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A review on: Antioxidant and its impact during the bread making process

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Abstract: Antioxidant compounds in food play an important role as a health protecting factor. Major sources of naturally occurring antioxidants are fruits, vegetables and whole grains. This review is focused on the classification, characteristics and mechanism of antioxidant and methodology were reported. Bread and bakery products have an important role in human nutrition. This review is focused also on Changes in antioxidant activity during the bread making process (mixing or dough, fermentation, and baking) and also antioxidant properties in the sourdough. The effects of heat on the antioxidant activity during bread making were reported. The addition of phenols-rich materials with wheat bread is an effective technique to improve the antioxidant potential of the final product.

Keywords: Antioxidant, Classification, Characteristics, Mechanism, Changes during the Bread Making

1. Introduction

Antioxidants are our first line of defense against free radical damage, and are critical for maintaining optimum health and wellbeing and Antioxidant compounds in food play an important role as a health protecting factor. major sources of naturally occurring antioxidants are fruits , vegetables and whole grains, . Free radical damage may lead to cancer. However, fruits and vegetables contain many different antioxidant components [24] Examples of antioxidants include beta-carotene, lycopene, vitamins C, E, A , phenolic acids, phytate and phytoestrogens [6][25]. Most of the antioxidant compounds in a typical diet are derived from plant sources and belong to various classes of compounds with a wide variety of physical and chemical properties. Some compounds, such as gallates, have strong antioxidant activity, while others, such as the mono-phenols are weak antioxidants [1].The main characteristic of an antioxidant is its ability to trap free radicals. Highly reactive free radicals and oxygen species are present in biological systems from a wide variety of sources. Antioxidant compounds like phenolic acids, polyphenols and flavonoids scavenge free radicals such as peroxide, hydro peroxide or lipid peroxyl and thus inhibit the oxidative mechanisms that lead to degenerative diseases. There are a number of clinical studies suggesting that the antioxidants in fruits, vegetables, tea and red wine are the main factors for the observed efficacy of these foods in reducing the incidence of chronic diseases including heart disease and some cancers [1].Cereal grains are also a good source of antioxidants. Phenolic acids are the main antioxidants in cereal grains, which seem to have the greatest potential to be beneficial to our health as a result of their scavenging free radicals, inhibition of lipid peroxidation, and thus their anticancer activity [22][26]. Phenolic compounds in cereals exist in free, soluble conjugated and bound forms, where the bound form represents the major proportion of phenolic acids [26][27].The Bread and bakery products have an important role in human nutrition. Generally, wheat bread is considered to be a good source of energy and indispensable nutrients for the human body.

2. Classification of Natural Antioxidants

The antioxidants in food systems may be classified by using diverse indicators. Depending on the origin and the methods of production, food antioxidants may be synthetic or natural. The natural antioxidants they are the chain breaking antioxidants which react with lipid radicals and convert them into more stable products. Antioxidants of this group are mainly phenolic in structures and include Antioxidants minerals for examples (selenium, copper, iron, zinc and manganese), Anti-oxidants vitamins for example (vitamin C, vitamin E, vitamin B), Phytochemicals for example (Flavonoids, Catechins, Carotenoids, Beta carotene, Lycopene, Herbs and spices-source) [6]. The synthetic antioxidants these are phenolic compounds that perform the function of capturing free radicals and stopping the chain reactions for example butylatedhydroxyanisole (BHA), but ylatedhydroxytoluene (BHT) and tertiary butyl hydroquinone (TBHQ) [2][6].

3. Characteristics of Antioxidants

The major antioxidants presently used in foods are monohydroxy or polyhydroxy phenol compounds with various ring substitutions. These compounds have low activation energy to donate hydrogen. Hence, the resulting antioxidants radical does not initiate another free radical due to the stabilization of the delocalized radical electron. Publishing and initiation of free radicals chain reaction can be delayed or minimized by the donation of hydrogen from the antioxidants and metal chelating agent. The resulting antioxidant free-radical is not subject to rapid oxidation due to its stability. Antioxidants free-radicals can also react with lipid free radicals to form a stable complex compound thereby preventing some of their damages [6].

4. Mechanism of Antioxidants

In food system, the most effective antioxidant functions by interrupting the free radical chain mechanism. Antioxidants have been broadly described as “all substances that inhibited oxidation reactions, regardless of the mechanism,” and narrowly as “those compounds that interrupt the free-radical chain reaction involved in food oxidation and those that scavenge singlet oxygen [6][3]. The biological term antioxidant refers to “any substance that when present at low concentrations compared with those of an oxidizable substrate, significantly delays or prevents oxidation of that substrate [6][3]. In order to fully understand the mechanism of action of antioxidants, one must understand the mechanism of chemical oxidation. Oxidation, in the broadest sense, is simply the removal of an electron from an atom or molecule. This is paired with a reduction reaction in which the electron or electrons involved are added to another atom or molecule. In biological, and food systems, oxidation reactions can generate a reactive species and initiate a free radical chain reaction. An example of this is illustrated

Initiation:

