Progress Report Krishnan

Project data
Project title (as awarded): End Use Applications for SD Wheat
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Total project period (if a multiyear project, give the beginning date of the full project and planned ending date): July 1, 2018 to June 30,2019
Report type: Annual progress report

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Research Summary:

Rapid tests that are accurate and precise are needed in wheat breeding programs as large throughput is needed in view of large numbers of samples and fast turn-around time needed. Breeders require information for effective decision-making in determining parental crosses to be made. Cereal Chemists provide information on the wheat grain, flour milled from the wheat, gluten developed from the flour and finished wheat food products. The quality of food products eaten by consumers may be explained by the growing environments and the choice of breeding material used in wheat breeding programs.

Introduction:

Approximately 40% of the Hard Red Winter (HRW) and Hard Red Spring (HRS) wheat varieties grown in the United States are used for making bread flours. Evaluating the bread making potential of wheat flours is a major priority for wheat breeders, flour millers and food processors. Actual baking tests are needed, conventionally, to determine bread baking quality of wheat flours. Bread Loaf volume (LV) is a significant economic factor in the baking industry and is used as an indicator of bread quality. No single evaluation method can effectively predict LV although numerous rheological and chemical methods exist that are highly correlated to bread making. A Vacuum Dough Expansion System (VDES) was developed at SDSU. It measures expansion capacity of dough under vacuum in less than two minutes utilizing dough made with flour and water. Measuring expansion capacity of dough may have the potential to predict baking performance. Researchers at Kansas developed a hybrid SDS- SRC method as a rapid, small-scale, test-tube method to predict loaf volume of hard winter wheat. However, the application of this test with HRS varieties needs to be established. This test directly measures gluten proteins that precipitate out on addition of solvents and detergents.

The objectives of the research are as follows:

1. To develop a method of dough expansion utilizing the VDES and study its applicability in measuring bread baking quality of wheat flours.
2. To study the applicability of the VDES for testing effects of dough modification ingredients.
3. To study the relation between the routine flour and dough tests used for flour end use quality, the hybrid SDS-SRC Sedimentation test, the VDES data and the baked loaf characteristics.
4. To combine the output of rheological test (VDES) with output of chemical test (hybrid SDS-SRC Sedimentation test) in a regression equation and measure its effectiveness in predicting bread loaf volume.

Description of Accomplishments:

A method for dough expansion utilizing the VDES was successfully developed. When a low protein flour was spiked with commercially purchased vital gluten (final gluten concentration from 7.3 – 14.7%), dough expansion height measured from VDES was significantly correlated with the corresponding baked loaf volume (R^2= 0.94). In a validation study performed on 24 HRW wheat flour samples, VDES dough expansion was significantly correlated to specific baked loaf volume and wet gluten. Another validation study utilizing 33 HRS wheat varieties each grown at three locations namely Brookings, Groten and Selby is being done. The results from analysis of samples from Brookings location indicate that the hybrid SDS-SRC Sedimentation test is applicable to Spring wheat as well. The test may be utilized to measure baking quality of wheat flour. The validation study will also help us determine if the dough expansion is a universal method that can predict bread baking potential of wheat flours. We will also determine if combining the results of dough expansion with results of the chemical test (the hybrid SDS-SRC Sedimentation test) increases the power of prediction of bread loaf volume.

Some important conclusions are listed below:

1. In the gluten concentration range of 7.5 – 14.7 %, low gluten doughs expanded to a lesser degree and higher gluten doughs expanded by a greater magnitude. The expansions, however, were linear. Therefore, dough expansion may be utilized as a rapid and effective tool to measure baking quality of wheat flours flour.

2. The hybrid SDS-SRC Sedimentation method which was originally developed for HRW wheat varieties in Kansas may be utilized for measuring baking potential of HRS and HRW wheat varieties of South Dakota. The test requires one-gram sample and can be completed in 10 minutes.

3. The dough expansion behavior in a weak flour system (low gluten range) provides evidence of the applicability of the VDES for testing effects of dough modification ingredients. This demonstrates that VDES is also an effective tool for evaluating the effectiveness of dough improvers when all other variables are held constant. The VDES shows promise for use in dough rheological tests and may be helpful in devising new instruments that directly measure dough behavior and bread volume.

Projections (for projects that are continuing into FY2019)**:**

Reference data from chemical and enzymatic analysis of HRS and HRW samples will be used to develop Near Infrared Reflectance Spectroscopy calibrations. Spectral data of these samples have been acquired. Predictive models are being developed based on true reference values to speed up measurement. We will determine effective predictive calibrations for protein, oil, fiber content of the wheat and its flour. We will also determine the variability of this data under the influence of genetics and environmental conditions. Proof of concept of the effectiveness of NIRS has been established with cereal crops such as oats. We are developing our own platform for evaluation of crops specific to South Dakota growing conditions.

