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# Effect of storage and product making on the antioxidant activity of wheat

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## Abstract

**This study presents the results for the effect of storage, chapatti and pasta making on the antioxidant activity of wheat. There was about 25% reduction in the antioxidant activity after 60 days of storage at -20°C, 4°C and RT. But, a sudden decrease in the activity was observed at 60°C within first fifteen days of storage. After making chapatti from the whole meal, a 30% reduction was observed in the antioxidant activity. Semolina production resulted in 45% reduction in the antioxidant activity. This reduction further continued during pasta making and in the final pasta product the antioxidant activity was reduced by 70%. Whole grain based food products like chapatti have more antioxidant activity than the refined products like semolina and pasta which do not contain the bran and the germ portion of the wheat. Therefore, there should be minimum processing of the grains before and during product making so as to have maximum health benefits.**

**Key words:** Antioxidant activity, bran, whole meal, chapatti, pasta, wheat.

## Introduction

Plants contain large number of phytochemicals, many of which act as natural antioxidants. Antioxidants are necessary in the diet since with increasing age and many other external factors, the level of endogenous antioxidants is not sufficient to maintain the redox balance in the body. This imbalance may lead to many degenerative diseases. Natural antioxidants present in fruits, vegetables and cereals can therefore provide additional health benefits (Velioglu *et al.*, 1998; Miller *et al.*, 2000; Kaur and Kapoor, 2001).

Most of the studies on antioxidants have reported their content in the raw foods. But it is the antioxidant content of the final product that is more important. The antioxidant potential and bioavailability depends on the species and variety of grains, fraction of grain and processing conditions. Storage, different forms of processing, formulations and product making can greatly influence the levels of antioxidants in the final product.

During processing, interactions among nutrients and/or antioxidants and/or oxidants, may modify the antioxidant activity of foods. Therefore, a food must be able to withstand these conditions before exerting their potential health benefits. Wheat is a very important cereal and is consumed in different forms as a staple diet in most parts of the world. A number of studies have reported the antioxidant potential of different wheat types and their fractions (Adom *et al.*, 2003; Liyana-Pathirana and Shahidi, 2007a; Okarter *et al.*, 2010; Sedaj *et al.*, 2011). However, very few studies are reported on the antioxidant activity of wheat based food products (Baubles *et al.*, 2000; Hirawan *et al.*, 2010; Angioloni and Collar, 2011).

Food antioxidants are lost in significant amounts as a result of food processing, storage, home handling and cooking (Nicoli *et al.*, 1997). Wheat grain and the milling products for human consumption are subjected to some type of heat processing before being consumed. This may include baking, frying, extrusion, puffing and flaking. Heat processing is known to affect nutrients such as carbohydrates, protein in foods, but its effect on phytochemical content and antioxidant activity is not well investigated. Results from other food systems showed that thermal treatment significantly reduced concentration of natural antioxidants, but the overall antioxidant properties of food products were maintained or even enhanced by the development of Maillard products (Slavin *et al.*, 2000). Effect of storage on antioxidants is not well studied although bread baking quality improves as wheat grain or flour ages during proper storage.

India is the second largest producer of wheat in the world and is consumed in the form of chapatti, bread, biscuit and also as noodles, pasta, daliya (porridge), suji (semolina) and ready to eat breakfast cereals. Around 80% of wheat in India is consumed in the form of chapatti. Therefore, it is important to know the antioxidant activity in the chapatti. This study was aimed to determine the effect of storage at different temperatures on the antioxidant activity of the whole meal and the bran and also to study the effect of processing and product making (chapatti and pasta) on the antioxidant activity of wheat.

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## Material and methods

*Material:* The wheat varieties used in this study were obtained from different growing centers during the seasons 2010-11 and 2011-12. For studying the effect of storage and chapatti making, bread wheat varieties were used, while for pasta making durum wheat varieties were used. All other chemicals and solvents used were of the highest commercial grade.

*Sample preparation and extraction:* To obtain bran, the grain samples were milled in Brabender Quadrumat Senior mill after proper tempering to have a constant moisture content of 14%. Whole meal was prepared in the Cyclotec 1093 mill (Tecator) using 0.5mm screen. Methanol extracts were prepared by adding 1.0 ml methanol to 0.1 g of each sample and shaking for 2h. After shaking, the contents were centrifuged at 2500xg for 10 min. The supernatants were collected as methanol extracts and used for estimating the total antioxidant activity.

*Effect of storage:* Whole meal and bran prepared from 15 wheat varieties were stored at four different temperatures (-20, 4°, RT & 60°C) for 60 days. Samples were analyzed at regular intervals for the total antioxidant activity.

