

# Development of a benchtop baking method for chemically leavened crackers



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# Comparison of ingredients

Ingredient	Cookie	Cracker
Sucrose	high	low
Fat	high	low
Water	low	low
Flour	unchlorinated	unchlorinated (requires gluten strength)
TS	high	low
%S	very high	low

# Objective

Develop a benchtop baking method  
to predict contribution of  
gluten functionality and performance  
to overall flour performance  
for chemically leavened crackers

# What are the hurdles in developing a cracker-baking method?

- Difficulty to find ideal diagnostic flours that differ only in gluten functionality (same SRC values, except SRC-LA)
- Absence of a powerful benchtop mixer, like a commercial plant-scale cracker mixer, to enable gluten development with low TS and %S formulas.
- Absence of a powerful 2-4 roll sheeter and reduction system to enable gluten development during machining.
- Absence of a suitable two-zone benchtop oven.

**In spite of the hurdles,  
if we want to develop a cracker-baking method,  
what will be the criteria?**

- The method should be simple and user-friendly.
- The method should be reliable, in terms of reproducibility and accuracy.
- The method should be diagnostic for gluten functionality of flour samples.

# Equipment used for experiments

**Mixer: Pin mixer with 100g mixing bowl**

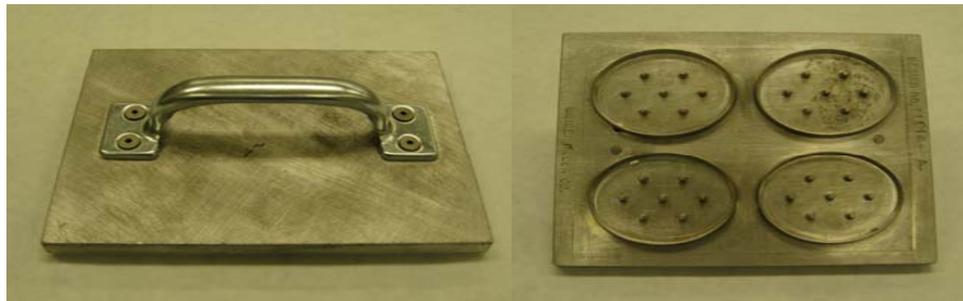
**Oven: Standard National lab baking oven**