Interrelationship between grain, flour and dough constituents provide insight into role that nutrient composition plays in food functional traits (Table 1). Our goal is to use the traits selectively to devise powerful predictive models for determining baking quality and other end-use traits.

Publications/Data:

Rajpurohit, B., Sehgal,S. Glover, K., and Krishnan, P. 2018. *Developing and correlating benchtop flour testing and simplified methods for dough evaluation*. Oral presentation at the AACC International Milling and Baking Division Spring Technical Conference, Nashville, TN.

Rajpurohit, B., Sehgal,S. Glover, K., and Krishnan, P. 2018. *Effectiveness of a Vacuum Dough Expansion System in measuring dough expansion attributes for predicting bread loaf volume*. Poster presentation at the Institute of Food Technologists Annual Conference and Food Expo, Chicago, IL.

Table 1. Correlations for Spring wheat, Selby location (N is indicated individually for each relation)

Correlations

		WV	GP	FP	DG	TWG	GWG	LV	DDT	WA	MTI	VDES
WV	Pearson Correlation	1	.469**	.515**	.090	-.106	.432*	.400*	.193	.057	-.155	-.584**
	Sig. (2-tailed)		.006	.002	.617	.557	.012	.021	.282	.754	.388	.009
	N	33	33	33	33	33	33	33	33	33	33	19
GP	Pearson Correlation	.469**	1	.838**	.548**	.413*	.444**	.464**	.155	.224	.129	-.006
	Sig. (2-tailed)	.006		.000	.001	.017	.010	.007	.390	.209	.476	.979
	N	33	33	33	33	33	33	33	33	33	33	19
FP	Pearson Correlation	.515**	.838**	1	.597**	.355*	.518**	.421*	.115	.198	-.001	.082
	Sig. (2-tailed)	.002	.000		.000	.042	.002	.015	.525	.270	.995	.738
	N	33	33	33	33	33	33	33	33	33	33	19
DG	Pearson Correlation	.090	.548**	.597**	1	.833**	.530**	.113	-.242	.291	.052	.431
	Sig. (2-tailed)	.617	.001	.000		.000	.002	.530	.175	.100	.772	.066
	N	33	33	33	33	33	33	33	33	33	33	19
TWG	Pearson Correlation	-.106	.413*	.355*	.833**	1	.234	-.076	-.454**	.215	.154	.537*
	Sig. (2-tailed)	.557	.017	.042	.000		.190	.673	.008	.228	.392	.018
	N	33	33	33	33	33	33	33	33	33	33	19
GWG	Pearson Correlation	.432*	.444**	.518**	.530**	.234	1	.316	.075	.365*	.064	-.035
	Sig. (2-tailed)	.012	.010	.002	.002	.190		.073	.677	.036	.725	.887
	N	33	33	33	33	33	33	33	33	33	33	19
LV	Pearson Correlation	.400*	.464**	.421*	.113	-.076	.316	1	.226	-.049	.105	-.233
	Sig. (2-tailed)	.021	.007	.015	.530	.673	.073		.207	.787	.562	.337
	N	33	33	33	33	33	33	33	33	33	33	19
DDT	Pearson Correlation	.193	.155	.115	-.242	-.454**	.075	.226	1	-.003	.217	-.331
	Sig. (2-tailed)	.282	.390	.525	.175	.008	.677	.207		.985	.225	.166
	N	33	33	33	33	33	33	33	33	33	33	19
WA	Pearson Correlation	.057	.224	.198	.291	.215	.365*	-.049	-.003	1	.070	-.150
	Sig. (2-tailed)	.754	.209	.270	.100	.228	.036	.787	.985		.697	.540
	N	33	33	33	33	33	33	33	33	33	33	19
MTI	Pearson Correlation	-.155	.129	-.001	.052	.154	.064	.105	.217	.070	1	-.177
	Sig. (2-tailed)	.388	.476	.995	.772	.392	.725	.562	.225	.697		.468
	N	33	33	33	33	33	33	33	33	33	33	19
VDES	Pearson Correlation	-.584**	-.006	.082	.431	.537*	-.035	-.233	-.331	-.150	-.177	1
	Sig. (2-tailed)	.009	.979	.738	.066	.018	.887	.337	.166	.540	.468	
	N	19	19	19	19	19	19	19	19	19	19	19

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

WV= Sedimentation test value, LV=Loaf volume, GP=grain protein, DG=dry gluten, GWG=good wet gluten, TWG, Total wet gluten,WA=Water Absorption, MTI=Mechanical, Tolerance Index, VDES=Vacuum dough expansion