*Effect of chapatti making:* Twenty wheat varieties (Chapatti quality score >7.0) were tested for the effect of chapatti making on the antioxidant potential of the whole wheat flour. Chapattis were cut into small pieces, dried for 24 hrs in the oven at 40°C and grinded in Cyclotec mill using 0.5mm screen.

*Effect of pasta making:* Semolina was prepared from 12 wheat samples with a moisture content of 16.0-16.5% in a Chopin mill. From the semolina then pasta was prepared in La Parmigiana, Italy pasta machine. The dried pasta samples were powdered and passed through the 0.5mm screen of Cyclotec mill. The total antioxidant activity was determined in whole meal, semolina and pasta samples.

*Determination of total antioxidant activity:* The radical cation $ABTS^{+}$ scavenging activity was determined in all the samples by the method of Re *et al.* (1999). All the tests were performed in duplicate. The ABTS radical scavenging activity was expressed as Trolox equivalent antioxidant capacity (TEAC) and defined as µM Trolox equivalent per gram of sample.

*Statistical analysis:* Data were reported as mean ± standard error for duplicate determinations of each sample. ANOVA and Tukey's comparison test were performed using XLSTAT software to identify differences between values. Statistical significance was declared at $P<0.05$.

## Results and discussion

The antioxidant capacities of whole grain products, their role in disease prevention and levels to be consumed remain subjects of intense interest. Grain antioxidants are lost in significant amounts as a result of processing. Antioxidant activity is retained to varying degrees after processing; however, the antioxidant components are likely to undergo a chemical transformation (Marquart *et al.*, 2003; Slavin 2003). In this study, efforts were made to study the effect of post harvest processing including storage and product making on the antioxidant activity of wheat. Storing cereal grains for long time is a very important step of post harvest processing. During storage, depending on the temperature, moisture and other conditions, the various chemical components including antioxidants may undergo chemical changes which may decrease the nutritional quality of wheat. The ageing effect in part is attributed to oxidation that facilitates disulfide bond formation. Oxidation can expend antioxidants resulting in reduced antioxidant activity (Lin *et al.*, 2008).

**Table 1.** Effect of storage on the antioxidant activity of wheat bran and whole meal.

| Storage duration | Mean TEAC values ± SE* | | | |
|---|---|---|---|---|
| | Bran | | | |
| | -20°C | 4°C | RT | 60°C |
| Initial | 8.73 ± 0.24a | 8.73 ± 0.24a | 8.73 ± 0.24a | 8.73 ± 0.24a |
| 15D | 8.24 ± 0.30ab | 8.43 ± 0.28ab | 8.21 ± 0.29a | 5.34 ± 0.24b |
| 30D | 7.42 ± 0.33bc | 7.47 ± 0.32b | 7.12 ± 0.27b | 4.09 ± 0.24c |
| 60D | 6.76 ± 0.36c | 7.37 ± 0.30b | 6.59 ± 0.30b | 3.19 ± 0.14d |
| | Whole meal | | | |
| Initial | 5.24 ± 0.14a | 5.24 ± 0.14a | 5.24 ± 0.14a | 5.24 ± 0.14a |
| 15D | 5.23 ± 0.13a | 4.00 ± 0.12b | 4.46 ± 0.11b | 4.03 ± 0.11b |
| 30D | 3.69 ± 0.08b | 4.22 ± 0.13b | 4.05 ± 0.13bc | 2.91 ± 0.10c |
| 60D | 3.96 ± 0.11b | 3.81 ± 0.11b | 3.83 ± 0.15c | 2.93 ± 0.08c |

* The values are the mean of 15 varieties. Means with the same letter in the same column are not significantly different ($P<0.05$).

The whole meal and bran from 15 wheat varieties were stored at four different temperatures (-20°, 4°, RT & 60C) for 60 days. Samples were taken after every 15 days for antioxidant activity estimation (Table 1). There was around 25% reduction in the activity when the whole meal was stored at -20°C, 4°C and RT for 60 days. The reduction was however, 45% at 60°C. In case of bran there was around 25% reduction at -20°C and RT, only 16% at 4°C and 64% at 60°C after 60 days of storage. At 60°C, the bran observed a very high reduction (38%) in the activity within the first fifteen days. This reduction was however less (22%) in case of whole meal. Significant reduction was visible even after 15 days storage at different temperatures. These results showed that there was not much effect of storage temperature except the higher temperature of 60°C on the antioxidant activity upto 60 days. High temperatures during storage can adversely affect the antioxidant activity. Some varieties exhibited less decrease in the antioxidant activity after 60 days of storage at all four temperatures. Other varieties however showed different trends of antioxidant activity at different temperature conditions and storage durations.

