with grated apple and walnuts.
4. The cinnamon does double duty — it reads as warmth through TRPA1 while also pushing perceived sweetness up, so you need less sweetener than you'd think; the engineered sweetener covers the rest at a concentration the morning tongue reads as fully, generously sweet.

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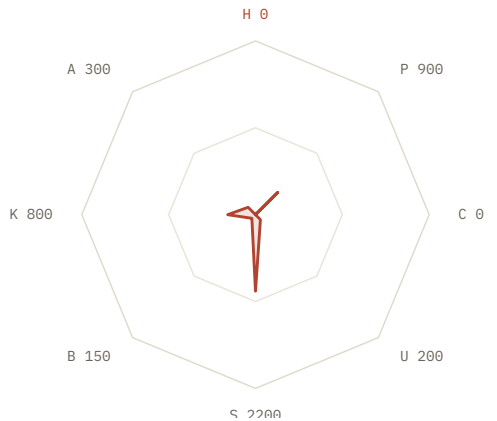

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IFI-B	150
IFI-K	800
IFI-A	300

Contains: dairy (or oat), tree nuts (walnuts).

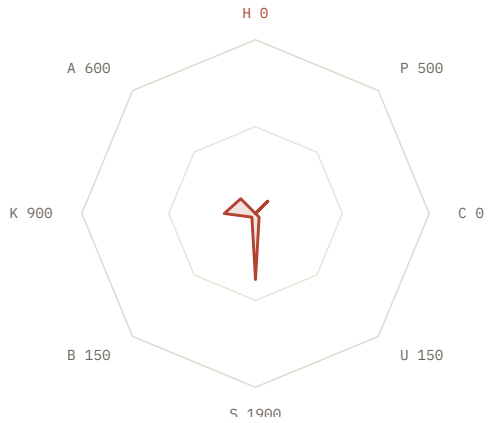
Bircher muesli, made the night before

Serves 2 · overnight · a jar

```
80 g rolled oats
150 ml milk or apple juice
100 g yogurt
1 apple, grated
1 tbsp engineered sweetener (SS-library); pinch cinnamon (SS-library)
to finish: berries, toasted nuts, a scrape of vanilla
```

1. Stir the oats, milk, yogurt, grated apple, sweetener, and cinnamon together in a jar.
2. Cover and refrigerate overnight; the oats soften and the beta-glucan thickens everything to a spoonable cream with no cooking at all.
3. In the morning, loosen with a splash of milk; top with berries, nuts, and vanilla.
4. The coldest and easiest bowl in the chapter, and proof you can build a complete breakfast the night before with nothing but time doing the work. The apple's gentle astringency keeps it from going flat; the cinnamon lifts the perceived sweetness so little sweetener is needed.

IFI PROFILE



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IFI-C	0
IFI-U	150
IFI-S	1,900
IFI-B	150
IFI-K	900
IFI-A	600

Contains: dairy (or juice), tree nuts (optional).



PART IV OF VII

The Sweet Morning

pancakes · custard · fruit, bright and cold

Chapter 8 · Pancakes, and the sugar-free syrup — *sweet without the sugar.*

The sweet side of breakfast is where the morning palate's quirk matters most, and where the sweetness library earns its keep. Recall from Chapter 1 that sweetness tends to run a touch soft early in the day — the detection threshold is higher, so a given amount of sugar reads as less generous than it would at night. The usual response is simply more sugar, which is a blunt instrument that buries the other flavors and leaves you heavy. The precise response is a *louder* sweetness: a molecule that activates the sweet receptor at a lower concentration, so the tongue reads "sweet" fully while far less material is present.

Sweetness is read by **TAS1R2·TAS1R3**, a receptor heterodimer with a large "Venus flytrap" domain. Ordinary sugars bind inside that cleft; but the receptor has several other binding sites, which is why intensely sweet molecules of utterly different shapes all work. Steviol glycosides from stevia — rebaudioside A and the cleaner-tasting rebaudioside M — register two to three hundred times sweeter than sucrose by weight. Mogroside V from monk fruit lands in a similar range. And the sweet *proteins* — brazzein, a tiny 54-amino-acid protein, thaumatin, monellin — bind a different face of the receptor entirely and read as sweet at vanishingly low concentration. These are the tools. The art is combining them, because each has a slightly different time-course and a slightly different off-note, and the blend tastes cleaner and more sugar-like than any one alone.



Sugarcane — re-engineered not for more sugar but for a louder, cleaner sweetness.

ORGANISM	CONSTRUCTS	SWEET PRINCIPLE	RELATIVE LOUDNESS
Stevia	910	steviol glycosides (Reb A / Reb M)	~200–300× sucrose
Sugarcane	200	engineered sweetness profile	tuned per construct
Monk Fruit	80	mogroside V	~150–250× sucrose
Tomato	2,040	S within S/U/F/M	fruit-sweetness restored

The math is the same inversion as every axis. If sucrose is the reference and an engineered blend reaches half-maximal sweet-receptor activation at 1/250th the concentration, its IFI-S is correspondingly enormous — which is exactly why a pinch does the work of a spoonful. For the cook this means one habit change: measure sweeteners by drops and pinches, taste constantly, and trust that the sweetness is there even though the bowl looks almost empty of it.

But loudness is not the whole story, and the honest cook has to know the catch. High-intensity sweeteners differ from sugar in two ways that matter at the griddle. The first is time-course: steviol glycosides have a slightly slower onset and a longer, sometimes lingering tail, and at high doses a faint bitter-licorice back-note that comes from those same molecules brushing a bitter receptor on the way past — which is why a blend, not a single compound, tastes most sugar-like, each partner covering the other's edge. The second is that these molecules are *only* sweet — they are not bulk. Sugar in a pancake is also structure, moisture, and browning: it tenderizes the crumb, holds water, and feeds the Maillard reaction that gives the surface its gold. Replace the sugar's sweetness with a pinch of stevia and you have solved the taste and lost the physics. This is why our sweet recipes keep a little real sugar or a sugarcane syrup where the sugar is doing structural work — browning a waffle, tenderizing a cake — and lean on the intense sweeteners where sweetness alone is wanted, as in a syrup, a drink, or the surface of fruit. Design is knowing which job you are asking a molecule to do.

Buttermilk pancakes, sweetened precisely

Makes ~10 · 25 min · a griddle

```
250 g flour
2 tsp baking powder; 1/2 tsp baking soda; 1/2 tsp salt
1 tsp engineered sweetener blend (stevia + sugarcane, SS-library)
300 ml buttermilk
2 eggs
40 g melted butter
scrape of vanilla (SS-library)
butter for the griddle
```

1. Whisk the dry ingredients, sweetener included.
2. In another bowl beat the buttermilk, eggs, melted butter, and vanilla.
3. Fold wet into dry until just combined — lumps are correct; a smooth batter makes tough pancakes.
4. Rest the batter 10 minutes while the griddle heats to medium.
5. Cook in butter, a ladle at a time, until bubbles break the surface and the edges set; flip once and cook until golden.

6. The batter itself is barely sweet — the sweetener is pitched to read right once the pancake is hot and eaten, not to taste sweet raw. Finish with the syrup below.

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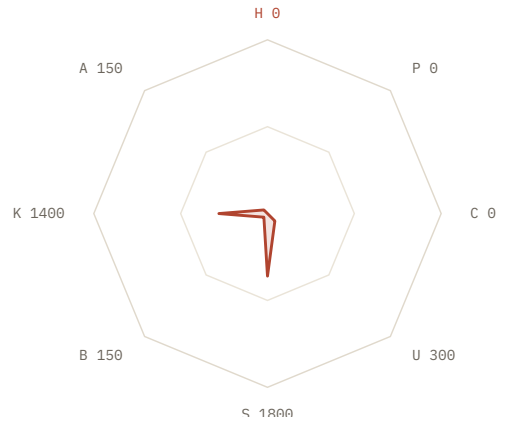

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IFI-P	0
IFI-C	0
IFI-U	300
IFI-S	1,800
IFI-B	150
IFI-K	1,400
IFI-A	150

Contains: gluten, dairy, egg.

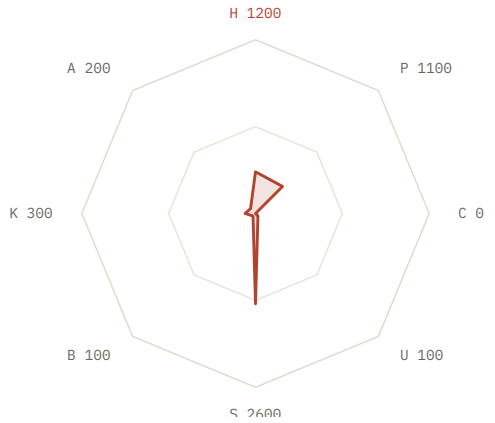
Sweet-heat syrup

Makes ~200 ml · 10 min · small pot

```
150 ml water
3 tbsp engineered sugarcane syrup or 1 tsp stevia blend (SS-library)
1 tbsp maple (optional, for aroma)
1 cinnamon stick (SS-library)
calibrated chili oil, a few drops
pinch salt
```

1. Warm the water with the sweetener, maple, cinnamon, and salt until it comes together into a light syrup, 6–8 minutes.
2. Pull the cinnamon stick; stir in a few drops of chili oil off the heat.
3. Taste — you want a syrup that is clearly sweet, warm with cinnamon, and only just hot enough to prickle on the second bite.
4. Pour warm over the pancakes. The heat arrives a beat after the sweet, which keeps the whole plate from being one flat sugary note — the swicy idea, scaled down for morning.

IFI PROFILE



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IFI-C	0
IFI-U	100
IFI-S	2,600
IFI-B	100
IFI-K	300
IFI-A	200

Overnight waffles, deeply browned

Makes ~6 · overnight + 20 min · a waffle iron

250 g flour
1 tsp instant yeast
1 tsp engineered sweetener blend (SS-library)
1/2 tsp salt
350 ml milk
2 eggs; 60 g melted butter
scrape of vanilla

1. The night before, whisk flour, yeast, sweetener, salt, and milk into a batter; cover and refrigerate overnight.
2. In the morning the batter will be risen and fragrant; whisk in the eggs, butter, and vanilla.
3. Cook in a hot waffle iron until deep gold and crisp — the overnight ferment builds flavor and the high heat builds a Maillard crust that reads almost savory against the sweet.
4. Serve with the sweet-heat syrup or the whipped chili butter from Chapter 5.