**Univex sheeter**



**Baking rack**

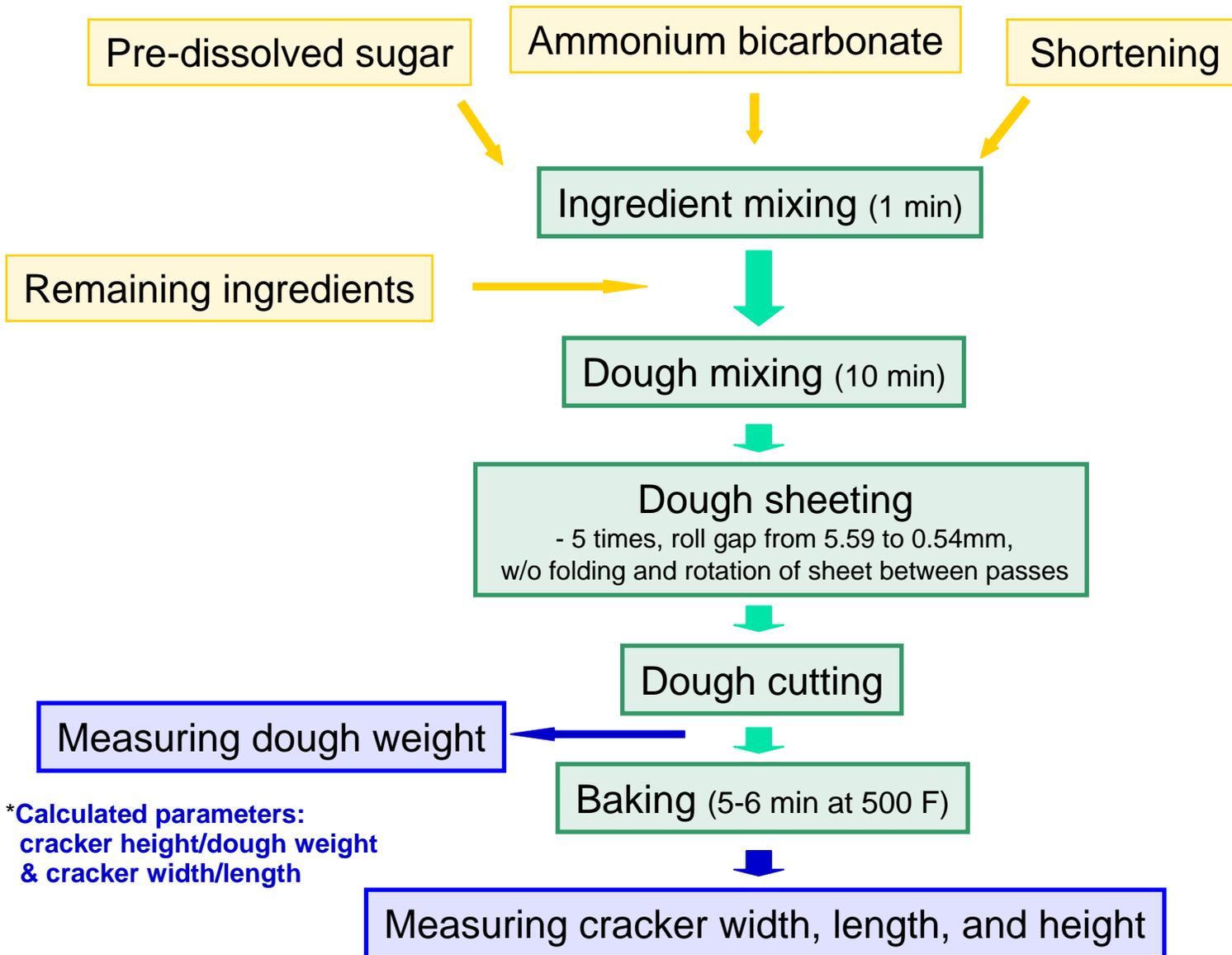


**Hand cutter (2.25 x 1.65 inch, 7 docker pins)**

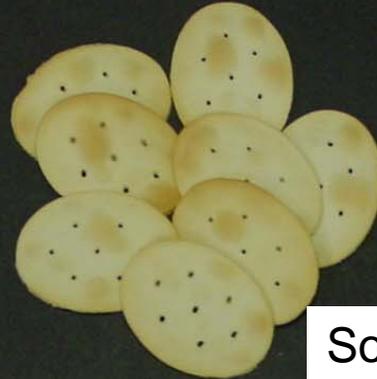
# Basic ingredients and formula

Ingredient	Formula (g)
Flour	100.0
FG Sugar	9
Salt	0.75
Sodium bicarbonate	1.25
Ammonium bicarbonate	1.25
Monocalcium phosphate	1.25
Shortening	12.0
Water	29.0
<b>TS</b>	<b>38</b>
<b>% S</b>	<b>23.7</b>

# Cracker-making procedure



# Effect of leavening agents



Soda: 0  
MCP: 0  
ABC: 0



Soda: 1.25  
MCP: 0  
ABC: 0



Soda: 0  
MCP: 1.25  
ABC: 0



Soda: 0  
MCP: 0  
ABC: 1.25

# Effect of ammonium bicarbonate

Branson SRW SG FL: 23.7%S, 38 TS, 10-min mixing  
Soda 1.25 g & MCP 1.25 g

0.00

0.625

1.25



ABC (g)	Dough/piece		Moisture loss	Cracker/piece			
	Weight	Height		Weight	Length	Width	Height
0	3.85	0.172	25.96	2.85	5.23	4.17	0.355
0.625	3.75	0.172	27.03	2.74	5.20	4.26	0.398
1.25	3.87	0.172	27.38	2.81	5.17	4.25	0.448

# Flour used for developing the formula and procedure

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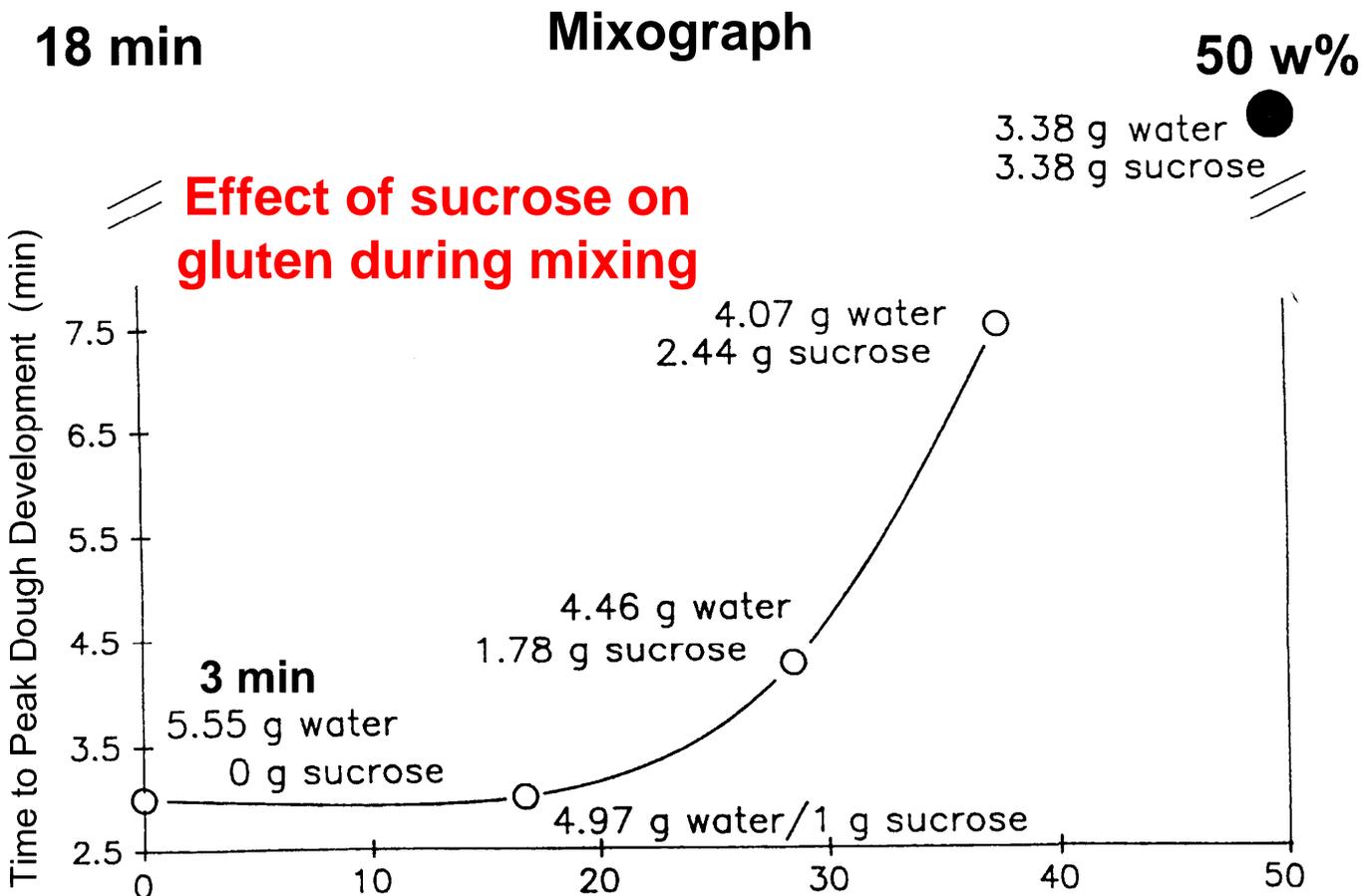
Flour	SRC			
	Water	LA	SC	Suc
Branson	46.9	94.8	60.7	86.9

