BAKING WITH RYE – The Devil's in the Chemistry

By **STANLEY GINSBERG** — Guild Member and Proprietor, The New York Bakers

One of the biggest lessons I learned while baking my way through the 100+ rye breads that were candidates for my upcoming book, *The Rye Baker*, is that rye baking's greatest challenge comes from the unique chemistry that happens when rye meets water.

First, some Botany 101. All vegetable seeds share a similar structure. Beneath the husk, a fibrous, highly absorbent bran covers the kernel, enclosing a germ that contains the embryo, fat, sugars, and other substances; a starchy endosperm made up mainly of complex carbohydrates (polysaccharides); and outer layers that hold high concentrations of fiber, protein, fat, and a variety of microorganisms and enzymes essential to the plant's reproduction.

Water affects wheat and rye differently. When water meets wheat flour, it triggers the formation of gluten, the elastic protein polymer that gives a wheat bread its structure. When water meets rye, which lacks wheat's gluten-forming ability, it combines with polysaccharides in the endosperm called arabinoxylans, also known as pentosans, to form a viscous, sticky gel. It's this gel that, like gluten in wheat doughs, traps baking gases and at baking temperatures hardens into the loaf's crumb.

But something else happens when flour meets water. In nature, when a seed gets wet, it germinates, activating a pair of enzymes, α-amylase and β-amylase, whose job it is to feed the embryo by breaking the polysaccharides (literally, "multiple sugars") into simple sugars like dextrose, fructose, and maltose.

In baking, the same thing happens, especially in high-extraction or whole grain doughs that contain part or all of the kernel's outer layers. In wheat doughs, that's a good thing, because the enzymes unlock the flour's hidden sugars without affecting the gluten, which is a protein. To encourage that activity, we use additions like diastatic malt and malted barley flour to increase the dough's enzyme content, long-duration preferments like poolish, biga, and pâte fermentée, and techniques like cold retardation to give the amylases time to work their chemistry.

In rye doughs, which are especially rich in polysaccharides, this so-called "starch attack" not only sweetens the dough considerably, it also degrades the gels that form the backbone of a rye bread's crumb structure. This can turn what should have been a proper loaf into a gummy doorstop.

Over centuries, Europe's rye bakers identified ways to manage starch attack. In some regions, they simply accelerated the bulk fermentation and proofing times to minimize the window of amylase activity. In most of Europe's rye belt, however, they discovered by trial and error that amylase activity grinds to a virtual halt in acidic (pH 5.0–3.5) environments, i.e., sourdough.

European rye bakers use two types of sponge: leavening/acidification (Type 1) sponges and acidification-only (Type 2) sponges, which typically require the addition of commercial yeast. Type 1 sponges can be built on both wheat and rye, and include *lievito madre* and basic and Detmold 1-, 2-, and 3-stage sponges. Prefermenting at least 30% of total flour generally produces enough acid to inhibit starch attack.

A sponge's leavening power and acidity depend on hydration, temperature, and time. In general, hydration <80%, and fermentation at room temperature (68°F–70°F) favors yeast reproduction – and for longer fermentations (1–7 days), acetic acid formation. Wetter (100%–120%) sponges and higher temperatures (90°F–95°F) produce high concentrations of lactic acid and low yeast activity. My workhorse Type 1 sponge is hydrated at 100% and ferments at room temperature for 10-12 hours.

There are limits, however, to yeast and lactic acid bacteria (lactobacillus) as enzyme inhibitors. That's because temperatures above 120°F kill both, while amylase activity peaks at 140°F–170°F – typical dough temperatures during the early stages of baking – before ceasing at 180°F. That's why most rye breads start their bake at 450°F–525°F and moderate down to 350°F–425°F after 10 or 15 minutes, with or without steam.

Scalds, which consist of flour, grain, spices, and/or malt plus boiling water, also are a way to manage the starch attack, but in the opposite direction. The boiling water kills off any microorganisms present in the dry ingredients, while it warms the dough to the ideal temperature range for peak amylase activity. The result is a sugar-rich addition to the final dough that both enhances the flavor of the finished loaf and provides a nutritional boost to the yeast and lactic acid bacteria. This strengthens the rise and acidity of the dough, the better to resist starch attack during baking.

Lyubitelsky Rye, a fine-crumbed 84% Russian bread, provides a great illustration of how sour sponges and scalds work together in high-percentage rye breads. The sponge preferments almost 32% of the total flour, producing a balanced Type 1 leavening-acidification sponge, while the scald, which includes both rye flour and roasted rye malt, adds a musky, chocolatey sweetness to the bread and provides ample sugars for the yeast and LAB.

This is also a great eating bread, with nicely balanced sweet, chocolate, citrus-coriander, and sour notes, all encased in a tender crumb. And the best part is that unlike wheat breads, which become stale after a day or two, the polysaccharide gel structure of a rye bread will keep tender for a week to 10 days – another benefit of rye's unique chemistry.