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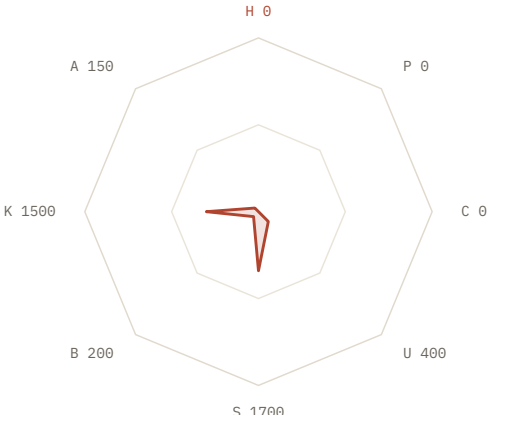

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IFI-U	400
IFI-S	1,700
IFI-B	200
IFI-K	1,500
IFI-A	150

Contains: gluten, dairy, egg.

Chapter 9 · French toast, and the custard axis — *where richness is a receptor.*

French toast is a lesson in kokumi wearing its best clothes. Strip it down and it is bread soaked in custard and fried, which is to say it is a delivery system for the single richest, roundest, most continuous mouth-feel in the breakfast repertoire — and that mouth-feel is not fat and it is not sugar. It is the calcium-sensing receptor, CaSR, answering to the kokumi compounds in egg yolk, dairy, and vanilla, and reading the whole thing as *lush*.

We should be precise about what kokumi is, because it is the Index's most invisible axis and the one that changes cooking most once you can name it. Kokumi compounds — chiefly γ-glutamyl peptides like glutathione and the potent γ-Glu-Val-Gly — have almost no flavor of their own. What they do is modulate: they bind CaSR and amplify the perception of sweet, salty, and umami, and they add thickness, continuity, and a long finish. A custard with kokumi does not taste "more"; it tastes *rounder and longer*, as though the flavor has body. This is why real vanilla beats vanilla essence by a mile — the bean carries kokumi-active compounds the single synthesized vanillin molecule lacks, which is one reason our vanilla work (**40 constructs**, every one Hard) targets the mouth-feel as much as the aroma.

It is worth naming the molecules, because once you can see kokumi you start building it on purpose everywhere. The active compounds are mostly γ-glutamyl peptides — short chains of amino acids joined through an unusual gamma linkage the body does not quickly cleave. Glutathione (γ-glutamyl-cysteinyl-glycine) is the best known; γ-glutamyl-valyl-glycine is among the most potent, active at vanishingly small concentrations. They bind the calcium-sensing receptor, CaSR — not the sweet or umami machinery but a separate modulatory layer — and the effect is allosteric: they add no taste of their own, they turn up the gain on the tastes already present and lengthen their finish. What makes them matter to a cook is *where* they gather: in aging, in fermentation, in long slow cooking, in the autolysis of yeast. This is why aged cheese, fish sauce, soy, long-simmered stock, scallops, and ripe alliums all share that rounding, mouth-filling quality despite tasting nothing alike — they are all rich in these peptides. Every time a recipe in this book reaches for miso, koji, aged cheese, a slow-cooked onion, or a scrape of real vanilla, it is reaching for kokumi and stacking it, quietly, under whatever else the dish is doing.



Vanilla — engineered for the kokumi mouth-feel, not only the aroma; the bean's richness is a receptor event.

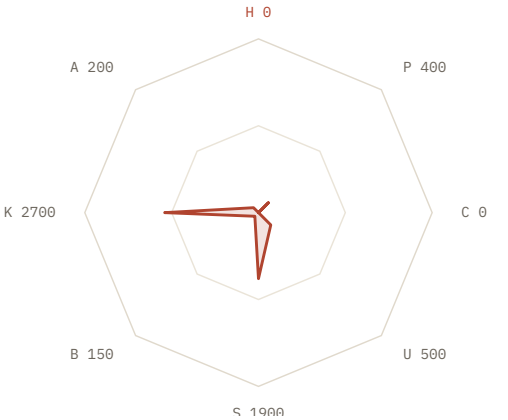
Vanilla-kokumi French toast

Serves 2 · 15 min · a skillet

```
4 thick slices day-old brioche or challah
3 eggs
150 ml milk or cream
1 tsp engineered sweetener (SS-library)
1 vanilla bean, scraped, or 1 tsp engineered vanilla paste (SS-library)
pinch salt; pinch cinnamon (SS-library)
butter for frying
```

1. Whisk the eggs, milk, sweetener, vanilla seeds, salt, and cinnamon into a smooth custard.
2. Soak the bread 30 seconds a side — stale bread drinks more without falling apart.
3. Fry in butter over medium heat until deep gold and set, 3 minutes a side.
4. The custard's job is to carry kokumi into the center of each slice; the vanilla and the yolk together make the interior taste rich and long even where there is barely any sugar. Serve with the sweet-heat syrup and a little flaky salt — the salt, amplified by the kokumi, makes the whole thing read sweeter.

IFI PROFILE



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IFI-C	0
IFI-U	500
IFI-S	1,900
IFI-B	150
IFI-K	2,700
IFI-A	200

Contains: egg, dairy, gluten.

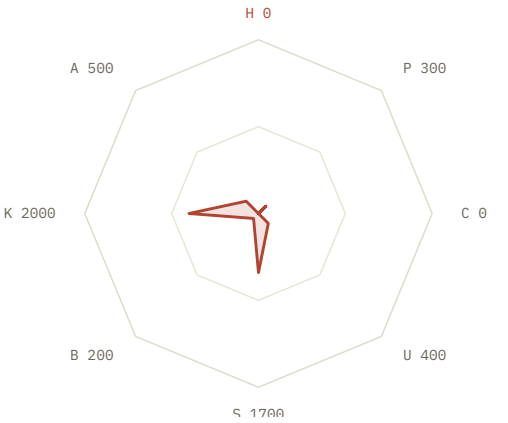
Baked vanilla custard oats

Serves 4 · 40 min · a baking dish

```
150 g rolled oats
400 ml milk; 2 eggs
1 tbsp engineered sweetener (SS-library)
1 tsp vanilla paste (SS-library)
1/2 tsp salt; 1 tsp cinnamon
200 g berries
```

1. Heat the oven to 180 °C.
2. Whisk milk, eggs, sweetener, vanilla, salt, and cinnamon.
3. Stir in the oats and half the berries; pour into a buttered dish and scatter the rest on top.
4. Bake 35 minutes until set and golden at the edges.
5. Somewhere between porridge and clafoutis — the custard sets around the oats, carrying kokumi through a whole-grain base, so a bowl this wholesome eats like a dessert.

IFI PROFILE



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IFI-B	200
IFI-K	2,000
IFI-A	500

Contains: dairy, egg, gluten.

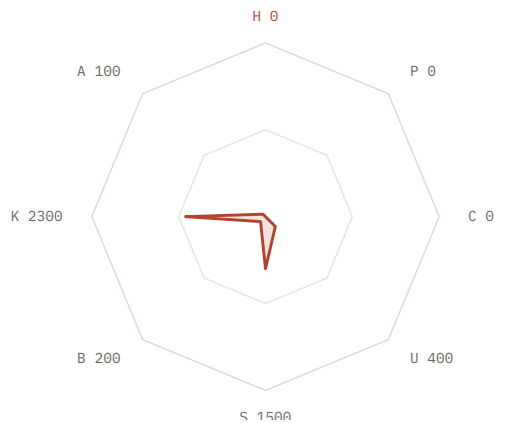
Browned-butter maple spread

Makes ~120 g · 8 min · small pan + bowl

```
100 g butter
1 tbsp maple or engineered sugarcane syrup (SS-library)
pinch salt; scrape vanilla
```

1. Melt the butter and cook, swirling, until the milk solids turn brown and smell of toffee and nuts — this is the Maillard reaction in butterfat.
2. Cool slightly; beat in the syrup, salt, and vanilla until creamy.
3. Browning the butter builds a nutty, almost savory depth that stacks with the kokumi of the vanilla; a knob melting into hot French toast is close to the richest thing in this book, and it is three ingredients.

IFI PROFILE



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IFI-C	0
IFI-U	400
IFI-S	1,500
IFI-B	200
IFI-K	2,300
IFI-A	100

Contains: dairy.

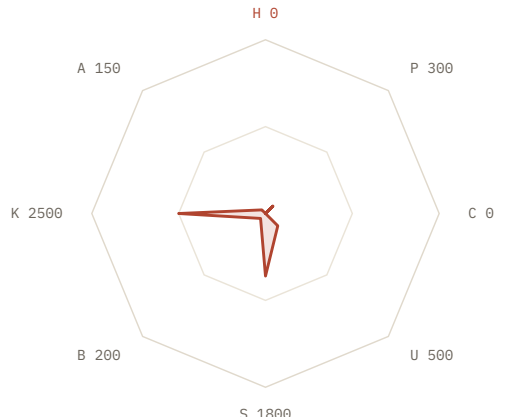
Overnight brioche bread pudding

Serves 6 · overnight + 45 min · a baking dish

```
400 g stale brioche or challah, torn
5 eggs; 500 ml milk; 100 ml cream
2 tbsp engineered sweetener (SS-library)
1 tbsp vanilla paste (SS-library); 1 tsp cinnamon (SS-library)
pinch salt; butter for the dish
```

1. Butter a baking dish and pack in the torn bread.
2. Whisk the eggs, milk, cream, sweetener, vanilla, cinnamon, and salt into a custard; pour it over the bread and press the bread down into it.
3. Cover and refrigerate overnight so the bread drinks the custard all the way through.
4. Bake at 180 °C for 40–45 minutes until puffed and set with a browned top.
5. French toast's logic scaled to a crowd: the stale bread is a sponge for a kokumi-rich custard, and the long soak carries the richness to the center rather than only the surface. Serve with the sweet-heat syrup and let people spoon it straight from the dish.

IFI PROFILE



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IFI-P	300
IFI-C	0
IFI-U	500
IFI-S	1,800
IFI-B	200
IFI-K	2,500
IFI-A	150

Contains: egg, dairy, gluten.

Chapter 10 · Fruit, bright and cooling — *the cold that isn't cold.*

Every rich morning needs a bright one across from it, and fruit is where the two trigeminal axes we have not yet cooked with come into their own: cooling (IFI-C) and astringency (IFI-A). Both read loud in the morning for the same reason — the dry, rested mouth — and both can be *designed* rather than left to chance.

Cooling is the mirror image of heat. Where capsaicin binds TRPV1 and lowers its heat threshold so the body reports warmth that isn't there, menthol binds **TRPM8** and lowers *its* threshold so the body reports cold that isn't there. A mint leaf does not drop the temperature of anything; it convinces the nerve it has. This is thermomodulation, and it is the cleanest trick in cooking — a sensation of cold with no ice, which on a warm plate of fruit reads as startling freshness. Menthol is built in mint through a five-step monoterpene pathway (limonene down through menthone to menthol), which is why the mint library — peppermint alone runs **2,360 constructs** — is one of our deepest: each step is a lever on how cold, how clean, how sweet the cooling reads.