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Gluten performance ratio:

$$\text{SRC LA}/(\text{SC}+\text{Suc}) = 0.644$$

# Can we use very low sugar concentration for faster gluten development in a cracker-baking method?



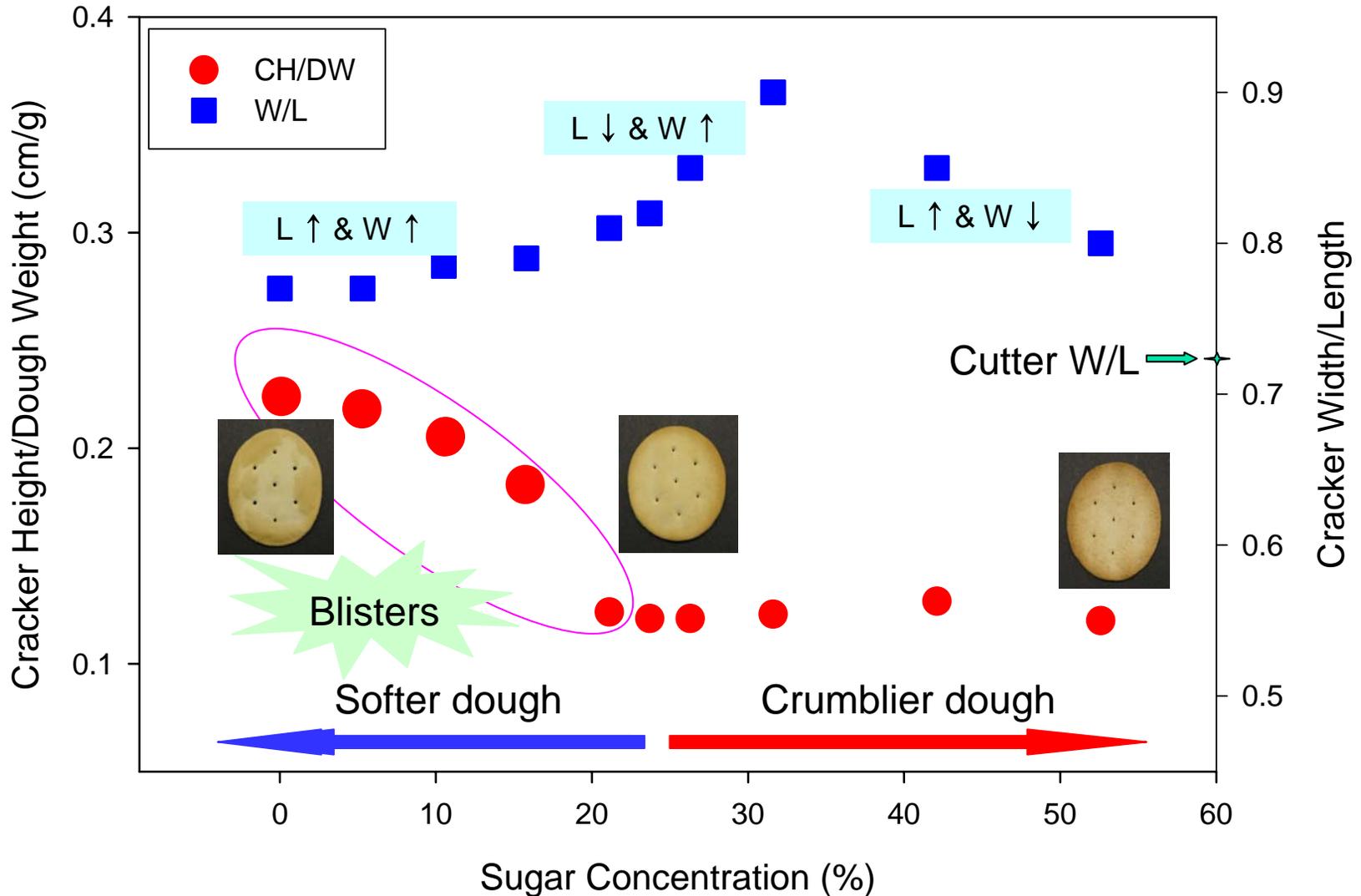
Sucrose weight % in Constant Volume (5.5 ml solution) with 5 g Climax Flour

