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Most Desirable Soft White Wheat for Asian Sponge Cakes

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Introduction

More than 75% of Pacific Northwest (PNW) soft white wheat (SWH) export goes to Asia. In 2014/2015, a total of 2.486 MMT of SW wheat was exported to Asia, and in 2015/2016 (as of Dec 31, 2015), this amount was 2.218 MMT according to the commercial sales data compiled by USDA. A major use of SWH flour in Asia is to make sponge cakes (SC) that often require low protein, low ash, and weak gluten strength flour. However, PNW has grown high protein (10.9% average) SWH wheat in the last two consecutive crop years (2014 and 2015). As a result, low protein SWH demanded a very high price premium compared to average protein SWH. For example, FOB price for SW 10.5% protein (max.) for February 2016 was $243/MT, while its price for 9.5% protein (max.) was $314/MT.

In South Korea, a significant amount of SWH is used for SC production. Wheat millers and bakery buyers rely on protein content as one of the important factors for determining the end use quality. Korean flour millers prefer using lower protein SWH (8.5% wheat protein max.) without blending with WHCB. In early 2016, this low protein SWH demanded more than $100/MT price premium compared to the 10.5% protein SWH. Milling customers who traditionally buy this lower protein wheat hesitated to raise their specs because their customers were not familiar with end use quality

characteristics of higher protein wheat. Thus, 8.5% protein SWH wheat had become the most expensive wheat in the world, which concerned flour mills in Asia and U.S. Wheat Associates (USW) alike. USW was very concerned if SWH had another year of high protein crop, Asian flour mills might consider purchasing similar wheat of other origins and SWH wheat would significantly lose its market share in Asia. Both USW and Asian millers were interested in the actual impact of SWH protein content on the sponge cake baking quality and the function of club wheat in improving Asian sponge cake quality.

Background

A number of studies have been conducted in the past to investigate wheat and flour quality requirements for Asian sponge cake products, but almost all of these studies dealt with individual varieties as research subjects, with the objectives of identifying intrinsic quality traits to improve breeding efficiency. However, in commercial trade SWH varieties are comingled at the country elevators when they are received and stored in different bins or silos based on protein content, falling number, and grade, among other things. As the wheat is transported to the export elevators from different sources, it is blended again to meet each buyer's contract specs. Therefore, a majority of overseas millers actually use in their milling operation is a blend of a few or more SWH varieties, not individual varieties. Moreover, Japanese millers traditionally purchase western white wheat (WW) that contains 20% white club (WHCB) for making sponge cake flour. Therefore, the research results on sponge cake flour quality requirements by studying individual varieties may not be applicable to commercial SWH or WW blend. There is a need to identify SWH quality characteristics that are related to sponge cake baking performance from a commercial operation perspective, i.e., using commercial exportable samples. To show its support from flour milling industry, Daehan Flour Mills in South Korea had sent Mr. Yosep Kim to Wheat Marketing Center (WMC) to assist with this research project. Mr. Kim spent seven months (January to August 2016) at WMC as a Visiting Scholar while conducting this project. We hope the results from this study will provide additional scientific data and help overseas millers revisit their SWH purchase specs to improve profit margins by reducing costs while maintaining high quality standard.

Current Project

In this study, we received four SWH (wheat protein: 8.5%, 9.5%, 10.5%, and 11.5%), and three WHCB (wheat protein: 10.5%, 12.0%, and 13.5%) samples. The wheat was milled on a Miag Multomat pilot flour mill to obtain short patent flour of approximately 40% extraction. Each SWH flour sample was blended with a WHCB flour at ratios of 85%:15%, 75%:25%, and 65%:35% to produce reconstituted WW flour. A total of seven (7)

individual SWH and WHCB and thirty (30) WW flour blends were analyzed for moisture, ash, protein, Farinograph, Mixolab, Alveograph, starch damage, particle size distribution, solvent retention capacity (SRC), falling number, rapid visco analyser (RVA), and Brookfield viscosity of flour-sugar-water slurry. Sponge cake was made and evaluated according to a standard Japanese sponge cake method.

When all data were analyzed altogether, we noted very few significant correlations between sponge cake quality (volume and crumb hardness) and flour quality parameters. These results indicated that SC is a very complex batter system and its quality is not determined by any single flour quality factor when commercial wheat blend is used. Instead, its quality is affected by a combination of flour characteristics and compositions. As a result, to better determine optimal wheat and flour quality specs for superior SC quality, five most-desirable flour samples and five least-desirable flour samples, based on sponge cake specific volume (SCSV) and hardness, were selected for comparative and correlation analyses.

Results showed that the most desirable flour blends for sponge cakes were made of 85% to 75% SWH (10.5% wheat protein) with 15% to 25% WHCB (10.5-12% wheat protein). The maximum flour protein content was 9.4%, which was equivalent to maximum of 10.5% wheat protein. The five most-desirable SC flour blends had slightly smaller median flour particle size (79.6 μm vs. 83.8 μm) and damaged starch (3.3% vs. 3.5%) than the five least-desirable flour blends. The most-desirable SC flour had much higher Brookfield viscosity of flour-sugar-water batter (41.2% sucrose solution) than that of the least-desirable flour (3670 cP vs. 3296 cP). The high flour-sugar-water batter viscosity suggests that Arabinoxylans may be beneficial to sponge cake volume as high batter viscosity helps retain gas bubbles during cake batter mixing that are available for volume expansion during baking.

On the other hand, batter pasting viscosities and final viscosity of flour-sugar-water batter (50% sucrose solution) as measured by the Rapid Visco Analyzer (RVA) were significantly lower for the most-desirable SC flour than for the least-desirable flour, confirming a previous study. Lower batter viscosity during cooling stage minimizes cake volume shrinkage and contributes to larger SCSV. Lactic acid SRC, Farinograph stability, Alveograph W value (dough strength), Mixolab C2 (protein stability at increasing temperature), C3 (starch gelatinization), C4 (hot gel stability), and mixing stability were positively correlated with SCSV. Flour particle size, lactic acid SRC, and Farinograph water absorption were positively correlated with cake hardness, whereas Mixolab C2 and C3 torques were negatively correlated with cake hardness. These correlation results indicated that these flour parameters were associated with sponge cake volume and

hardness, but an optimum range of SWH/WHCB flour composition, flour protein content, flour particle size distribution, lactic acid SRC, Mixolab profiles, and starch gelatinization values was required to achieve large sponge cake volume with soft texture.

Summary Conclusions

In summary, the recommended sponge cake flour specifications are:

1) Wheat

Western white wheat of 85-75% SWH (wheat protein 10.5%) and 15-25% WHCB (wheat protein 10.5-12.0%); 10.5% wheat protein max.

2. Flour characteristics

Protein: 9.4% max.

Median particle size: ≤80 µm

Starch damage: ≤3.3%

SRC Lactic acid: 107-112%

GPI value: 0.66

Farinograph stability time: 2-4 min

Alveograph W value: 80-96 (10^{-4} joules)

Mixolab stability time: 4.6- 5.3 min

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