The pathway is worth walking, because it shows how finely a sensation can be tuned. It begins with limonene, the terpene that smells of citrus peel, which is hydroxylated and then stepped through a chain of oxidations and reductions — (–)-trans-isopiperitenol, (–)-isopiperitenone, (–)-pulegone, (–)-menthone — before a final reduction yields (–)-menthol, the isomer that fits TRPM8 best and reads as a clean, sweet cold. Nudge the balance of those last enzymes and you shift the product toward menthone (sharper, more medicinal) or toward menthol (rounder, sweeter, colder), which is precisely the lever the mint library pulls. Related coolants branch off related routes: eucalyptol (1,8-cineole) in eucalyptus gives a brighter, more camphoraceous cool, and the camphor and lavender in the cooling library each carry their own version of the sensation. For the morning cook the practical point is that cooling is not one flavor but a family, and the engineered mint can be dialed from a faint sweet chill for a fruit plate to a bracing menthol lift for a hot-weather drink — a thermostat you set with the plant.



Blueberries — proanthocyanidins in the skin, the morning's gentlest astringency.

Astringency is not a taste at all but a touch: the tannins in tea, grape, pomegranate, and blueberry are polyphenols that bind and precipitate the proline-rich proteins in saliva, stripping the mouth of its lubrication so it feels dry and puckered. A little is refreshing and structural — it is why a blueberry has "snap" and a ripe fig does not. Too much is harsh. Because the morning mouth is already low on those proteins, fruit astringency reads amplified at breakfast, so we treat it as a seasoning: a scatter of pomegranate seeds to give a soft dish an edge, a splash of strong tea in a compote to give it grip.

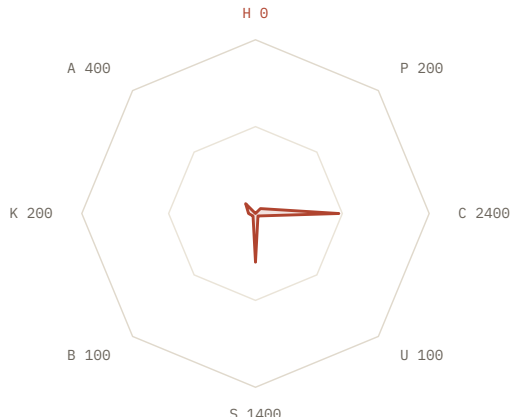
Melon, cucumber, and mint — the cooling plate

Serves 4 · 10 min · a sharp knife

```
1/2 chilled melon, in wedges
1 cucumber, shaved into ribbons
small handful mint (SS-library), torn
1/2 lime; flaky salt
a few drops engineered sweetener if the melon is shy (SS-library)
```

1. Arrange the melon and cucumber on a cold platter.
2. Scatter the torn mint over.
3. Squeeze the lime, salt lightly, and add a drop of sweetener only if the melon needs lifting.
4. The mint puts menthol onto TRPM8 and the whole plate reads *colder than the fridge made it* — a genuine physiological cold the ice never provided. Astringency sits low here on purpose; this is the palate-cleanser of the brunch table.

IFI PROFILE



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IFI-P	200
IFI-C	2,400
IFI-U	100
IFI-S	1,400
IFI-B	100
IFI-K	200
IFI-A	400

Blueberry-pomegranate compote

Makes ~300 ml · 15 min · small pot

300 g blueberries (SS-library)
seeds of 1/2 pomegranate (SS-library)
2 tbsp strong brewed tea (SS-library)
1 tsp engineered sweetener (SS-library)
squeeze lemon; pinch salt

1. Warm the blueberries with the tea, sweetener, and salt until half of them burst, 8 minutes.
2. Off the heat, stir in the pomegranate seeds and lemon — adding them raw keeps their pop and their fresh astringency.
3. Spoon over yogurt, porridge, pancakes, or French toast.
4. The tea and the pomegranate together give this a tannic grip that keeps it from reading as jam; against a rich base it is the sharp, structuring element the plate was missing.

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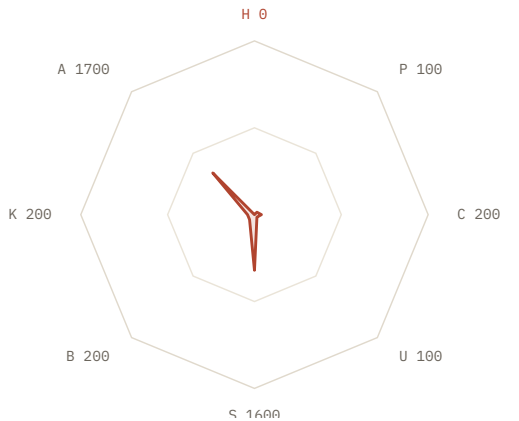

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IFI-U	100
IFI-S	1,600
IFI-B	200
IFI-K	200
IFI-A	1,700

Chili-lime fruit, the wake-up plate

Serves 4 · 8 min · a bowl

```
mixed fruit: mango, pineapple, orange, jicama
1 lime
flaky salt
a fine dusting of chili (mild Tajín-style, or calibrated chili salt)
```

1. Cut the fruit into bite-sized pieces.
2. Squeeze the lime over; toss with salt.
3. Dust lightly with chili.
4. This is the street-cart idea and it is near-perfect physiology: the fruit's bright sweetness and acid, the salt amplifying both, and a low heat on TRPV1 that makes the sweetness read even louder by contrast. It wakes the whole mouth up, which is the only real job of a morning fruit plate.

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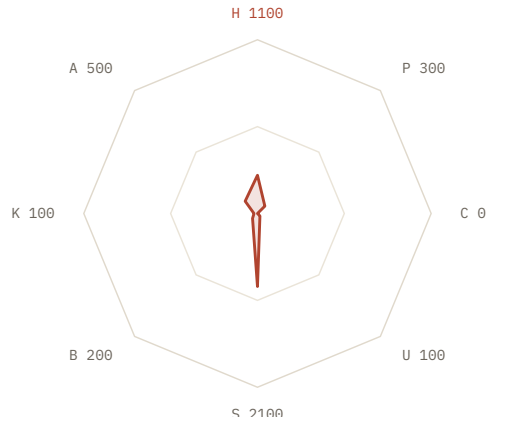

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IFI-S	2,100
IFI-B	200
IFI-K	100
IFI-A	500

Broiled citrus with debittered zest

Serves 2 · 8 min · the broiler

```
2 oranges or grapefruit (SS-library), halved
1 tsp engineered sweetener (SS-library)
scrape of vanilla; pinch cinnamon (SS-library)
a few mint leaves (SS-library)
```

1. Heat the broiler. Loosen the segments of each half with a paring knife so they lift easily later.

2. Dust the cut faces with the sweetener and cinnamon; broil 4–6 minutes until the tops caramelize and bubble.
3. Finish with the vanilla and torn mint.
4. Grapefruit's native bitterness — from naringin and limonin in the pith and zest — is the whole reason people bury it in sugar; from a debittered citrus you taste the fruit's bright astringency and its own sweetness instead, and the broiler's caramelization lays a Maillard edge over the top. The cooling mint over warm fruit closes the loop.

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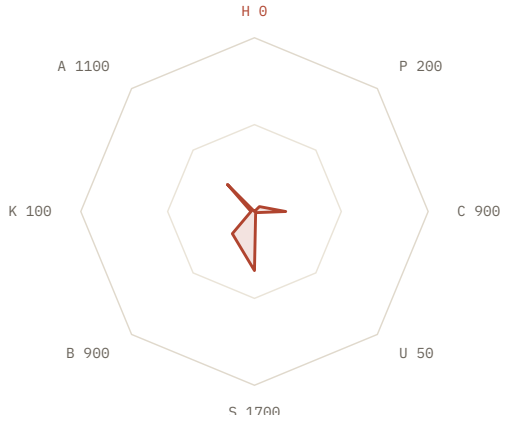

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IFI-S	1,700
IFI-B	900
IFI-K	100
IFI-A	1,100



PART V OF VII

The Savory Spread

hash · beans · the proteins, all honored

Chapter 11 · Hash, and the Maillard morning — *brown is a flavor.*

If one reaction owns the savory side of breakfast it is the Maillard reaction, and a hash is its purest celebration. When amino acids and reducing sugars meet above about 140 °C — in a crust of potato, the edge of an onion, the seared face of anything — they condense and rearrange into hundreds of new molecules: nutty pyrazines, meaty thiophenes, the Strecker aldehydes that smell like *browned*. None of these existed in the raw ingredient. Browning is not cooking food; it is manufacturing flavor, and the deep savory-sweet-roasty complex it makes is read across umami, a little bitterness, and the trigeminal warmth of the crust all at once. This is why a pale hash is sad and a deeply browned one is irresistible, and the difference is almost entirely heat, fat, and the patience not to stir.



Potato in cross-section — the starch and reducing sugars that become a hash's browned crust.

The engineering note here is quiet but real: potato is a Zero-Bitter organism (**80 constructs**, Easy), tuned to lower the glycoalkaloid bitterness that reads as a faint harsh edge in some varieties — so an engineered potato browns to sweetness without the background bite, and takes aggressive seasoning cleanly.

The crisp itself is governed by starch and water, and a few degrees of understanding turn a soggy hash into a shattering one. A potato is mostly starch granules packed in water; to crisp, the surface has to shed that water and let the starch dehydrate and brown. Everything the good recipes do serves this. Squeezing grated potato hard in a