## One Sugar Type: Different Concentrations

(Used with permission from Louise Slade)

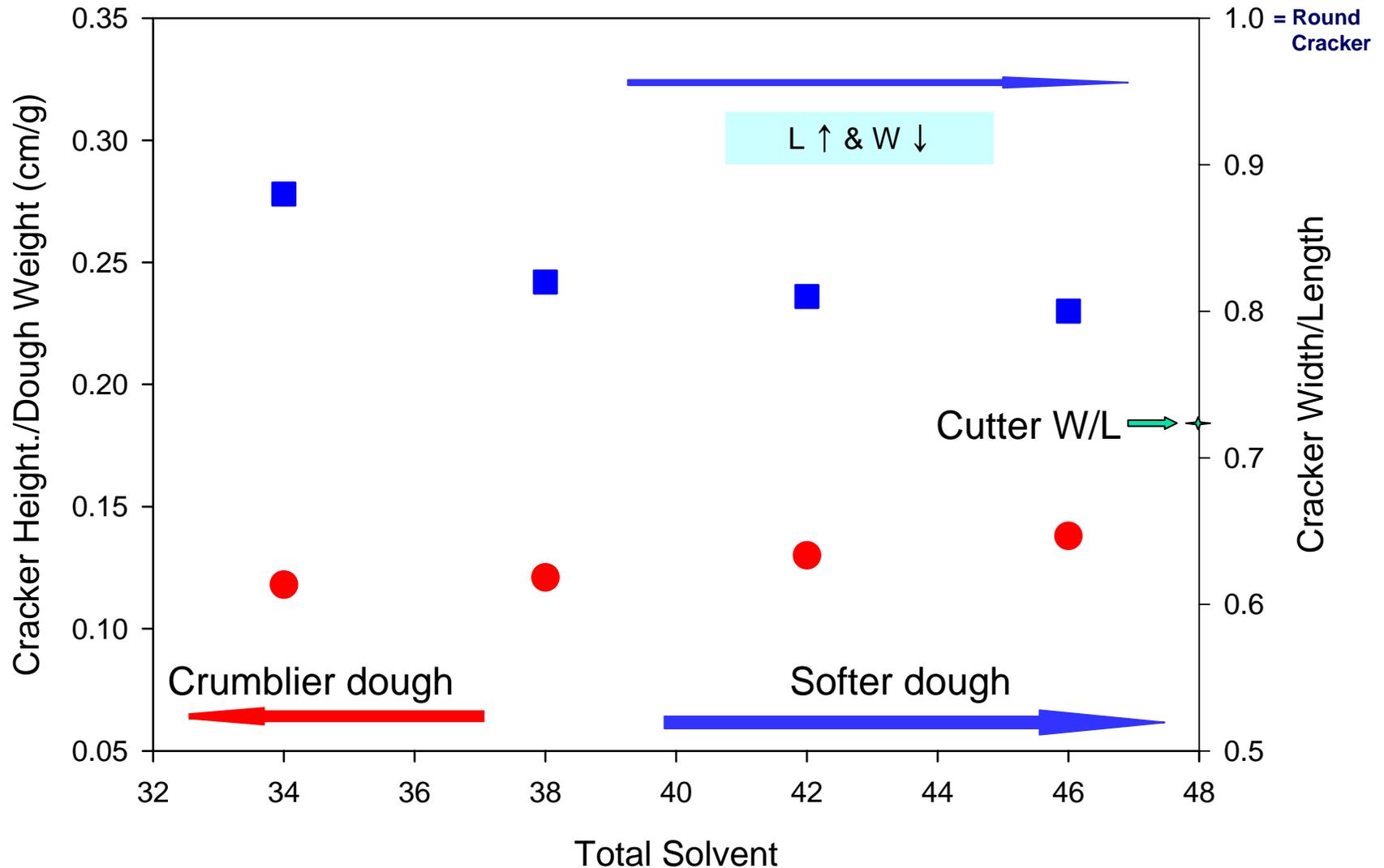
# Cracker geometry at various %S, 38TS

Crackers baked with too much water (lower %S at constant TS) resulted in blisters



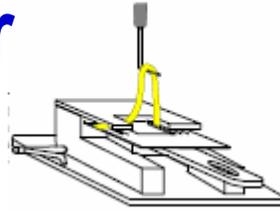
# Cracker geometry at various TS, $\approx 23.7\%S$

