

# IMPROVING OXIDATIVE STABILITY OF BEEF BURGERS UNDER CHILLED STORAGE USING CEREAL GRAIN FRACTIONS

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## Abstract

*This paper studied the addition of cereal grain fractions as natural antioxidants source to improving the oxidative stability of beef burgers. The %DPPH scavenging activity of cereal grain fractions added in the chilled storage beef burgers demonstrate that the sorghum milling fractions recorded the highest antioxidants activity (37.28-50.52%) compared with other studied milling fractions. The ability to scavenge DPPH radicals by fractions was in the order of coarse bran > fine bran > whole grain > flour, for all studied samples. Peroxide values (PV) had gradually increased during chilling storage at 5±2°C for 15 days. The highest levels of PV varied from 13.32 to 20.92 (m. equiv./kg fat) after 6 days of chilling storage for all studied beef burgers except the sample with sorghum coarse bran formulas, the highest level was 14 m. equiv./kg fat after only 3 days of storage. Thiobarbituric acid (TBA) values of beef burgers increased throughout storage up to 9 days then decreased with the end of storage periods. This investigation was carried out to study the possibility of using some cereal milling fractions as natural antioxidants led to improve the oxidative stability of beef burgers. Sensory evaluation demonstrated that taste, odor, appearance and general acceptability of all tested meat burgers has not significant changes compared with control.*

**Key words:** oxidative stability, cereal fractions, PV, TBA, burger, sensorial characteristics

## INTRODUCTION

Oxidation is one of the major causes of deterioration of fats and oils leading to the development of rancid odours and taste, and causing a reduction in the shelf life of the fat or oil. Oxidation can also decrease the nutritional quality and safety of lipids through the formation of toxic products in foods after cooking and processing [19]. Phenolic compounds from plant sources may act as antioxidants by scavenging lipid radicals, and in the presence of transition metal ions, phenols may act as both radical scavengers and metal chelators [1]. Beef burgers are made from ground beef and have high lipid content. Typical composition of ground beef is about 18% lipids and its fatty acids content is divided into 46% saturated, 51% mono-unsaturated and 3% poly-unsaturated [10]. The ability of unsaturated fatty

acids, especially those with more than two double bonds and induced by irradiation processes, to rapidly oxidise, is important in regulating the shelf life of meat rancidity and colour degradation [28]. In order to inhibit the development of oxidative reactions in meat products, natural and synthetic antioxidants have been commonly used in meat industry [7]. Stodolak *et al.* (2007) reported that the effect of phytic acid addition (0.1, 1 and 5 mM) to pork and beef homogenates on thiobarbituric acid reactive substance (TBARS) and metmyoglobin levels in raw meat, and TBARS and hem iron contents in cooked meat during 3 days of storage at 4°C, its effectively decreased the TBARS accumulation in raw and cooked meat homogenates. Wheat, sorghum and corn are cereal grains rich in antioxidants, which make them excellent sources for increased health benefits [20]. By using natural antioxidants, there is a potential advantage of reducing or replacing synthetic ones, reducing the production of off-flavors, with a greater

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acceptance by the consumer [6]. Therefore this investigation was carried out to study the possibility of using some cereal milling fractions which contain high levels of phenolic compounds and phytates as natural antioxidants source to improve the stability of meat burger.

## MATERIAL AND METHODS

**Materials:** Three cereal grains: wheat (*Triticum aestivum* L.) Sids 1, corn (*Zea mays* L.) Hybrid 310 and sorghum (*Sorghum bicolor* L.) Giza 15 was obtained from Faculty of Agriculture farm, Sohag University, Sohag Governorate during the 2010 season. Beef meat obtained from local market in Sohag city. The samples receipt at the laboratory, were washed carefully then deboned within two hours after slaughtering, coarsely minced using a meat mincer and used in burger processing (71.5%). Salt (1.5%), onion (7%), egg (5%) and bread crust powder (5%) were obtained from the local market. Soy bean meal (10%) was purchased from the Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

**Milling:** All grains were dried then conditioned by rising its moisture content up to 14% and left for 24 hours as tempering time. Milling was run in a Brabender Quadrumat® Senior Duisburg experimental mill (type 880200) by progressively receiving the milling fractions (patent flour, fine bran and coarse bran), according to [25].