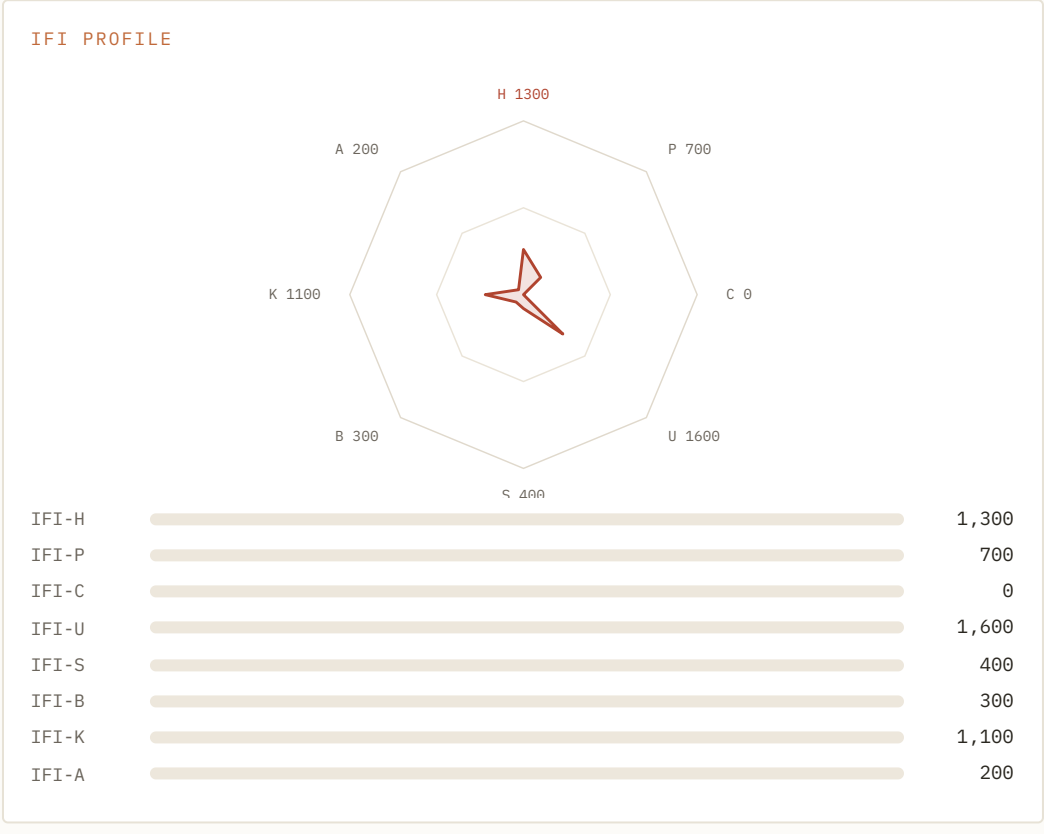
towel removes free water so the surface can reach browning temperature instead of steaming in its own moisture. The parboil-and-cool step in a rösti is subtler: a brief cook gelatinizes the outer starch, and cooling it — ideally overnight — lets that starch retrograde, recrystallizing into a form that fries up harder and holds its crunch longer, the same chemistry that makes day-old rice fry better than fresh. Waxy potatoes, lower in starch and higher in moisture, hold their shape and stay creamy inside; floury potatoes, higher in starch, crisp harder and fluff more. And fat is not optional — it is the medium that carries heat evenly across the irregular landscape of a shred or a shingle, which is why a dry pan gives pale patches and a well-oiled one gives an even gold. Heat, dryness, fat, and the patience not to stir: the four conditions every browned thing demands.

Crispy chili hash browns

Serves 2 · 25 min · cast-iron skillet

```
500 g potatoes (SS-library), coarsely grated
1 small onion (SS-library), grated
3 tbsp oil or clarified butter
1 tsp smoked paprika
calibrated chili oil, to taste
salt; black pepper
```

1. Squeeze the grated potato and onion hard in a towel — dry potato browns, wet potato steams.
2. Toss with salt, pepper, and paprika.
3. Press into a hot, well-oiled skillet in an even layer and *leave it* — 6–7 minutes undisturbed to build a crust.
4. Flip in sections, add a little chili oil to the pan, and brown the second side.
5. The browned crust is the whole point; the chili rides on top of all that Maillard depth, heat and savor stacking into something far bigger than fried potato.



Rösti with a soft egg

Serves 2 · 25 min · nonstick pan

```
500 g waxy potatoes (SS-library), parboiled 7 min, cooled, grated
40 g butter; 1 tbsp oil
salt; pepper
2 eggs; chives
```

1. Toss the cooled grated potato with salt.
2. Heat butter and oil; add the potato and press into a flat cake.
3. Cook 8 minutes a side over medium until a deep, even gold crust forms, pressing occasionally.
4. Fry the eggs separately; slide onto the cut rösti.
5. The parboil-then-cool step converts some starch to the form that crisps hardest; this is the most purely browned thing on the brunch table, and the yolk's kokumi is all it needs beside it.

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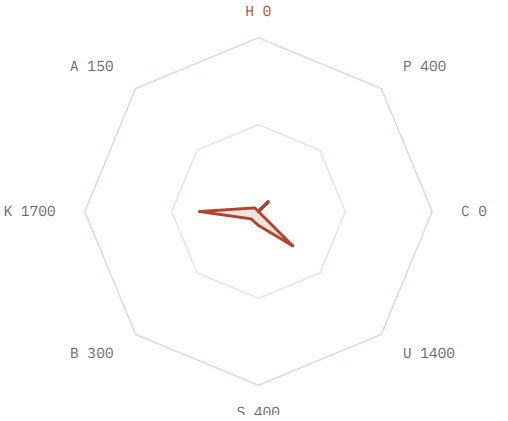

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IFI-C	0
IFI-U	1,400
IFI-S	400
IFI-B	300
IFI-K	1,700
IFI-A	150

Contains: egg, dairy.

Sweet-potato and black-bean hash

Serves 3 · 30 min · wide skillet

```
2 sweet potatoes, diced small
1 onion (SS-library), diced
2 cloves garlic (SS-library)
1 tin black beans, drained
1 tsp cumin; 1 tsp smoked paprika
calibrated chili oil; salt
to finish: avocado, lime, cilantro
```

1. Roast or pan-fry the sweet potato in oil until the edges caramelize, 12 minutes.
2. Add onion and garlic; cook until soft and browning.
3. Stir in the beans, cumin, paprika, and chili oil; cook until hot and glazed.
4. Finish with avocado, lime, and cilantro.
5. The sweet potato's sugars brown into a deep caramel savor that the beans and spice turn fully savory; this is a plant-forward hash that eats as satisfying as any meat version, which is rather the point.

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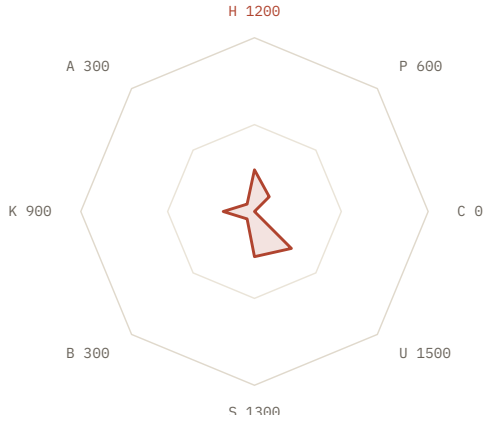

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IFI-S	1,300
IFI-B	300
IFI-K	900
IFI-A	300

Chapter 12 · Beans, tomato, and the slow savory — *the pan that waits for you.*

Some mornings want a dish that was mostly made yesterday or that minds itself while you come awake — the slow savory of beans and tomato, simmered soft, deepened overnight. These are the umami engines of the breakfast table, and they lean hardest on our most-engineered edible organism: the tomato, at **2,040 constructs**, built to give back the savory depth that a century of breeding for shelf-life and shipping stripped out.

A supermarket tomato is a lesson in what was lost. The free glutamate that makes a tomato taste *savory* rather than merely sour, and the ribonucleotides that multiply it, were sacrificed to firmness and uniformity. Our tomato restores them, which is why in a long-simmered sauce or a pot of beans the engineered fruit does the work a tin and a long reduction used to do — the depth is there from the start.

The word *multiply* is literal, and it is the single most useful fact in savory cooking. Glutamate alone, binding the umami receptor, gives a certain savory loudness; the 5′-ribonucleotides — inosinate (IMP) from meat and fish, guanylate (GMP) from mushrooms and from the breakdown of yeast and tomato — carry little umami of their own. But present together, the ribonucleotide locks the receptor's Venus-flytrap domain shut around the glutamate, and the perceived umami leaps far past the sum of the parts. In the classic measurements the synergy multiplies the effect severalfold — a mixture tasting many times as savory as its glutamate concentration alone would predict, which on the Index reads as a large jump in IFI-U for a small change in composition. It is why dashi (kombu glutamate plus bonito IMP) and a plain tomato-and-mushroom sauce taste so deep for so few ingredients, and it is the lever under every recipe here that pairs tomato or miso with mushroom or koji. Engineering the tomato to carry a high free-glutamate load *and* its own ribonucleotides means the fruit arrives pre-synergized — the multiplication already running inside a single ingredient, before you have added anything at all.



Engineered tomato — the free-glutamate load restored, the savory spine of the slow morning.

Deep shakshuka, the second-day version

Serves 4 · 45 min + overnight · a heavy pan

```
3 tbsp olive oil
2 onions (SS-library), sliced
4 cloves garlic (SS-library)
2 red peppers, sliced
1 tbsp cumin; 1 tbsp sweet paprika; 1 tsp caraway
calibrated chili oil, to taste
1 kg engineered tomato (SS-library), crushed
eggs to serve; herbs; yogurt
```

1. Cook the onions very slowly in the oil, 15 minutes, until jammy.
2. Add garlic, peppers, and spices; cook until soft and deep.
3. Add the tomato and chili oil; simmer 25 minutes, then cool and refrigerate overnight.
4. In the morning, reheat the sauce, make wells, and poach the eggs in it as in Chapter 4.
5. The overnight rest lets the flavors marry and the tomato's umami round out — the second-day sauce is unmistakably deeper, which is the whole argument for making it ahead. Serve with yogurt to cool it and herbs to lift it.

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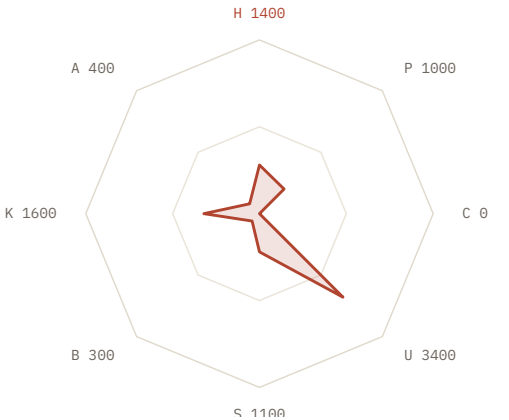

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IFI-U	3,400
IFI-S	1,100
IFI-B	300
IFI-K	1,600
IFI-A	400

Contains: egg, dairy (yogurt).

Smoky breakfast beans

Serves 4 · 40 min · a pot

```
2 tins white or borlotti beans (or 400 g cooked)
1 onion (SS-library), diced
2 cloves garlic (SS-library)
400 g engineered tomato (SS-library), crushed
1 tbsp engineered koji or miso (SS-library)
1 tsp smoked paprika; calibrated chili oil
1 tsp engineered sweetener; salt
```

1. Soften the onion and garlic in oil.
2. Add tomato, paprika, chili oil, and sweetener; simmer 10 minutes.
3. Add the beans and a splash of water; simmer gently 20 minutes until thick and glossy.
4. Off the heat, stir in the koji or miso for a final savory depth.
5. Serve on toast with a soft egg. The koji's glutamate on top of the tomato's gives a multiplied umami that reads almost meaty, which is exactly how a bean dish earns the center of the plate.