The formula with 23.7%S, 38TS was chosen for testing various flours

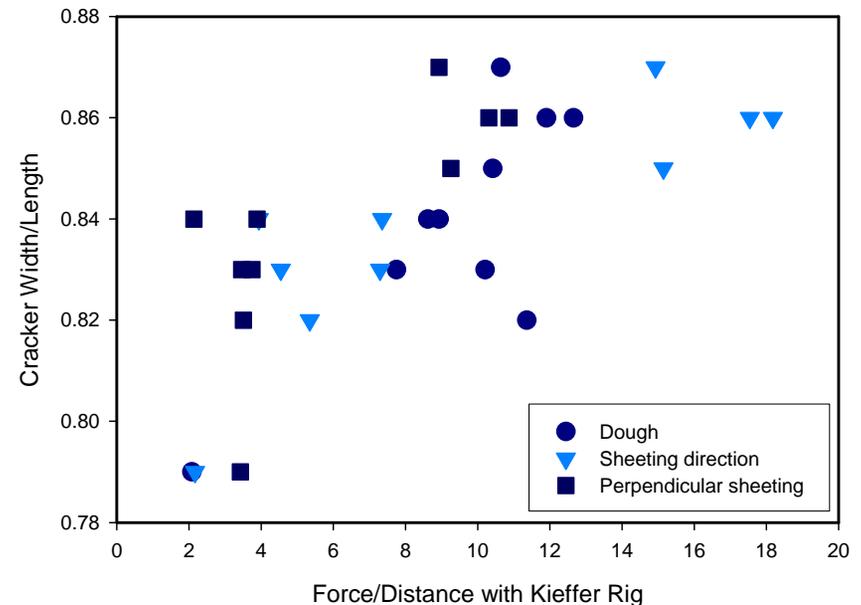
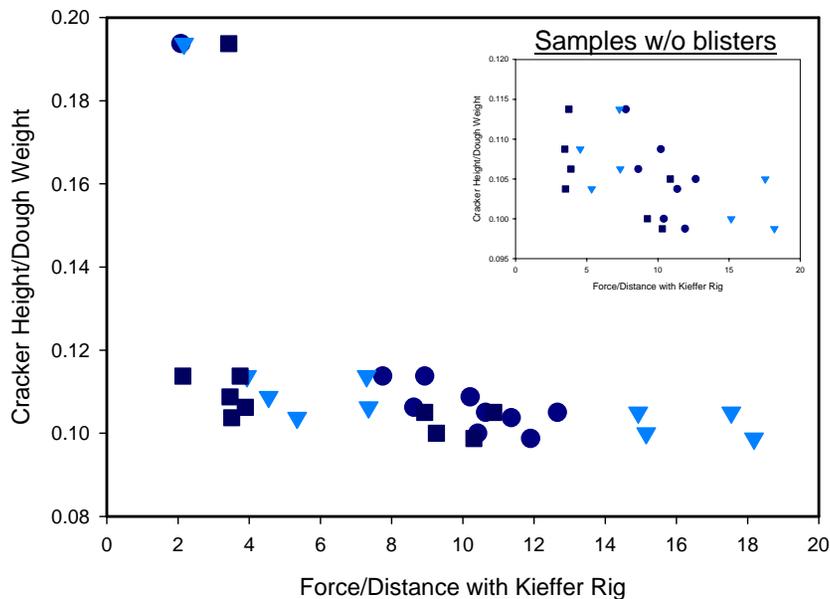


# Rheological test for 2007 QEC flour

(Used Kieffer Rig with TAXT)



Evaluate extent of gluten development during mixing and machining  
- Force/Distance of dough in the direction of sheeting was related to both cracker height/dough weight and cracker width/length.



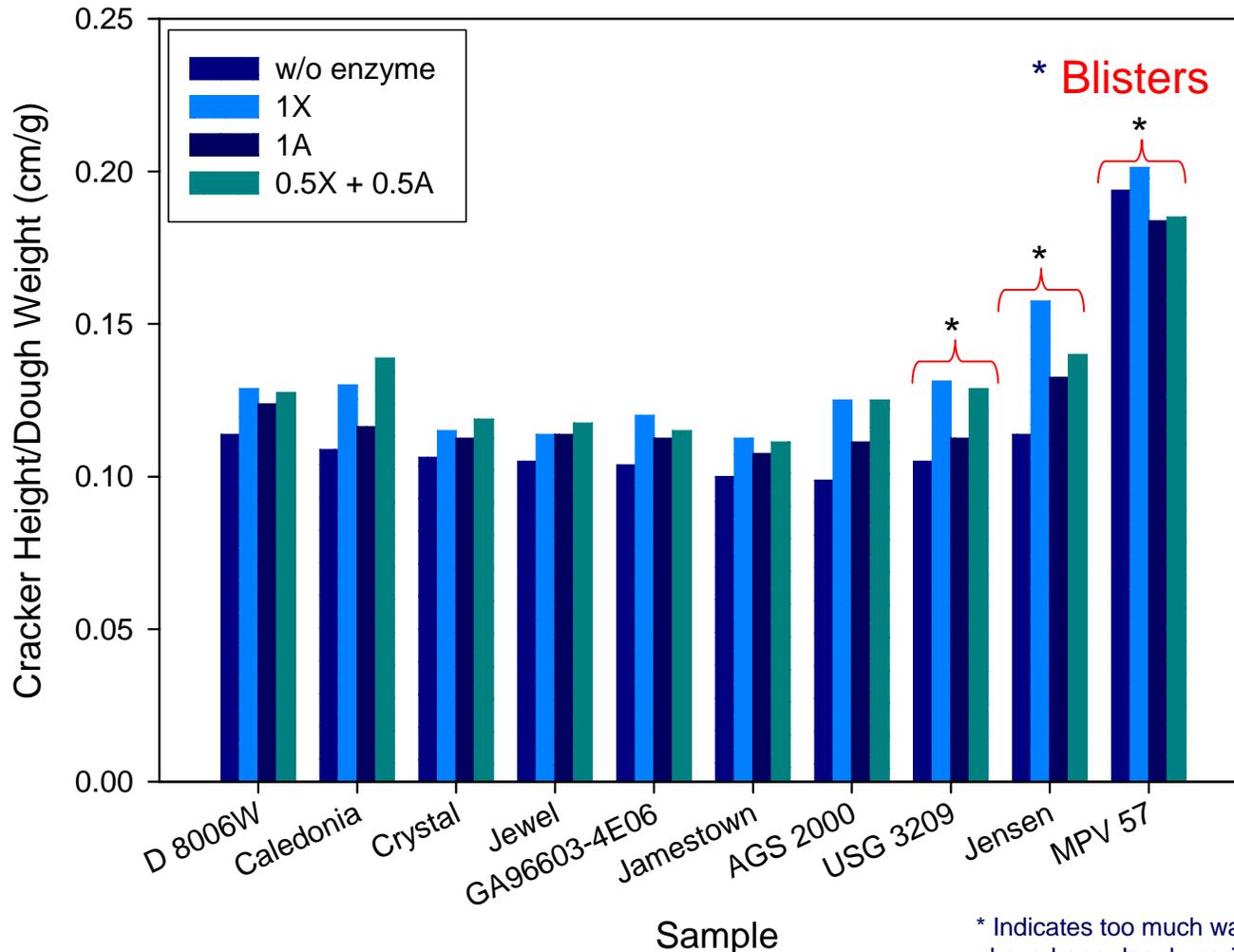
# Effect of enzyme treatment on water SRC