**Preparation of beef burger:** Fresh burger samples were prepared as described by [17]. All ingredients were minced twice. The mixture was shaped manually using a patty marker (stainless steel model "Form") to obtained round discs of 10 cm diameter and 0.5 cm thickness with average weight 50 g. Burgers were packaged in polyethylene bags (in foam dishes). The burger was stored in cooling up to 15 days at  $5\pm 2^\circ\text{C}$ . The studied beef burger formulas were divided to six parts, the first formula was remained with bread crust powder (control) and the other five formulas were individually replaced the bread crust powder with different fractions of wheat, sorghum and corn to give five treatments (coarse and fine bran of wheat and sorghum and semolina of corn fractions).

## Methods:

**Extraction of total antioxidants:** Ten grams of dry sample was ground fine using a coffee grinder, weighed and transferred into a test tube (25 x 150 mm). 40 mL of methanol as extraction solvent was added in a test tube and vortexes to mix with the sample well triplicate. The test tubes were capped and incubated at  $60^\circ\text{C}$  in the water bath for 20 min and vortexed twice during the incubation. Then, the solvent layer from each test tube was separated by centrifugation at 2000 rpms for 15 min. The supernatant solvent was transferred to clean, previously weighed and labeled test tubes. The residue was mixed with 20 mL of the same solvent again and mixed at vortex. The combined supernatant solvent was removed by using a rotary evaporator. The dried extract in the test tube was weighed to measure the extraction yield of the sample and kept in the freezer set at  $-20^\circ\text{C}$  prior to testing [20].

## Determination of antioxidant activity by DPPH radical scavenging method:

0.2 g of each dried whole flour extracted was re-dissolving in 10 mL methanol. 2 mL of the DPPH solution (0.025 g in 1000 mL of methanol) was mixed with 100  $\mu\text{L}$  of the sample extract/methanol solution and transferred to a cuvette. The reaction solution was measured after 30 min incubation at room temperature using a spectrophotometer at 517 nm [29]. The inhibition percentage of the absorbance of DPPH solution was calculated using the following equation:

$$\text{Inhibition\%} = \frac{(\text{Abst}=0 \text{ min} - \text{Abst}=30 \text{ min}) / \text{Abst}=0 \text{ min}}{\times 100}$$
 Where  $\text{Abst}=0 \text{ min}$  was the absorbance of DPPH at zero time and  $\text{Abst}=30 \text{ min}$  was the absorbance of DPPH after 30 min of incubation.

**Evaluation of burger:** The beef burgers were sensorial evaluated immediately after manufacturing as well as the values of peroxide and thiobarbituric acid was estimated during storage for 3, 6, 9, 12 and 15 days at  $5\pm 2^\circ\text{C}$ .

**Peroxide value determination (PV):** Peroxide value as an indication for lipid oxidation was determined according to method of AOAC (2000).

**Thiobarbituric acid values (TBA):** Thiobarbituric acid (TBA) values were

determined in burger samples according to the method of Lemon (1975) to evaluate efficiency of additives as natural antioxidants. The absorbance was measured using ultraviolet visible scanner spectrophotometer (LKB 4054 Cambridge, England) at 538 nm. The TBA values were calculated by multiplying the absorbance by the factor of 7.8 and the result was represented as mg of malonaldehyde per kg sample.

**Sensory evaluation:** Sensory evaluation of prepared beef burgers were performed by a panel of ten judges and included two replications. The order of presentation of the samples to the panel was randomized. The samples were descriptively characterized, pointing out the most relevant sensory characteristics [23]. The obtained data were statically analyzed.

**Statistical analysis:** Data were statistically analyzed by analysis of variance (ANOVA) using the statistical package MSTATC program, and least significant differences (L.S.D) at  $P \leq 0.05$ .