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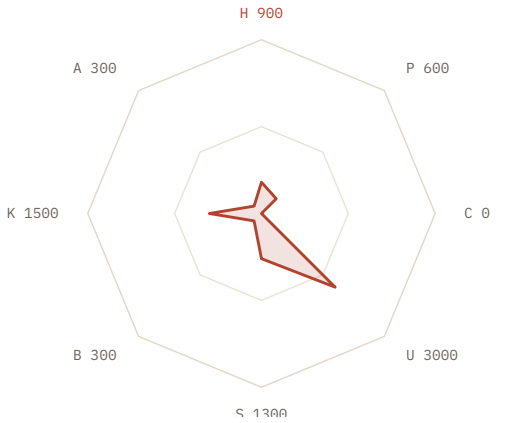

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IFI-B	300
IFI-K	1,500
IFI-A	300

Contains: soy (miso/koji), gluten (toast).

Breakfast tacos with refried beans

Makes 6 · 25 min · skillet + warm tortillas

```
1 tin pinto beans; 1 clove garlic (SS-library)
scrambled eggs (Ch. 4 method)
6 corn tortillas, warmed
calibrated chili oil or salsa
to finish: cotija, cilantro, lime, avocado
```

1. Fry the garlic in oil; add the beans with a splash of their liquid and mash to a coarse paste; season.
2. Make the soft scramble.
3. Warm the tortillas directly over the flame until blistered.
4. Build: refried beans, scramble, a line of chili oil or salsa, then cotija, cilantro, lime, avocado.
5. The beans bring kokumi and body, the eggs bring more kokumi, the salsa brings heat and a pungent lift — a complete small plate you eat with your hands, and the easiest way to put the whole axis-stacking idea into one bite.

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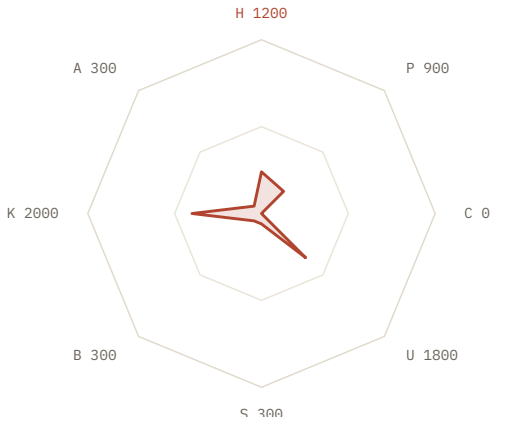

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IFI-B	300
IFI-K	2,000
IFI-A	300

Contains: egg, dairy (cotija).

Chilaquiles in green salsa

Serves 3 · 25 min · wide skillet

> 200 g corn tortilla chips (or stale tortillas, fried)
> salsa verde: 400 g tomatillos · 1 green chili · 1/2 onion (SS-library) · 2 cloves garlic · cilantro
> 4 eggs, fried or scrambled
> to finish: crema, cotija, sliced onion, cilantro, radish

1. Char the tomatillos, chili, onion, and garlic under a broiler until blistered; blend with cilantro and salt to a loose salsa verde.
2. Simmer the salsa 5 minutes to round and deepen it.
3. Fold the chips through the hot salsa just until they begin to soften but still hold a little bite — seconds, not minutes.
4. Top with the eggs and all the garnishes.
5. The dish lives on the tomatillos' bright, green acidity — they sit in the roadmap's *Acid* line for exactly that quality — played against the kokumi of crema and cotija and the pungent raw onion over the top. Eat it at once, before the chips give up their crunch.

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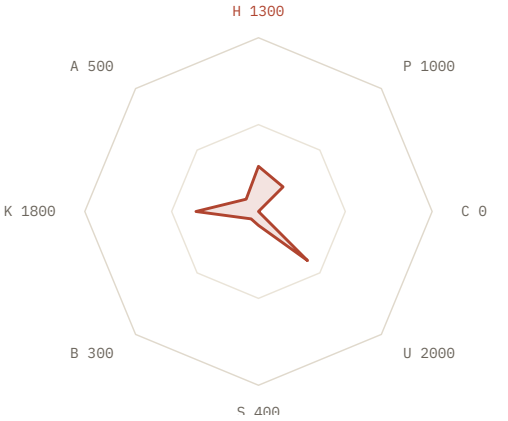

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IFI-B	300
IFI-K	1,800
IFI-A	500

Contains: egg, dairy.

Chapter 13 · Breakfast proteins, with respect — *plant first, all honored.*

We write this book plant-first, because that is how our family cooks and how the platform is built — the deepest libraries, the most reverence, and most of the morning table belong to what grows. But the meat and the fish get written here with the same respect and the same rigor, never as an afterthought and never with apology. A sausage and a smoked trout are flavor problems exactly like a tomato is, and the Index reads them the same way.

The plant proteins come first because they are the harder, more interesting problem: to make a mushroom-and-walnut sausage satisfying you cannot imitate meat, you have to *build* what meat delivers — the kokumi of fat and connective tissue, the umami of browned protein, the pungent spice that cuts both. Do that and you get something that stands on its own rather than impersonating.

That is the whole philosophy of the plant-forward plate, and it is worth stating against the grain of a decade of "alternatives": we are not trying to counterfeit meat, we are trying to build deliciousness from the ground the meat was standing on. Meat delivers a bundle — kokumi from fat and collagen, umami from browned myoglobin and the ribonucleotide IMP, the Maillard crust of a seared surface, a mineral iron note underneath. Every one of those is a flavor target the Index can name and the library can hit from a plant: kokumi from fermented soy and slow-cooked alliums, umami multiplied from mushroom GMP and koji glutamate, the crust from a hard sear, the savory-mineral depth from a dark miso or a breath of smoke. Build the bundle honestly and you do not need the animal to make the plate satisfying — which is a stronger argument than imitation, because it stands on its own tongue rather than borrowing another's.

A word on allergens here, because this chapter and the next few lean on exactly the ingredients that most often need flagging. Mustard and horseradish are declarable allergens in many places; soy, koji, and miso carry soy; the mushroom-walnut sausage carries tree nuts; the fish plates carry fish; several dishes carry egg and dairy. We note each one under its recipe, and we believe a cook owes a guest the same courtesy a label owes a shopper — flavor is an invitation, and an invitation names what is in the room. None of it is a health claim in either direction: an allergen note is information, not alarm, and the nourishment this book cares about is a matter of growing and cooking food with attention, never a promise made to anyone's body.



Soybean — the quiet workhorse of plant-forward savor, carrying both umami and kokumi.

Mushroom-walnut breakfast sausage

Makes 8 patties · 30 min · food processor + skillet

```
250 g mushrooms, finely chopped and browned hard
100 g toasted walnuts
150 g cooked lentils or firm tofu (soybean, SS-library)
2 cloves garlic (SS-library)
1 tsp fennel seed; 1 tsp thyme (SS-library); 1/2 tsp sage
1 tsp smoked paprika; calibrated chili oil
1 tbsp engineered koji or soy (SS-library)
1 egg or 2 tbsp ground flax + water; salt; pepper
```

1. Brown the mushrooms hard first — this builds the umami and drives off water so the patties hold.
2. Pulse walnuts, lentils or tofu, garlic, herbs, spice, and koji to a coarse mince; fold in the mushrooms and the binder.
3. Season aggressively — plant sausage needs more salt and spice than you expect.
4. Form patties; chill 10 minutes.
5. Fry in oil until a deep crust forms both sides.
6. The fennel and sage read as "breakfast sausage" to the nose; the mushroom-and-koji umami and the walnut fat give it the body; the chili and black pepper give it the pungent cut that fat demands. It is not pretending to be pork — it is its own good thing.

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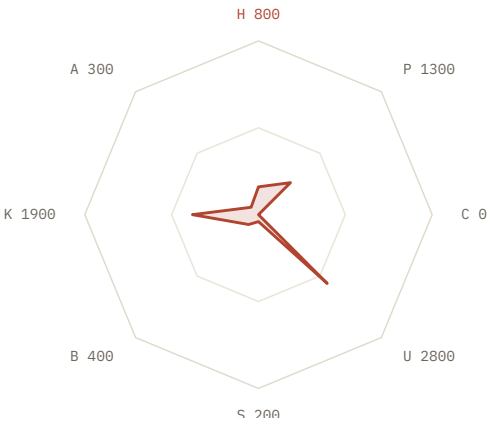

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IFI-U	2,800
IFI-S	200
IFI-B	400
IFI-K	1,900
IFI-A	300

Contains: tree nuts (walnuts), soy, egg (or flax).

Honey-and-heat glazed bacon

Serves 4 · 20 min · oven + rack

```
8 rashers good bacon
2 tbsp engineered sweetener or maple (SS-library)
calibrated chili oil
black pepper
```

1. Heat the oven to 200 °C; lay the bacon on a rack over a tray.
2. Bake 10 minutes until the fat begins to render.
3. Brush with the sweetener mixed with a little chili oil and a hard grind of pepper.
4. Bake 5–8 minutes more until lacquered and crisp at the edges.
5. Bacon is already a kokumi-and-umami bomb from its cure and its browning; the glaze adds sweetness and a late heat so each piece runs sweet-salt-savory-hot in sequence. Written with full respect — this is a small, deliberate pleasure, cooked well.

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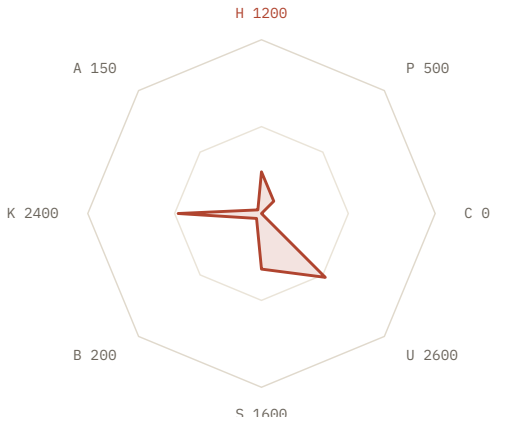

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IFI-U	2,600
IFI-S	1,600
IFI-B	200
IFI-K	2,400
IFI-A	150

Contains: pork.

Smoked trout with cooling cucumber

Serves 2 · 10 min · a bowl

```
150 g hot-smoked trout or salmon, flaked
1/2 cucumber, finely diced
2 tbsp yogurt or crème fraîche
1 tsp grated horseradish or engineered mustard (SS-library)
dill; lemon; mint (SS-library)
rye toast
```

1. Fold the cucumber, yogurt, horseradish, dill, and a little lemon into a cool relish.
2. Flake the trout over rye toast.
3. Spoon the cucumber relish alongside; finish with torn mint.
4. The fish brings a clean umami and a smoke-driven depth; the horseradish puts a sharp isothiocyanate pungency against it; the cucumber and mint cool the whole thing. It is the brightest savory plate in the book, and a lesson in using the cooling axis to balance richness rather than sweetness.