Used xylanase (X) and alpha-amylase (A)

Cultivar	w/o enz.	1X	1A	0.5X + 0.5A
D8006W	48.5	44.9	48.5	46.8
Caledonia	47.1	43.9	47.0	45.6
Crystal	47.2	44.8	47.1	46.1
Jewel	51.1	47.7	51.1	49.3
GA96603-4E16	49.2	46.3	49.5	47.9
Jamestown	51.9	46.9	51.6	49.3
AGS 2000	52.4	46.7	52.0	49.1
USG 3209	55.8	48.6	55.9	51.8
Jensen	48.7	44.9	48.8	47.0
MPV 57	47.9	43.3	48.0	45.5

These very soft wheats did not generate damaged starch during milling, so alpha-amylase was not needed.

# Effect of enzyme treatment on cracker baking



\* Indicates too much water, when arabinosylans have been depolymerized. Reduction in water and sucrose is typically required.

# Reduction of blisters by baking crackers with flour blend

(GA 96603-4E16:MPV 57=1:1)

GA 96603-4E16

GA+MPV

MPV 57

Photos show L dimension



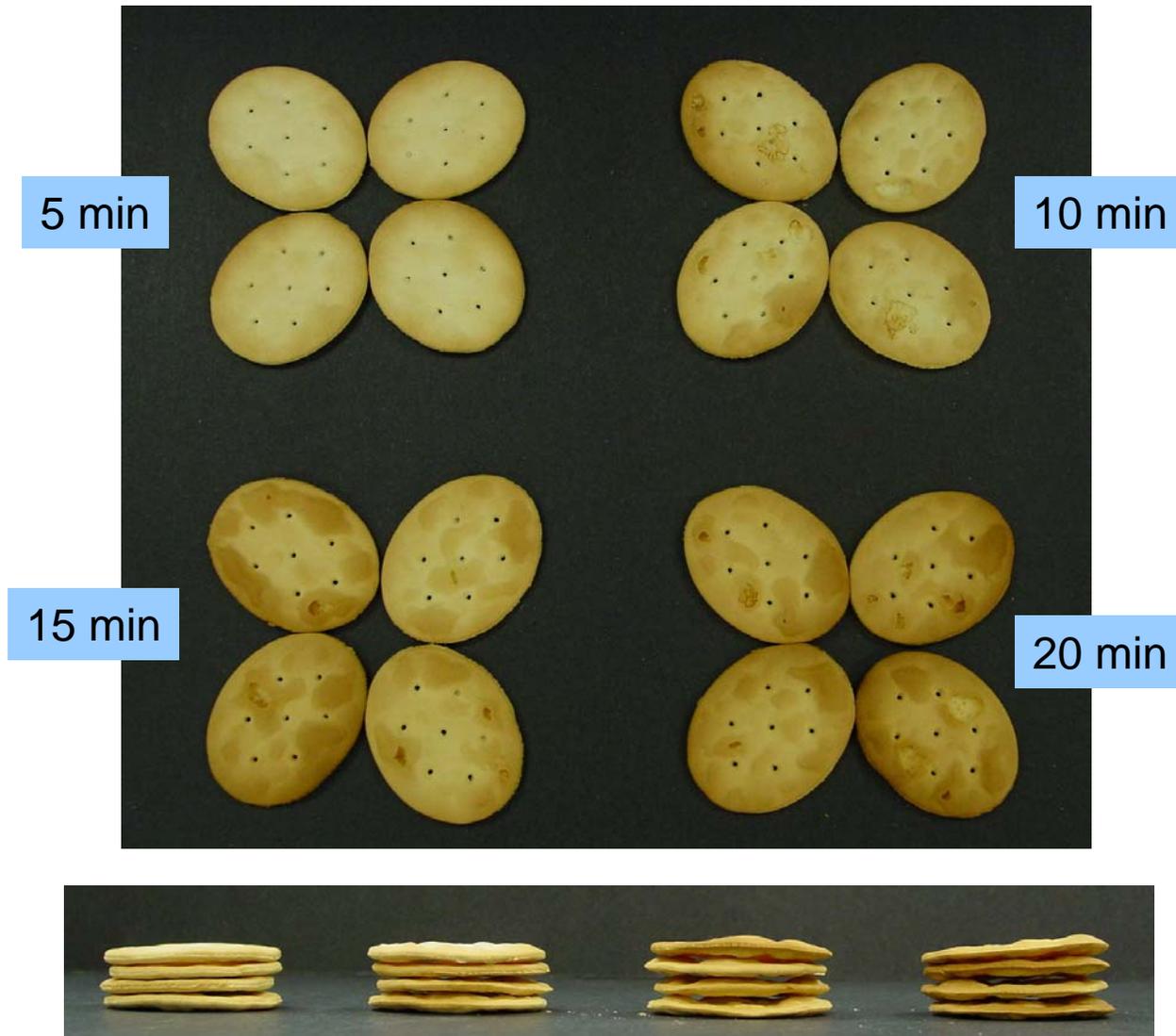
Flour	SRC				LA/ (SC+Suc)	Cracker	
	Water	LA	SC	Suc		CH/DW	W/L <sup>1</sup>
GA 96603-	49.2	105.9	64.4	96.0	0.66	0.104	0.817
1G+1M	48.5	89.5	63.5	94.9	0.56	0.119 <sup>2</sup>	0.823
MPV 57	47.9	73.0	62.7	93.8	0.47	0.194 <sup>2</sup>	0.790