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LYUBITELSKY RYE

Contributed by STANLEY GINSBERG

Lyubitelsky Rye is of Russian origin and resembles the more familiar Borodinsky Rye, but with a finer-textured crumb and – thanks to the sugar, molasses, and toasted rye malt – a sweeter, more chocolatey flavor.

PHOTO: SYLVIA SPIELER GINSBERG

LYUBITELSKY RYE

	Total Flour Fermented in Levain 31.50%	Total Flour Fermented in Scald 15.75%	Total Flour Fermented in Opara 15.75%	Total Flour Prefermented 62.99%
	Medium Rye Flour 37.38%	Medium Rye Flour 18.69%	Medium Rye Flour 18.69%	Medium Rye Flour 74.77%
	Whole Wheat Flour 0.00%	Whole Wheat Flour 0.00%	Whole Wheat Flour 0.00%	Whole Wheat Flour 0.00%

	TOTAL FORMULA		LEVAIN		SCALD		OPARA		FINAL DOUGH	
Ingredients	**%**	**kilograms**	**%**	**kilograms**	**%**	**kilograms**	**%**	**kilograms**	**%**	**kilograms**
Total Flour	100.00	6.350	100.00	2.000	100.00	1.000	100.00	1.000	100.00	2.350
Medium Rye Flour*	84.25	5.350	100.00	2.000	100.00	1.000	100.00	1.000	57.45	1.350
Whole Wheat Flour	15.75	1.000							42.55	1.000
Water, 100°F	48.82	3.100	80.00	1.600					63.83	1.500
Salt	0.94	0.060							2.55	0.060
Instant Yeast	0.63	0.040							1.70	0.040
Water, boiling	27.56	1.750			175.00	1.750				
Starter†	5.51	0.350	17.50	0.350						
Whole Pale Malted Rye‡	3.15	0.200			20.00	0.200				
Unsulphured Dark Molasses	4.41	0.280							11.91	0.280
Sugar	2.52	0.160							6.81	0.160
Ground Coriander	0.47	0.030			3.00	0.030				
Levain							395.00	3.950		
Scald							298.00	2.980		
Opara										7.930
Totals	**194.02**	**12.320**	**197.50**	**3.950**	**298.00**	**2.980**	**793.00**	**7.930**	**186.81**	**12.320**
Coriander seeds, crushed		0.040								

*1.35% ash content; whole grain rye flour may be used but will give a denser, more acidic loaf
†100% medium or whole grain rye flour, 100% water, 10% starter
‡See Process Notes

PROCESS – Lyubitelsky Rye

Prefermments		Levain	Scald	Opara
Mixing	**Type of mixer**	Planetary with paddle	Planetary with paddle	Planetary with paddle
	1st Speed	Until incorporated	Until incorporated	Until incorporated
Fermentation/Rest	**Length of time**	10:00–12:00	10:00–12:00	3:30–4:00
	Temperature	72°F	150°F	72°F

Final Dough		
Mixing	**Type of mixer**	Spiral
	Mix style	Short
	1st Speed	0:10–0:12
	Dough temp	82°F
Fermentation	**Length of time**	1:00–1:15
	Temperature	72°F
Shaping	**Divide**	1.250 kg
	Shape	Bâtard
	Proofing device	9″x4″x4″ greased Pullman pan
Proof & Bake	**Final proof time**	0:45–0:55
	Temperature	72°F
	Garnish	Crushed coriander seeds
	Oven type	Rack, no convection
	Steam	2–3 sec (or steam pan)
	Initial bake	0:10
	Initial temp	500°F
	Final bake	0:40–0:50
	Final temp	390°F
	Damper Open	Last 0:40–0:50

INGREDIENTS

- Scale and then roast the whole pale malted rye in a 400°F oven until brick red-brown, 18–20 minutes. When cool, mill into flour.

MIXING

- Dissolve the molasses in the water.
- Combine the remaining final dough ingredients using spiral mixer at low speed until evenly blended, 10–12 minutes.

FERMENTATION

- Ferment at room temperature until doubled in volume and surface shows cracking, 60–75 minutes.

SHAPING

- Divide into 1.250 kg pieces, place into greased 9″x4″x4″ Pullman loaf pans, cover, and proof at 72°F until the dough has risen to within 1″ of the pan rim and the surface shows cracks or broken bubbles, 45–55 minutes.

PROOF & BAKE

- Brush with water and apply crushed coriander seeds.
- Bake with steam for 10 minutes at 500°F.
- Open damper or remove steam pan, reduce temperature to 390°F, and bake to an internal temperature of at least 198°F, 40–50 minutes.
- Unpan and cool thoroughly before slicing.