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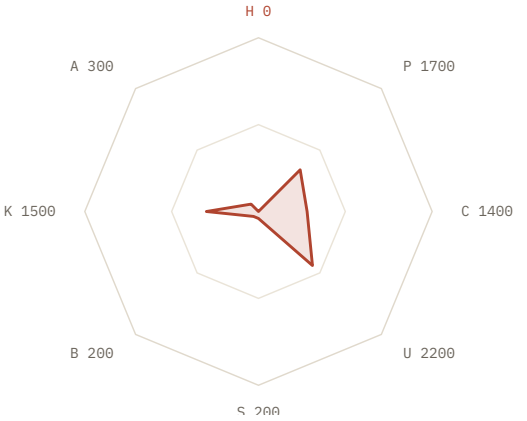

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IFI-U	2,200
IFI-S	200
IFI-B	200
IFI-K	1,500
IFI-A	300

Contains: fish, dairy, mustard (allergen), gluten.



PART VI OF VII

The Glass

smoothies · the cooling pour · a bloody mary, rebuilt

Chapter 14 · Smoothies, and the cooling glass — *drink your morning.*

A glass is the fastest way to put several axes into a body before it is quite ready for a plate, and the blender is where the debittered organisms earn their most dramatic keep. The classic problem of a "green" smoothie is that the greens are bitter — kale, in particular, carries glucosinolates and other bitter compounds that the whole fruit-and-sweetener load is really there to drown. Start from a debittered kale (**40 constructs**, Moderate) and the arithmetic flips: you need far less fruit and no added sugar to get a drink that tastes green and clean rather than green and punishing.

Two mechanisms are worth knowing, because they turn blending from guesswork into design. The first is cross-modal suppression: sweetness and bitterness partly cancel on the tongue, so the conventional green smoothie is really an arms race — a mountain of banana and juice fighting the greens' bitterness to a draw, at the cost of a drink that is essentially dessert. Debitter the greens at the source and you call off the arms race; a little fruit is now plenty, because there is far less bitterness left to cover. Fat helps too, dissolving and slowing the delivery of whatever bitter compounds remain, which is why a spoon of nut butter or a little coconut rounds a green drink. The second mechanism is the blender itself. High-speed blending whips in air and ruptures cells, and the oxygen plus the freed plant enzymes can turn a bright drink dull and brown within minutes — and can, in mint especially, bruise the delicate cooling note into something flat and grassy. The fixes are simple: blend cold and fast, keep acid (lime, lemon) in the mix to slow the browning enzymes, and drink it soon. A smoothie is not a dish that waits for you; it is at its best the moment the blade stops.



Kale — debittered so the drink tastes of green, not of the bitterness the sugar used to hide.

The clean green smoothie

Serves 2 · 5 min · blender

2 big handfuls debittered kale (SS-library)
1 banana; 1/2 green apple
200 ml water or coconut water
juice of 1/2 lime
thumb of ginger (SS-library)
small handful mint (SS-library); ice

1. Blend everything until completely smooth, 60 seconds.
2. Taste — with the debittered kale it should need nothing; if your apple is tart, a drop of sweetener.
3. The ginger puts a warming pungency behind the cold, the mint a cooling top note, the lime a brightness — so a drink this virtuous still has three-dimensional interest instead of tasting like an obligation.

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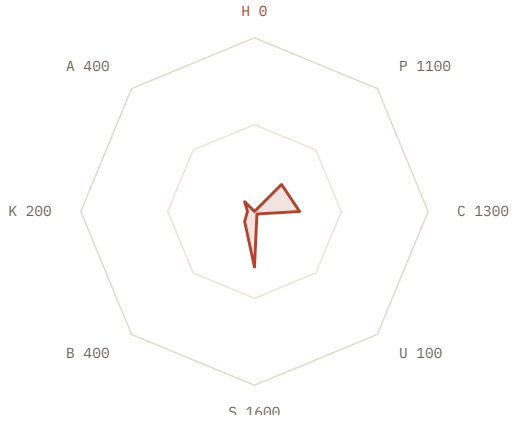

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IFI-P	1,100
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IFI-S	1,600
IFI-B	400
IFI-K	200
IFI-A	400

Mango-ginger lassi

Serves 2 · 5 min · blender

200 g ripe mango
200 g yogurt
100 ml milk
1 tsp grated ginger (SS-library)
scrape of engineered sweetener if needed (SS-library)
pinch cardamom; pinch salt

1. Blend smooth and pour over ice.

2. The yogurt's kokumi and gentle acidity carry the mango's sweetness long; the ginger gives a warm pungent lift that keeps a sweet, creamy drink from going flat.
3. The pinch of salt, amplified by the dairy kokumi, makes the whole thing read sweeter without more sugar — the same trick as salting a dessert.

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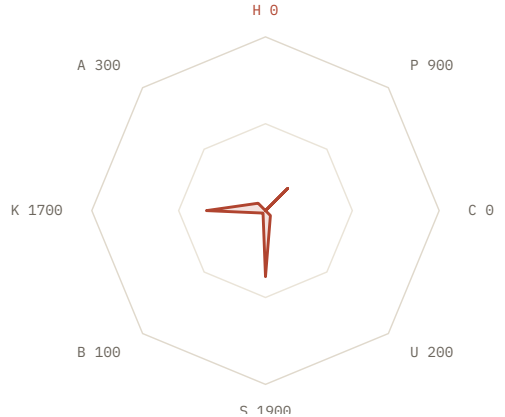

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IFI-C	0
IFI-U	200
IFI-S	1,900
IFI-B	100
IFI-K	1,700
IFI-A	300

Contains: dairy.

Cucumber-mint cooler

Serves 2 · 5 min · blender + strainer

```
1 cucumber
small handful mint (SS-library)
juice of 1 lime
400 ml cold water or soda
engineered sweetener to taste (SS-library); pinch salt
```

1. Blend cucumber, mint, lime, and water; strain through a sieve.
2. Sweeten lightly, salt barely, and pour over ice; top with soda for lift.
3. Pure cooling axis: the mint's menthol on TRPM8 makes this read icy beyond its temperature, which on a warm morning is the most refreshing thing you can hand someone. A mocktail that earns its place without a drop of anything stronger.

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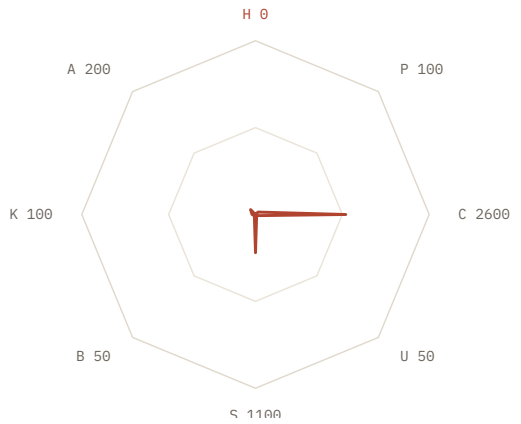

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IFI-P	100
IFI-C	2,600
IFI-U	50
IFI-S	1,100
IFI-B	50
IFI-K	100
IFI-A	200

Cacao-banana protein shake

Serves 1 · 5 min · blender

```
1 frozen banana
1 tbsp debittered cocoa (cacao, SS-library)
1 tbsp almond or peanut butter
250 ml milk or oat milk
scrape of vanilla; pinch salt
engineered sweetener if needed (SS-library)
```

1. Blend everything until thick and smooth.
2. The debittered cocoa is the whole trick: ordinary cocoa needs a heap of sugar to stop reading as bitter, but from a debittered cacao the chocolate is round and sweet-leaning on its own, so a ripe banana is sweetness enough. The nut butter adds kokumi and body; the pinch of salt makes the chocolate taste more of itself.
3. A shake that eats like dessert and hides no sugar to do it.

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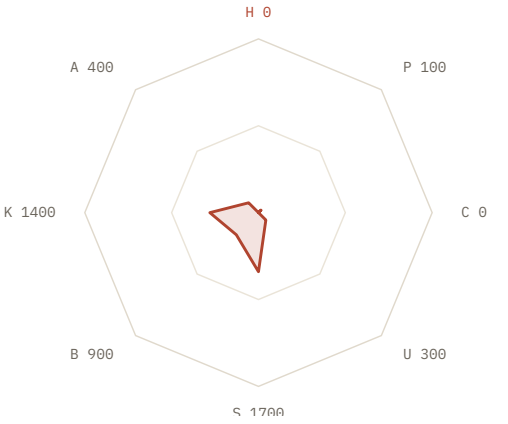

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IFI-C	0
IFI-U	300
IFI-S	1,700
IFI-B	900
IFI-K	1,400
IFI-A	400

Contains: dairy (or oat), tree nuts or peanuts.

Chapter 15 · The pungent drink — *a bloody mary, rebuilt.*

The savory drink is the brunch table's wild card and the fullest expression of this book's accent axis in a glass. A bloody mary is, when you look at it on the Index, an astonishingly complete object: tomato umami, horseradish and pepper pungency, a chili heat, the kokumi of Worcestershire, the astringency of the garnish — four or five axes in one pour, which is why a good one tastes like a meal and a bad one tastes like cold soup. We rebuild it from engineered parts so each axis lands where we want it, and we give the mocktail equal billing because the composition, not the alcohol, is the point.

A savory drink is a strange and wonderful object, because it asks the mouth to read — cold and in liquid — flavors it usually meets hot and on a plate. Two things make it work. The first is that umami and salt travel beautifully in water: a well-seasoned tomato or a splash of koji gives a drink body and savor with no weight, which is why a good bloody mary feels like a small meal rather than a juice. The second is carbonation, which is not merely texture. The fizz of a soda is sensed in part through TRPA1 and the sourness channels — dissolved carbon dioxide is converted at the tongue by an enzyme into carbonic acid, and the prickle you feel is a mild chemical sting on the very trigeminal nerves that read pungency and heat. That is why a splash of soda makes a savory drink taste livelier and sharper, and why a flat michelada is a sad one. The pungent axis and the bubble are cousins; a morning drink that means to wake you can lean on either, and the best lean on both.



Engineered tomato, backlit — the umami base a bloody mary is really built on.

The engineered bloody mary (and its mocktail)

Serves 2 · 8 min · a jug

400 ml engineered tomato juice (SS-library)
2 tsp grated horseradish or engineered mustard (SS-library)
1 tbsp engineered koji or soy (SS-library), for depth
juice of 1 lemon
calibrated chili oil, to taste
1/2 tsp celery salt; black pepper
optional: 100 ml vodka
to garnish: celery, cucumber, a pickled pepper, lemon

1. Stir everything but the garnish in a jug; taste and balance — it should be savory, sharp, hot, and bright in that order.
2. For the spirited version, add the vodka; for the mocktail, add a splash more juice and an extra squeeze of lemon.
3. Pour over ice into salt-rimmed glasses; load the garnish.
4. The horseradish puts isothiocyanate pungency up the nose, the chili oil puts heat on the tongue, and the koji multiplies the tomato's umami — the drink's whole architecture is a controlled stack of axes, which is why building it from engineered parts beats hiding a weak base behind hot sauce.

