

## 2009 MAFMA Final Report

<b>Project Title</b>	Effect of Processing on the Fate of Phenolic Compounds and Antioxidant Activity in Wheat Products
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### 1. Objective Summary

The ultimate goal of this project was to increase phytochemical and antioxidant activity in wheat-based products through processing improvements. We specifically evaluated ingredient and process variables in whole-wheat cookie and cracker systems to determine their effects on phytochemical content (free and bound phenolics) and total antioxidant activity. Three specific research objectives were evaluated:

- A. Effect of wheat variety (red vs. white) and milling particle size (traditional vs. fine) in refined and whole wheat wire cut cookie, straight dough cracker, and saltine cracker model systems.
- B. Effect of moisture content and baking time/temp conditions in refined and whole wheat wire cut cookie, straight dough cracker, and saltine cracker model systems.
- C. Effect cook temperature, moisture content during processing, and baking time/temp conditions on intact wheat in shredded wheat cracker systems.

### 2. Objective Accomplishments

#### A. Effect of wheat variety and milling particle size

As expected, the refined control flour had significantly less bound phenolics and lower antioxidant activity vs. the whole grain flours. Due to the substantial diversity of phenolic content in wheat it became important to focus on changes due to processing with one wheat variety in subsequent testing. The quality of analysis was also critical in order to obtain meaningful results. A change in subcontractors for analysis was required due to poor analytical technique resulting in a significant delay in results for this program. Significant

differences were observed free phenolics for flour grind and wheat variety while antioxidant activity was different among flours and grinds in the bound fraction.

### **B. Effect of moisture content and baking time/temp conditions**

Cookie phenolic analysis did not yield significant differences for flour grind, moisture, or baking conditions due to subcontractor error. Straight dough and saltine cracker experimental designs utilized 2x2x2 factorial design with centerpoints for the continuous variables of moisture content and baking temperature. Significant variable differences for free phenolics were determined and conditions to maximize release of free phenolics during processing included lower water content, lower baking temperature, and coarser grind. Antioxidant activity of the free fraction, however, was maximized at the highest water content with low baking temperature and coarse flour grind. Although significant differences were also measured for the variable effect on bound phenolics, the actual values were not greatly different in a practical sense. ORAC antioxidant activity results contained large variability and results were inconsistent across groups and within groups of similar samples.

Saltine crackers were tested in a similar design. Although some variables were significant and the levels of free phenolics were much greater than the straight dough crackers, only minor differences in free or bound phenolics were found across all treated samples. It is likely that the increase in free phenolic levels were due to release of bound phenolics during fermentation. Due to the similarity of measured free and bound phenolics, ORAC testing was not done on saltine crackers.

### **C. Effect of process variables on shredded wheat cracker systems**

The shredded wheat experimental design utilized a 2x2 factorial for cook temperature and moisture target (with replication) and three different toasting temperatures for each cook yielding 54 toasted shredded wheat samples for analysis. Although cook temperature did not significantly affect phenolic analysis, moisture, toasting temperature, and interactions of all three variables were significant for both free and bound phenolics. Process settings to maximize free phenolics and bound phenolics in shredded wheat crackers include low cook temperature, high moisture, and higher toasting temperature. The results for bound phenolics were similar to the results for crackers in that the differences between maximum and minimum bound phenolic content were small from a practical sense. To maximize free antioxidant activity, low cook moisture and high toasting temperature should be used regardless of cook temperature. Antioxidant activity of the bound fraction was greatest at low toasting temperature.

## **3. Unexpected findings**

The large increase in free phenolic measurement in saltine crackers was somewhat unexpected. The average free phenolic content across all 30 treatments and replications for each cracker type rose dramatically as shown in the tables below.

<b>Straight Dough Cracker Phenolics</b>		
	Free	Bound
Low	375.4	880.6
High	800.6	1071.6
Mean	487.1	966.6

<b>Saltine Cracker Phenolics</b>		
	Free	Bound
Low	783.7	881.1
High	963.8	1032.6
Mean	885.0	935.8

There was also poor correlation between total bound phenolics measured by HPLC, Folin, and ORAC methods. This is most likely due to the non-specificity of the Folin method measuring other reducing substances, and antioxidant activity changes during processing due to other substances either present in the wheat (B-Carotene, flavonoids, etc.) or formed/changed during processing (Maillard browning compounds).

#### **4. Practical impacts of research efforts**

##### **a. Short Term Impacts**

We have provided solid evidence of the impact of changing product and process variables on the phenolic content and antioxidant activity of cookie, cracker, and shredded wheat systems. In the case of shredded wheat, the conditions maximizing availability of free phenolics are similar to standard operating conditions currently utilized in the industry. Kraft and other industry manufacturers can utilize this information to help maximize the beneficial release of bound antioxidants in their whole grain food products

##### **b. Long Term Impacts**

While this study contained several screening designs in model baking systems, there is a need for optimization of ingredient and process variables for each particular product. The groundwork laid here will simplify that process for all manufacturers wanting to improve the healthfulness of their products by releasing bound phytonutrients through processing. Results from the saltine cracker testing indicate a large benefit of fermentation to release bound phenolics.

Although the PI is not continuing this specific applied research program, the PI realizes the importance of maximizing the physiological benefits of whole grains and whole grain ingredients. Currently the PI has a Ph.D. student working on bran ingredient processing technologies to maximize the release of bound phytonutrients while maintaining and improving ingredient functional properties. This is part of a larger multi-university research collaboration to develop improved bioactive whole grain food products.

## **6. Publications resulting from this research**

A Publication is in early draft form. The proper credit will be given to USDA for funding the work. A complete presentation of the data has been submitted to Kraft Foods and is included as a separate attachment to this report.