Cheng *et al.* (2006) stored the wheat grains for 9 days under different temperatures (20, 60 and 100°C) and found that regardless of the assay method used, there was no change in the phenolic compound and the antioxidant activity. However, exposure of wheat bran to high temperature (100°C) resulted in partial loss of total phenolic compounds and significant decline in antioxidant activity. Martinez-tome *et al.* (2004) found no change in the antioxidant activity of wheat bran when stored at 40°C for 28 days.

Inclusion of other ingredients containing antioxidants in food formulations helps preserve original wheat phytochemicals from loss resulted from oxidation. Regular chapatti is prepared from the whole meal and during chapatti making, no external ingredient is added except water. During preparation, chapatti is subjected to very high heat and there are chances of degradation of phytochemicals responsible for antioxidant activity. In the present study, it was observed that there was reduction in the antioxidant activity after chapatti making. In 20 selected varieties, the reduction in the activity was between 9 - 44% and on an average there was around 30% reduction in the antioxidant activity (Fig. 1). The variety HS 277 showed the least reduction in the activity in both the years. Other varieties with low reduction in both the years were PBW 343, NW 2036, DBW 14 and HS 240.

Regular semolina is obtained by repeated grinding and sieving of the durum wheat resulting in maximum yield of the granular endosperm product and little amounts of bran powder. Since most of the antioxidant activity is in the bran, the final activity of the semolina is very less as compared to that of the whole grain. Further, during the preparation of pasta, water is added to semolina followed by mixing, extrusion, trimming and drying in the oven at high temperatures. In this study while making semolina from the whole grains on an average around 45% of the activity was lost (Fig. 2).

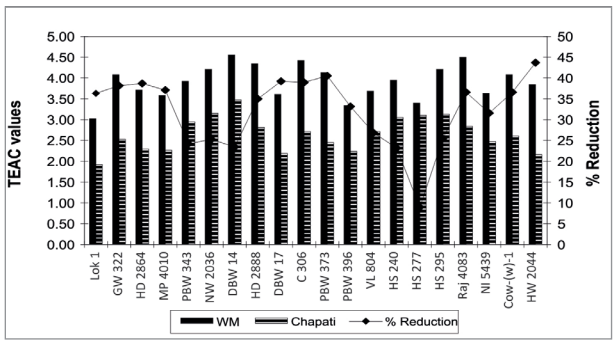


**Fig. 1.** Effect of chapatti making on the antioxidant activity of wheat whole meal.

When the activity of the final pasta product was compared with that of the whole grain, on an average there was around 70% loss of the antioxidant activity. Liyana-Pathirana and Shahidi (2007a and 2007b) also reported around 48% and 60% less antioxidant activity in semolina prepared from CWAD wheat by ORAC and ABTS methods, respectively. Pasta had antioxidant or pro-oxidant properties depending on temperature, time and moisture conditions during the drying process (Anese *et al.*, 1999). Now a days whole wheat pasta is being prepared which has higher antioxidant activity than the regular pasta (Hirawan *et al.*, 2010).

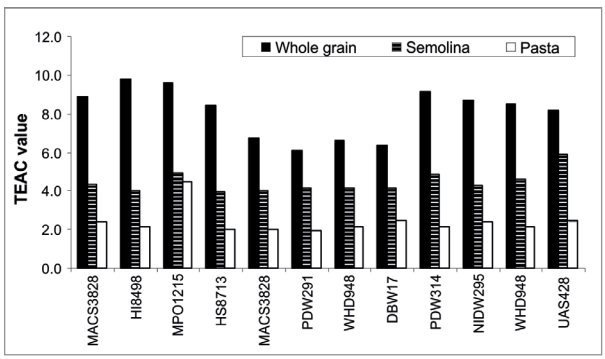


**Fig. 2.** Effect of semolina and pasta making on the antioxidant activity of wheat. The vertical bars represent the standard error.

This study was an effort to study the effect of post harvest processing on the antioxidant activity of wheat grain fractions. Both the bran and whole meal could retain 75% of their activity after 60 days of storage at different temperature. Storage at high temperature drastically reduced the antioxidant activity. After chapatti making, 70% of the antioxidant activity was retained in the final product. But, in case of semolina preparation, almost half of the activity was lost due to removal of bran layer.

When this semolina is used for pasta making, further reduction in the antioxidant activity takes place because of different steps involved especially the hot air oven drying. To retain the maximum antioxidant potential of the wheat grains, minimum processing which can retain the bran and the germ should be involved in making the final product. By consuming whole grain food products we can take advantage of the additional health benefits of wheat antioxidants.

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