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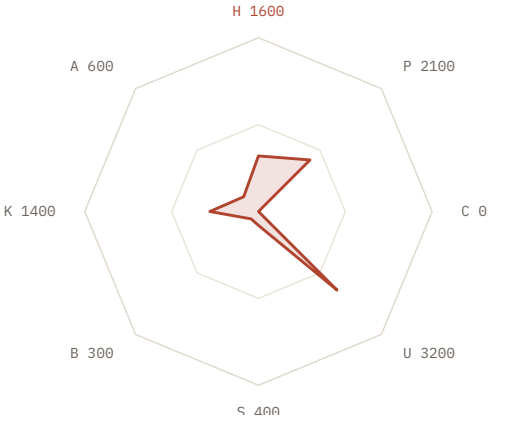

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IFI-C	0
IFI-U	3,200
IFI-S	400
IFI-B	300
IFI-K	1,400
IFI-A	600

Contains: mustard/horseradish (allergen), soy. Mocktail by default; spirit optional.

Quick chili crisp

Makes ~200 ml · 20 min · small pot

150 ml neutral oil
3 tbsp dried chili flakes (mild to medium)
3 cloves garlic (SS-library), sliced thin
1 small shallot, sliced
1 star anise; 1 piece cinnamon (SS-library)
1 tbsp engineered koji or soy (SS-library)
1 tsp engineered sweetener; 1 tsp salt
2 tbsp toasted sesame

1. Fry the garlic and shallot slowly in the oil until pale gold and crisp; scoop out and reserve.
2. Warm the oil with the star anise and cinnamon 5 minutes; discard the whole spices.
3. Put the chili flakes, sesame, salt, sweetener, and koji in a heatproof bowl.
4. Pour the hot oil over — it will sizzle and bloom the chili.
5. Stir in the crisp garlic and shallot. Keep in a jar; this is the condiment that appears on half the recipes in this book, and making your own means you control the heat to the match-head.

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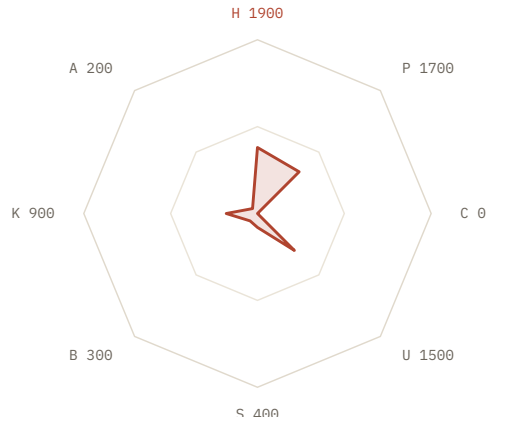

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IFI-P	1,700
IFI-C	0
IFI-U	1,500
IFI-S	400
IFI-B	300
IFI-K	900
IFI-A	200

Contains: soy, sesame.

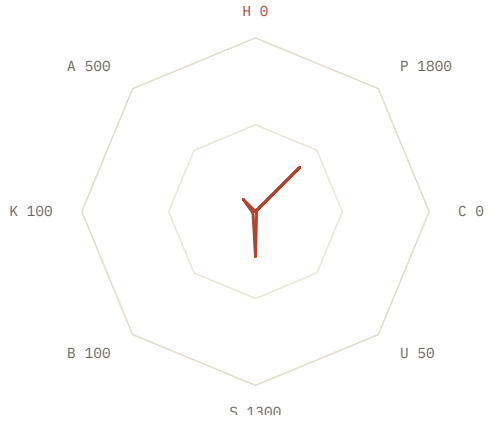
Ginger switchel

Serves 4 · 5 min + chill · a jar

a large thumb of ginger (SS-library), grated
3 tbsp cider vinegar
2 tbsp engineered sugarcane syrup or maple (SS-library)
750 ml cold water
pinch salt

1. Stir everything together; chill at least an hour.
2. Strain and serve over ice.
3. The old haymaker's drink: the ginger's gingerol gives a long warming pungency, the vinegar a sharp brightness, the sweetener just enough to round it. A non-alcoholic morning drink with real structure, and the gentlest possible way to drink the pungent axis.

IFI PROFILE



IFI-H	0
IFI-P	1,800
IFI-C	0
IFI-U	50
IFI-S	1,300
IFI-B	100
IFI-K	100
IFI-A	500

Virgin michelada

Serves 2 · 5 min · tall glasses

```
300 ml tomato or clamato-style juice (engineered tomato, SS-library)
juice of 2 limes
1 tbsp engineered koji or soy (SS-library)
calibrated chili oil; a few dashes hot sauce
chilled soda water, or a crisp non-alcoholic beer
chili-salt rim; ice
```

1. Rim the glasses with chili salt; fill with ice.
2. Stir the juice, lime, koji, and chili oil together in a jug; pour over the ice.
3. Top with cold soda or non-alcoholic beer for the lift.
4. A savory, sour, lightly hot cooler that drinks like brunch in a glass. The koji multiplies the tomato's umami, the lime brightens, the chili warms, and the bubbles carry a prickle on the same nerve as the heat — proof you can build a complete, grown-up drink from nothing stronger than engineered plants and soda.

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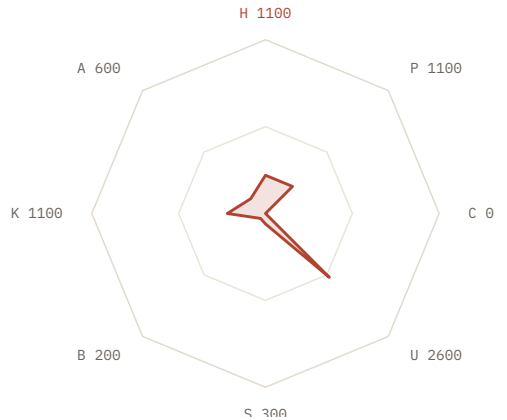

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IFI-P	1,100
IFI-C	0
IFI-U	2,600
IFI-S	300
IFI-B	200
IFI-K	1,100
IFI-A	600

Contains: soy (koji).



PART VII OF VII

The Table

composing eight axes · the method behind the morning

Chapter 16 · Composing the table — *how eight axes share one plate.*

A single dish is a chord; a brunch table is a whole piece of music, and the same mathematics that tunes one recipe governs the spread. Once you can read the Index, laying out a table stops being guesswork and becomes composition — which is the most useful skill this book can leave you with, because you will improvise far more breakfasts than you will cook from a page.

The governing idea is that axes interact, and the interactions are the difference between a table that sings and one that exhausts. Three interactions matter most.

Stacking across systems. Axes on different receptor systems do not compete — they add dimension. Heat (TRPV1), pungency (TRPA1), and cooling (TRPM8) are three different channels; umami (mGluR1) and kokumi (CaSR) are two more; sweetness and bitterness and astringency are others again. A dish or a table that touches several *different* systems reads as rich and complete, which is why the chili-crisp egg (heat + pungency + umami + kokumi) satisfies so completely while a plate of three sweet things cloys.

Competition within a system. Where two stimuli hit the same receptor, they compete — and this is a lever, not a flaw. Sweetness suppresses bitterness: a little sweet genuinely reduces how much bitter the tongue reports, which is the whole principle behind a touch of sweetener in coffee or the sweet-hot syrup over savory bacon. The Index lets you be precise about it rather than dumping sugar until the problem hides.

Cross-adaptation and sequence. Heat accumulates; the fourth bite of chili reads hotter than the first because TRPV1 is still open. Cooling resets it. This is why a cooling plate across from a hot one is not decoration — the mint cooler and the melon plate are structural, the rests between the loud notes. A well-sequenced table alternates: something hot, then something cool; something rich, then something bright.

There is a deeper analogy to how we design the plants themselves, and it genuinely helps at the table. When we engineer a cultivar to carry several axes, we run a flux-balance model — a map of the plant's entire metabolism as a network of reactions, solved for how to route limited carbon and energy toward the flavor molecules we want without starving the rest of the organism. The governing fact is that resources are finite: push hard on one branch and another goes quiet. A menu is the same optimization at human scale. The finite resource is the eater's attention and the tongue's dynamic range — a palate can register only so many loud notes before it stops telling them apart, a kind of sensory saturation. A table of six loud dishes is an unsolved network: everything competes, nothing resolves, and the diner leaves overwhelmed rather than fed. The solved table

routes the loudness deliberately — one or two dishes carry the heat and the pungency, others are kept deliberately quiet to give the palate room, and the cooling and bitter notes serve as the rests that reset the channels between. You are balancing a flux the way we balance one in the plant: spending a fixed budget of intensity where it will be felt most.



Phoenix — the full-spectrum cultivar, proof that eight axes can be held in tune at once.

This composition is exactly the problem the platform solves at the molecular scale. Designing a single cultivar to carry multiple axes is a multi-axis engineering problem, and the library quantifies it: there are **8,400 dual-axis (M2)** constructs and **2,800 triple-axis (M3)** constructs, and at the summit **300 full-spectrum products** that touch all eight at once. Phoenix — the cultivar above, the only one in the flagship line to register on all 8/8 — is the proof that it holds together: H 4,200 · P 252 · C 800 · U 1,800 · S 1,100 · B 2,200 · K 1,900 · A 1,400, eight axes in balance in a single fruit, delivered through nanoparticle encapsulation so the axes release in sequence rather than all at once. A brunch table is that same object disassembled across a dozen plates. You are composing with cultivars what we compose with genes.

Here is a table built on the principle — a spread where no two neighbors fight and the loud notes have their rests.

DISH	LEADING AXES	ROLE AT THE TABLE
Shakshuka	U, K, H	the savory anchor
Chili-crisp fried eggs	H, P, K	the loud, bright center
Pan con tomate	U, S	the pure savory rest
Melon-cucumber-mint	C, S	the cooling palate-cleanser
Sweet-heat ricotta toast	S, K	the sweet counterweight
The clean green smoothie	P, C, S	the bright drink
Debittered pour-over	B, A	the grounding bitter note

A note on claims, because it belongs here more than anywhere. These are computational designs; Scoville Splice's cultivars and constructs have not been experimentally validated in a laboratory. The IFI scores, SHU predictions, and pathway descriptions throughout this book are computational estimates — our model's best accounting of what the designed plants should deliver. Everything in this book is written as flavor and as intention — we cook toward nourishment, toward food grown to hold the most it can and given to the body with care, and we stop exactly there. Nothing

on these pages is a health claim; we do not say a dish cures, detoxes, boosts, or heals, because it would not be true and because the respect we owe a reader is the same respect we owe the science. The pleasure is the claim. And one practical kindness in the same spirit: flag your allergens at the table. Mustard and horseradish, soy and koji, egg, dairy, tree nuts, sesame, fish, and gluten all appear in these recipes and all are things a guest may need to know about. A good host names them without being asked.