Notes: <sup>1</sup> Cutter W/L was 0.73.

<sup>2</sup> Crackers with blisters. But, the crackers with flour blend showed much smaller and fewer blisters.

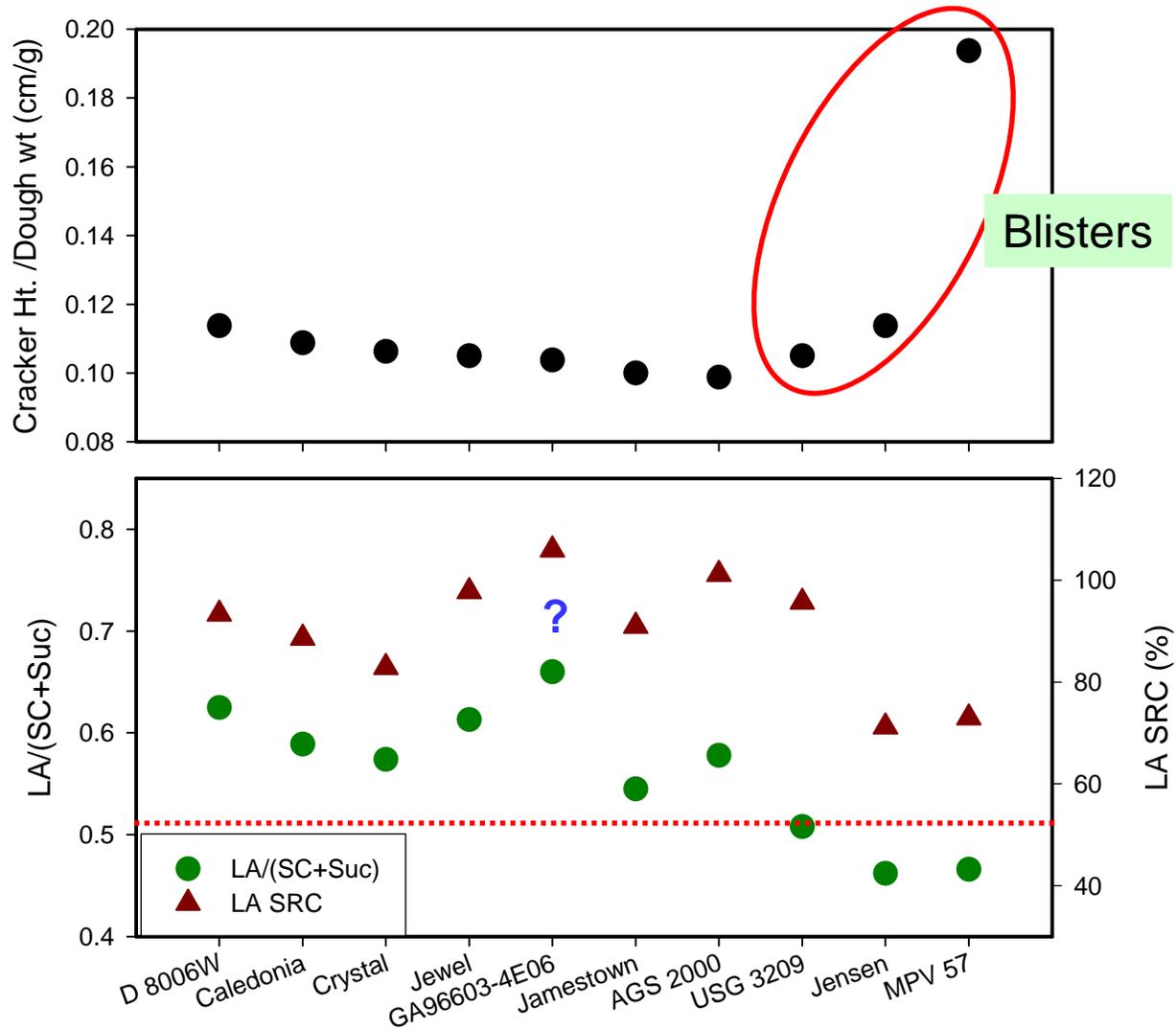
# The effect of mixing time on blisters

(MPV 57)