$R_2RN_2R \rightarrow 2R^{\bullet} P + N_2$

$R^{\bullet}P + OR2R \rightarrow ROOP^{\bullet}$

$ROOP \bullet P + LH \rightarrow ROOH + LP^{\bullet}$

Propagation

$L^{\bullet}P\ P + OR2R \rightarrow LOOP^{\bullet}$

$LOOP \bullet P + LH \rightarrow LOOH + LP \bullet$

Inhibition

$LOO^{\bullet}P\ P + AH \rightarrow LOOH + A^{\bullet}P$

Termination

$AP \bullet P + (n - 1)\ LOOP \bullet P \rightarrow$ non radical products

$LOOP \bullet P + LOOP \bullet P \rightarrow$ non radical products

4.1. Antioxidant Activity Using (DPPH) Radical Scavenging

The principle of this assay is based on the measurement of the scavenging ability of the antioxidants towards the stable radical. The free radical DPPH is reduced to the corresponding hydrazine, when it reacts with hydrogen donors, this stability is evaluated by decolorizing assay, which evaluates the decrease in absorbance at 517 nm produced by the addition of antioxidant to DPPH solution in ethanol. The scavenging reaction between (DPPH) and an antioxidant (H-A) can be written as:

DPPH) + (H-A)

(Purple) ⟶ (Yellow)

The color turns from purple to yellow as the molar absorptivity of the DPPH radical at 517 nm. The degree of discoloration indicates the scavenging potential of the antioxidant compounds or extracts in terms of hydrogen donating ability [4].Antioxidants react with DPPH, which is a stable free radical and is reduced to the DPPH- H and as a consequence the absorbance’s decreased from the DPPH radical to the DPPH-H.

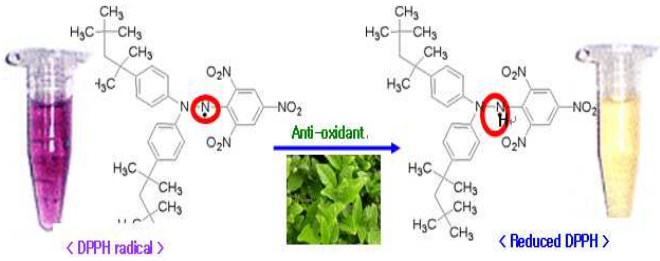

Fig. 1. *2, 2'-diphenyl-1-picrylhydrazyl, 2, 2'-diphenyl-picrylhydrazine.*

4.2. Antioxidant Activity Using β Carotene Bleaching Assay

The antioxidant activity has also been assessed as ability to prevent from oxidation. This method usually used to evaluate the antioxidant activity of compounds in emulsions, accompanied with the coupled oxidation of b-carotene and linoleic acid. In the BCB assay, the oxidation of linoleic acid generates peroxyl free radicals due to the abstraction of a hydrogen atom from diallylic methylene groups of linoleic acid.

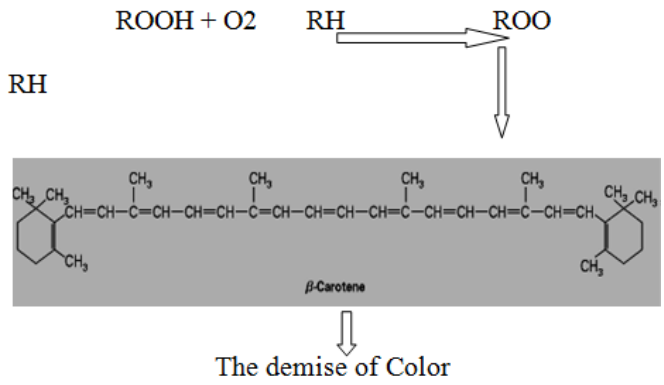

Fig. 2. *Antioxidant interaction (BCB).*

4.3. Antioxidant Activity Using Reducing Power

The reducing power of a compound may serve as an indicator of it antioxidant activity. The presence of reductants such as antioxidant substances causes the reduction of Fe3+/ferricyanide complex to fe2+/ ferrous form. Therefore, the reducing power of the sample could be monitored by measuring the formation of Perl's Prussian blue at 700nm [23].

In this analysis, the presence of antioxidants caused the reduction of the Fe3+/ferricyanide complex to the ferrous form and the yellow color of the test solution changed to various shades of green and blue depending on the reducing power of each compound.