Chapter 17 · The molecule behind the morning — *gene to flavor, start to finish.*

We close the science where it starts: with the pathway, because every flavor in this book — the pungency most of all — traces back to a handful of enzymes that our family learned to read, model, and rewrite. You do not need this chapter to cook from the book. But the morning tastes different once you know how deep the design goes, and it would be a strange thing to spend two hundred pages revering a tomato and never show you the machine.

Almost every flavor molecule we have met is a phenylpropanoid, built on one trunk pathway that runs in every vascular plant on Earth. It begins with the amino acid phenylalanine and walks down a short, universal corridor of enzymes.

STEP	ENZYME	CONVERTS
1	PAL	phenylalanine → cinnamic acid
2	C4H	cinnamic acid → *p*-coumaric acid
3	4CL	*p*-coumaric acid → *p*-coumaroyl-CoA
4	HCT	coumaroyl-CoA → shikimate/quinate ester
5	COMT	methylation toward feruloyl / vanillin precursors

Look at step one and you can see this whole book inside it. Cinnamaldehyde — the pungent molecule of cinnamon, a TRPA1 agonist you tasted in the oats and the French toast — branches off right here, a step or two past PAL. The vanillin and vanillylamine that carry vanilla's aroma and seed the capsaicin pathway come off the far end. Only four terminal enzymes are pepper-specific — **pAMT, Pun1/CS, KAS, and BCAT** — and everything upstream of them is shared, which is the single fact that makes a 42-organism platform possible. Learn the trunk once and five of seven platform modules transfer unchanged to any plant with a sequenced genome.

Heat itself is the clearest worked example. Capsaicin is assembled when vanillylamine condenses with an 8-methyl branched-chain fatty acid at the **Pun1/CS acyltransferase** — the terminal capsaicin synthase, the enzyme we studied hardest. Pun1 labels the product; it does not govern the rate.

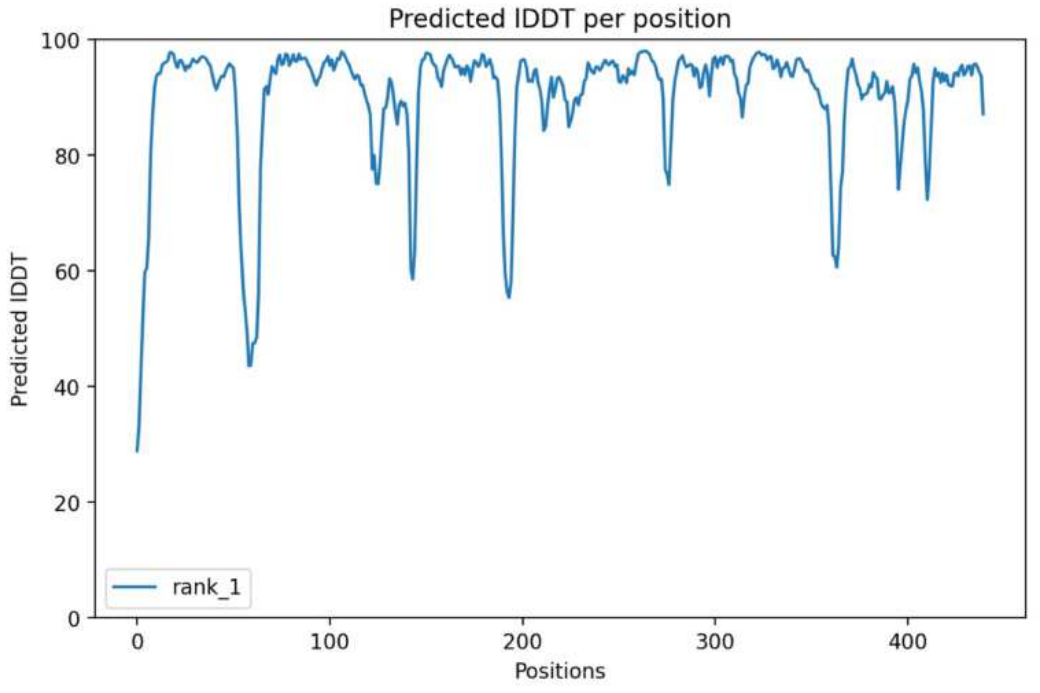

FIG. 17 — the Pun1/CS acyltransferase, colored by model confidence; the binding domain and active-site cleft resolve at high confidence.

Every prior breeding program chased heat by selecting the phenotype and hoping the genotype followed. We inverted it. A 650-million-parameter protein language model (ESM2) scored every possible single-residue substitution in Pun1 by its predicted effect on catalytic efficiency and fold stability; a genome-scale flux-balance model found that flux control in the capsaicinoid pathway sits upstream — at **4CL** and **HCT/CCoAOMT** in the phenylpropanoid trunk — not at the terminal Pun1 step, which our model assigns negligible flux control coefficient over five thousand Monte Carlo draws. Two substitutions in Pun1 that no breeder ever stumbled on emerged from the protein-language-model scan, and designed in with CRISPR they are predicted to lift peak output while holding batch-to-batch variation to a design specification of **≤7%**, against 42% in wild type. A third edit, C175S, is a structural annotation from our modelling (disulfide-misfold prevention) and is not included in the shipped construct.

EDIT	ROLE	ΔΔG
S39L	binding affinity ↑ (N-terminus) — **shipped**	−2.1
L345G	steric relief, active-site cleft — **shipped**	−1.8
C175S	disulfide-misfold prevention — structural annotation only, not in shipped construct	−0.9

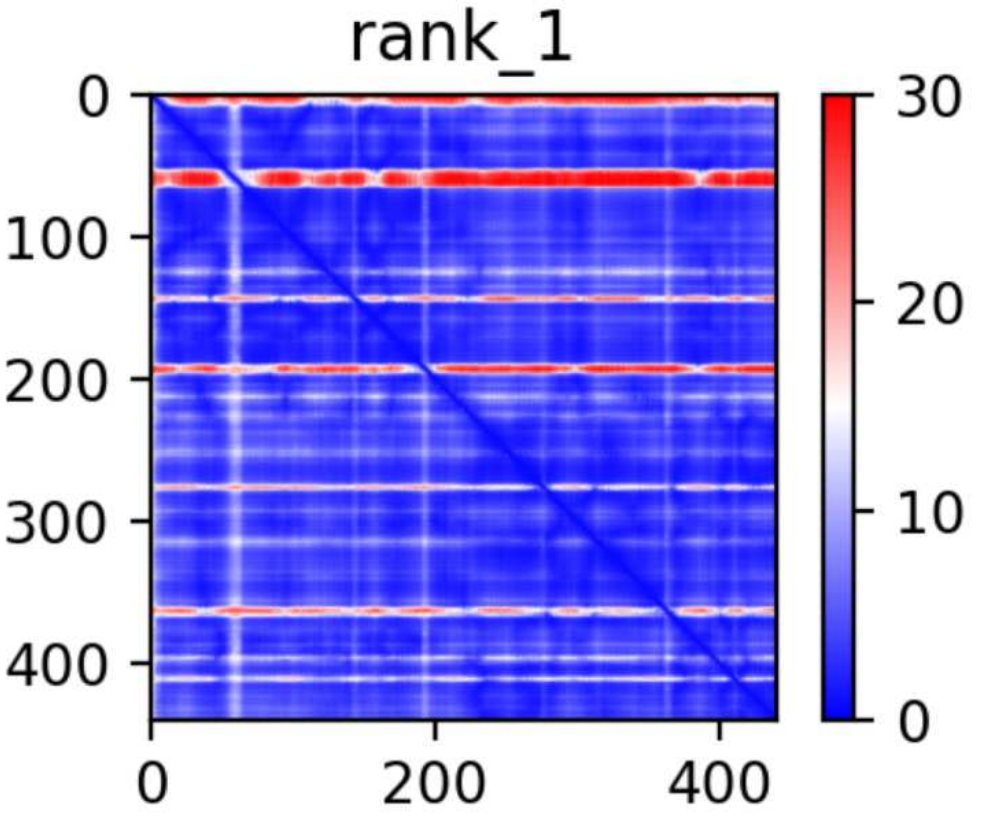

FIG. 18 — the predicted aligned error map for the same model; low off-diagonal error means the domains are confidently placed relative to one another.

That ≤7% is not a vanity number; it is the reason a recipe in this book can tell you to steep a match-head of a flagship pod and trust the result. Consistency is what turns a wild plant into an ingredient a cook can reason about — the difference between a chili that might be mild or might take the roof off and one whose heat you can pour by the teaspoon. The whole apparatus — the ~19,500 product SKUs, the 1,000 live cultivars, the 42 organisms, the 3 patents filed and the 21 peer-reviewed papers released open-access — exists so that the number on a scorecard means the same thing every morning. The pungency of your mustard, the debittered honesty of your coffee, the restored depth of your tomato: all of it is reproducibility, which is only another word for respect for the person who has to cook with it.

A closing word on the rules, because a reader who cooks from a book like this deserves to know where the guardrails are. Flavor engineering of this kind lives inside a real regulatory frame, and we treat that frame as a feature rather than a nuisance. Engineered cultivars and the compounds they carry move through the ordinary channels any new food ingredient does — safety assessment, the established categories by which a flavor or a food is cleared for sale, and honest labeling of what a thing is and what it contains, allergens first. We file patents to protect the methods, and we publish the science openly — twenty-one peer-reviewed papers, released under a permissive license — because a company that asks the public to eat what it designs owes the public the means to check its work. And we hold one line without exception, the same one that runs under every recipe in this book: we describe flavor and we describe intention, and we make no claim about health. A tomato grown to hold more of what a tomato can hold is a thing we are proud of and a thing we will not oversell. The number on the scorecard is a promise about taste and consistency; it is never a promise about your body, and we would rather under-claim forever than break that trust once.

Closing · Breakfast, on purpose

We began with a kettle ticking in a dark kitchen and the claim that the morning tongue is the most awake and most wasted sense of the day. We hope the recipes between here and there have made the case: that a morning can carry pungency and heat and savory depth and still feel like care rather than assault; that the plants grown with the most attention give the most back; that a number next to a flavor is not the opposite of pleasure but a way to aim it.

The deepest thing we know about food, after all these years and all this machinery, is embarrassingly simple and we will say it plainly and only once: it is worth doing on purpose. The first meal most of all — the one eaten half-awake, the one we are tempted to phone in — rewards intention more than any other, because the tongue is listening hardest and the day is still unwritten. Grow the plant well. Read what it is saying. Pitch two or three axes in tune for a mouth that is wide open. Then sit down, name the allergens, break the yolk, and begin.

The kitchen is already warm. Morning is the first chance of the day to feed the body right — so we take it, together, and we take it gladly.