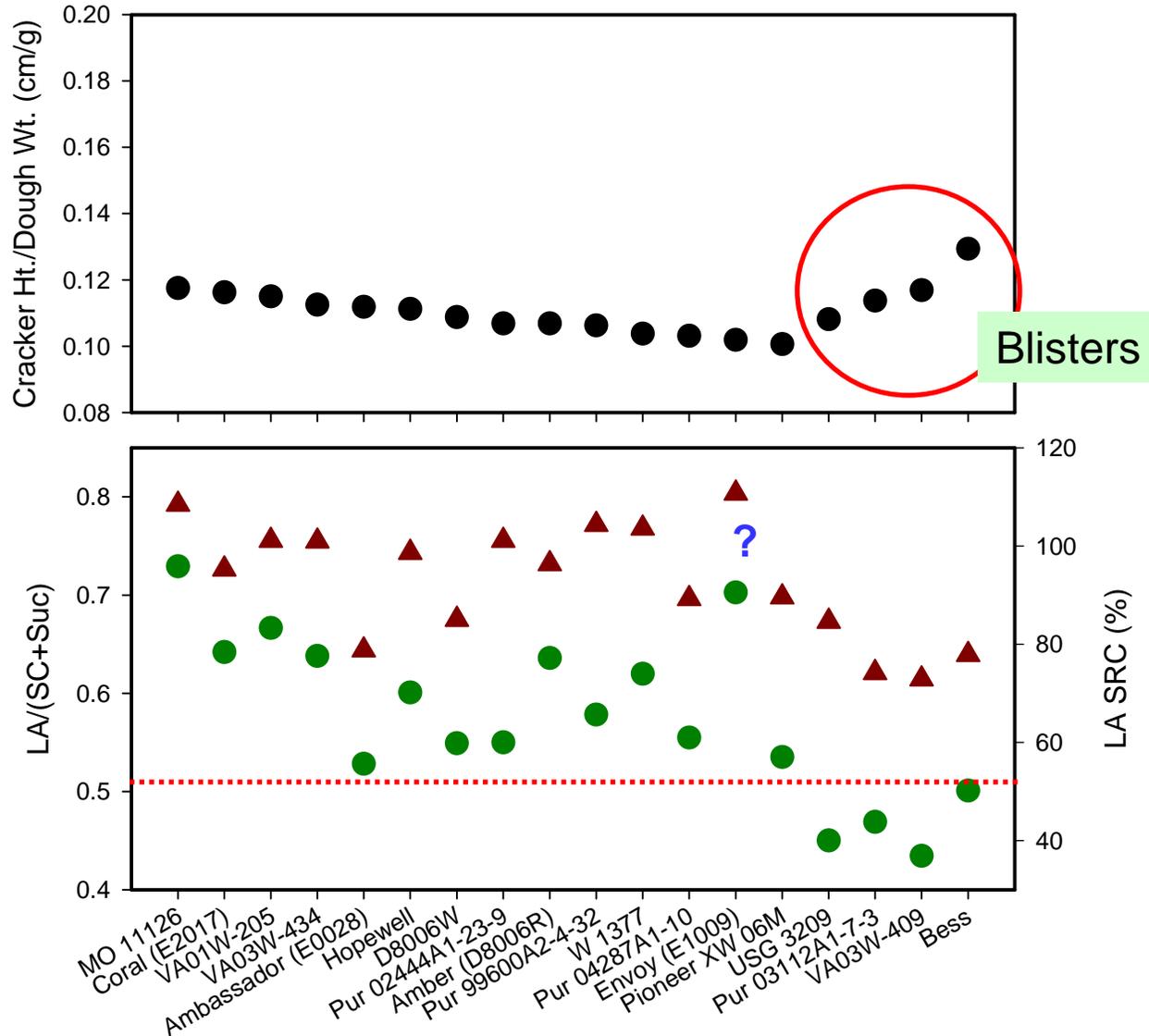
# Cracker baking with 2007 QEC flours

The **gluten performance ratio, SRC LA/(SC+Suc)**, accounted for the ratio of cracker height to dough weight, but **gluten functionality alone, individual SRC LA**, did not.



# Cracker baking with 2008 QEC flours

The **gluten performance ratio, SRC LA/(SC+Suc)**, accounted for the ratio of cracker height to dough weight, but **gluten functionality** alone, individual **SRC LA**, did not.



# Conclusions

- Based on preliminary investigation of the effects of total solvent and sugar concentration, 38TS and 23.7%S were selected as a diagnostic formula to distinguish differences in gluten functionality or performance and overall flour performance for chemically leavened crackers.
- The **gluten performance ratio** of **SRC LA/(SC + Suc)** was a better predictor of cracker geometry than the individual **gluten functionality value** of **LA SRC** alone. Flours with a gluten performance ratio smaller than 0.52 resulted in blistering.
- Use of alpha-amylase and xylanase demonstrated the effect of enzymes on improved cracker-baking performance, as a result of decreased crumbliness of dough and increased height of cracker.
- Cracker-dough rheology (Force/Distance) in the direction of sheeting showed a negative relationship with the ratio of cracker height to dough weight, but a positive relationship with the ratio of cracker width to length.

# Acknowledgements

- Ron Martin
- Tom Donelson
- Scott Beil



*THANK YOU!*