## RESULTS AND DISCUSSIONS

### Total antioxidant activity of cereal grains:

The results presented in Table (1) demonstrate the %DPPH scavenging activity of cereal grain fractions. Sorghum milling fractions recorded the highest antioxidants activity ranging from 37.28% for whole grain to 50.52% for coarse bran. Coarse bran of

sorghum and corn recorded high levels of antioxidant activity. This may be due to coarse bran contain highest level of phenolic compounds and phytates as antioxidant compounds. The results are in accordance with that reported by Liyana-Pathirana and Shahidi (2007), the ability to scavenge DPPH radicals by wheat fractions was in the order of bran > shorts > feed flour > whole grain > flour, for two wheat cultivars. Iqbal *et al.* (2007) found that the remaining amount as % of DPPH radical at 5 min after initiation of the reaction was 24, 30, 38, 43, and 48% for five wheat varieties bran. Free radical and radical action scavenging activity were comparable to previous findings for wheat bran of different varieties from USA [30]. The DPPH scavenging activity of purple wheat bran extract was 63.17%. [13]. The presented data are in agreement with Awika *et al.* (2004), they concluded that, sorghum grains and bran had significantly higher phenols and antioxidant activity than other cereals. Bran from wheat, barley, buckwheat, and rice, among others, are promoted as good sources of antioxidants [22, 31, 29]. Such bran is sold in the market for use in fortified baked products. Black sorghum bran offers a major advantage in terms of antioxidant value per unit weight. The sorghum bran can be used as a high value source of antioxidants at lower quantities than other cereal bran, or used at similar quantities to provide higher antioxidant activity in products.

Table 1 The %DPPH scavenging activity of cereal grains fractions\*

Cereal grains	Milling fractions			
	Flour	Fine bran	Coarse bran	Whole flour
Sorghum	34.55±3	40.39±4	50.52±5	37.28±0.9
Wheat	30.71±3	38.41±3	36.89±4	34.44±0.8
Corn	28.84±4	32.75±4	45.71±5	33.05±2

\*Mean ±SD

### Effect of cereal grains by-products addition on peroxide value (PV) of beef burger:

Results presented in Figure1 illustrated the changes in peroxide values (PV) of treated beef burgers during storage for 15 days at  $5 \pm 2^\circ\text{C}$ . PV of beef burger formulas increased during storage and reached to the highest values after 6 chilling storage days. Moreover, PV of all beef burger formulas tended to significant increase with the progressive of storage period then decrease

suddenly at the end of storage period. A decrease in PV was most likely due to the decomposition of hydroperoxide, a primary oxidation product, to the secondary lipid oxidation products [5]. The highest levels of PV were after 6 days in all beef burger formulas followed by a sharp decrease. This was in the same trend with Maqsood and Benjakul (2010), they studied the changes in PV and TBARS of ground beef treated without and with tannic acid as

phenolic antioxidant during chilling storage. They showed that a gradual increase in PV was found in all samples throughout the chilling storage period of 15

days ( $P \leq 0.05$ ), except for the samples without tannic acid treatment, in which the PV decreased markedly after 9 days of chilling storage ( $P < 0.05$ ).

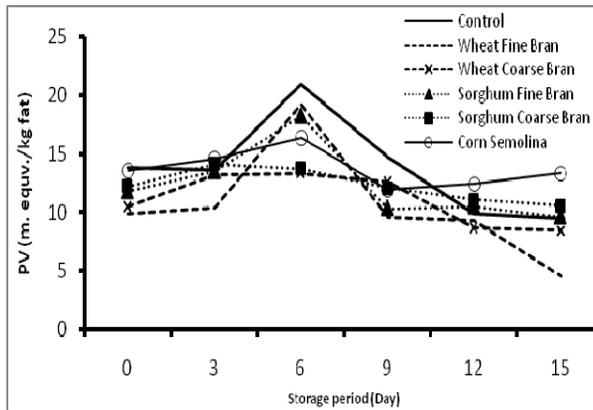


Figure 1 Peroxide values (m. equiv. /kg fat) of beef burger formulas during storage for 15 days at  $5\pm 2^{\circ}\text{C}$

**Effect of cereal grains by-products addition on thiobarbituric acid value (TBA) of beef burgers:** The thiobarbituric acid value (TBA) test is a sensitive test for the decomposition products of highly unsaturated fatty acids which do not appear in peroxide value determination [16, 18]. The results

presented in Fig. 2 showed the changes in thiobarbituric acid (TBA) values (mg malonaldehyde / kg) of beef burger with addition of cereal grains by-products (5%) during storage at  $5\pm 2^{\circ}\text{C}$  up to 15 days compared with the control.