4.4. Antioxidant Activity Using ABTS

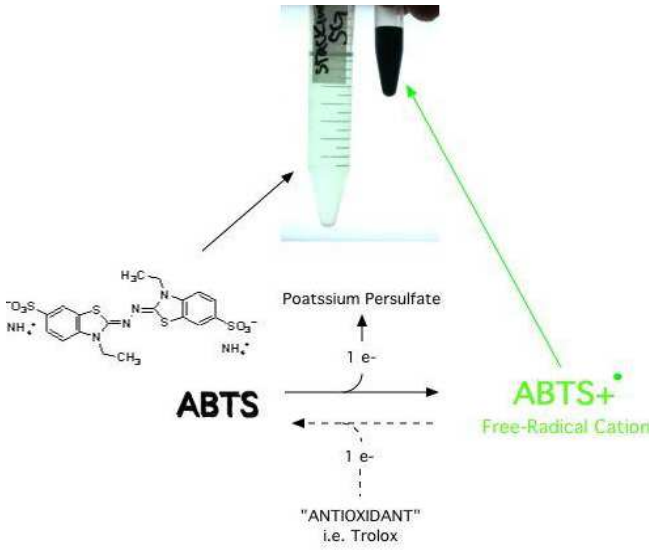

Fig. 3. *ABTS (2, 2'-azino-bis (3ethylbenzthiazoline-6 sulphonic acid).*

ABTS is chemical compound used to observe the reaction kinetics of specific enzymes. A common use for it is in the enzyme-linked immunosorbentassay (ELISA) to detect for binding of molecules to each other. ABTS is converted to its radical cation by addition of sodium per sulfate. This radical cation is blue in color and absorbs light at 734 nm [4]. The ABTS radical cation is reactive towards most antioxidants including phenolic, thiols and Vitamin C [5]. During this reaction, the blue ABTS radical cation is converted back to its colorless neutral form. The reaction may be monitored spectrophotometrically. This assay is often referred to as the Trolox equivalent antioxidant capacity (TEAC) assay. The reactivity of the various antioxidants tested is compared to that of Trolox, which is a water-soluble analog of vitamin E.

4.5. Changes in Antioxidant Activity during the Bread Making Process

The processing of bread can be divided into three basic operations: mixing or dough, fermentation, and baking. Optimum baking processing depends on the type of bread to be baked and the desired bread characteristics [26]. It has been found that the antioxidant potential in bakery products is strongly dependent on manufacturing conditions and recipes [11][26] showed that antioxidant activity and free phenolic acid levels were reduced by mixing, but recovered after fermentation and baking. They explained this increase by the fact that bonds with antioxidants are hydrolysedduring fermentation, releasing antioxidants. Phenolic acid recovery after baking was 74-80%.In the Comparison to baker's yeast wheat bread, sourdough wheat (durum and Kamut) offered more antioxidant protection[12].The aim of another study was to investigate the fermentation behavior (spontaneous fermentation for 18 h at 30 and 40 C), antioxidant activity and rheological behavior of sourdoughs prepared with Lactobacillus helveticusand Kluyveromycesmarxianus. The type of fermentation and the metabolic activity of LAB influenced the levels of bioactive compounds enabling the increase of the phenolic content of the sourdough [9][13]. The antioxidant properties of the sourdoughs are correlated with the metabolic activity of the microorganisms, the DPPH radical scavenging activity being higher for the optimum conditions of L. Helveticus growth. The antioxidant properties of the sourdough were highly influenced by the metabolic activity of the lactic acid bacteria and yeasts used for fermentation. The antioxidant activity of the controls (sourdough prepared without starter culture) was lower compared to samples fermented with L. helveticusand K. marxianus, regardless of flour type, fermentation temperature or dough yield [14].

Baking is the most common manufacturing process applied to bread, involving thermal and moisture conditions that facilitate the Maillard reaction (MR) and, at the sametime, the destruction-formation of natural-labile and thermally-induced antioxidant compounds, respectively [10] [26]. In another study, increased baking temperature promoted antioxidative activity in the crust but not in the crumb. Crusty bread baked in loose form had higher antioxidant capacity than tin bread, particularly in the crust; longer baking times also led to higher antioxidant capacity values [15]. While an increase in antioxidant activity in bread made of 100% wheat flour was observed during bread making. [17] found that baking had a negative impact on antioxidant properties of gluten-free breads, and polyphenol content was generally found to be reduced in the bread

samples when compared in original seeds. They showed that, in the case of wheat bread 40% replaced with barley flour, the amount of free phenolic decreased by up to 23.5% during the baking process, while the amount of bound phenolic increased [18][22]. At the same time, the measured antioxidant activities were relatively stable during the baking process. The addition of phenols-rich materials with wheat bread is an effective technique to improve the antioxidant potential of the final product [20] [26]. Wholegrain buckwheat flour is a good source of phenols and possessed good antioxidant activity [21]. Buckwheat bread had a highest content of phenolic compounds [8] [16]. The addition of buckwheat flour to wheat flour can increase total phenols concentration and improve antioxidant status of bread. Baking temperature influenced significantly more the loss of total phenols in wheat flour than in buckwheat flour and increase of antioxidative activity in bread samples by the formation of products of Maillard's reaction [7]. These interactions between added phenolic and bread proteins, and starch influenced the antioxidant capacity, protein and starch digestibility or functional properties of fortified Bread. The thermal processing exerts a significant effect on the antioxidant activity of cell-free systems [19]. It is possible that thermal processing can increase the bioavailability of phenolic, and increase antioxidant activities [26]. Thus, further experimental clarification is needed.

5. Conclusion

This review is focused on classification, characteristics and mechanism of antioxidant and methods of antioxidant evaluation and Changes in antioxidant activity during the bread making process (mixing or dough, fermentation, and baking) and effect antioxidant activity during bread making. The addition of phenols-rich materials with wheat bread is an effective technique to improve the antioxidant potential of the final product.

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