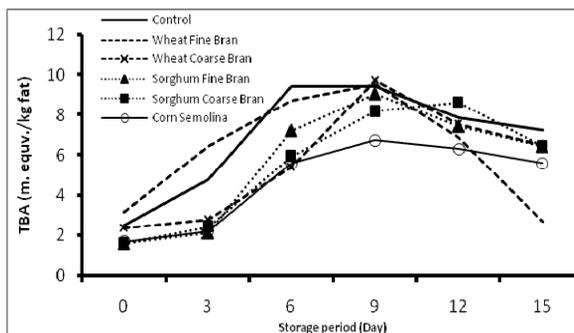


Figure 2 Thiobarbituric acid values (mg malonaldehyde/kg) of beef burger formulas during storage for 15 days at  $5\pm 2^{\circ}\text{C}$

The initial TBA values varied from 1.58 to 3.12 mg/kg for the studied burger formulas which are in agreement with Al-Mrazeeq *et al.* (2008) (2.26 mg/kg meat). It could be noticed that TBA values of all beef burgers were gradually increase during storage periods up to 9 days at  $5\pm 2^{\circ}\text{C}$ , (6.73-9.73 mg/kg) except sorghum coarse bran formula recorded the

highest value (8.62 mg/kg) after 12 chilling storage days. The TBA values decreased up to 7.23, 2.66, 6.50, 6.44, 6.45 and 5.60 mg/kg for control and burgers formulated with wheat fine bran, wheat coarse bran, sorghum fine bran, sorghum coarse bran and corn semolina after 15 chilling storage days respectively. Oxidation of unsaturated fatty acids occurs

extensively during the chilling and frozen storage of beef, poultry and fish meat. It is considered a major cause of meat quality deterioration. Undesirable changes in color, flavor and nutritive value occur as meat lipid are oxidized and interact with other meat constituents such as pigments, proteins and vitamins [24]. Data also revealed that the

addition of milling by-products (5%) in beef burger may refer to decrease of lipid oxidation for raw beef burger especially the wheat fine bran formula; this probably was due to the presence of other natural antioxidants in cereal grain milling fractions which could retard lipids oxidation during chilling storage.

Table 2 Sensory evaluation of different beef burger formulas

Burger formula	Color (10)	Taste (10)	Odor (10)	Appearance (10)	acceptability (10)
Control	7.08	7.00	6.69	7.08	6.96
Wheat fine bran	6.92	7.31	7.15	7.38	7.19
Wheat coarse bran	7.08	7.23	6.77	7.38	7.12
Sorghum fine bran	7.23	7.62	6.85	7.23	7.23
Sorghum coarse bran	7.62	7.85	7.23	7.15	7.46
Corn semolina	7.62	7.77	6.92	7.31	7.40
Main	7.26	7.46	6.94	7.26	7.23
LSD	0.8339	0.9838	1.029	1.03	0.8003
	NS	NS	NS	NS	NS

Main value of 10 replicates

There were significant differences among all studied beef burger formulas and during chilling storage period in their TBA values. Karema and Badr (2011) reported that the oxidative reactions are enhanced in meat products after mincing and restructuring as well as during chilling storage due to the interaction of unsaturated fatty acids with prooxidants, also the extent of oxidation significantly decreased with increasing the added wheat bran in burger samples after refrigerate storage ( $4^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ).

**Sensory evaluation of beef burger formulas:** Data showed that there were no significant differences between all beef burger formulas compared with the control in their color, taste, odor, appearance and general acceptability (Table 2). The mean values of general acceptability ranged from 6.96 to 7.46 for the control and sorghum coarse bran formula, respectively. The results are in agreement with those reported by Karema and Badr (2011). They found that the beef burger formulated with wheat bran had no adverse effects on the acceptability of their color and appearance as well as their odor. Moreover, the formulation of beef burger with partial replacement of different cereal bran produced acceptable samples compared with the control in their consistent

texture, adequate juiciness and good flavor. Feiner (2006) reported that the wheat fiber is neutral in taste and help to retain moisture and fat leading to producing of a more succulent and juicy meat product.

## CONCLUSIONS

In the oxidation analysis, the results indicated that TBA value and PV increased throughout the 15 chilling storage days at  $5 \pm 2^{\circ}\text{C}$ . Results showed that the addition of cereal grain fractions as natural antioxidants led to improve the oxidative stability of beef burgers. These results demonstrate that the utilization of cereal grain brans' in beef burger could be able to slow the oxidation rate without any negative influence on the studied sensorial characteristics (color, taste, odor, appearance and general acceptability).

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