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Chemical constituents and biological activity of Natural plant sources used against enzymatic browning - A review

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Abstract
Enzymatic browning is a common problem affecting many fruits and Vegetables during post harvest handling. Today the food processing industries need to focus on the freshness of minimally processed fruits and vegetables in order to attract more consumers. Any food product is chosen by the consumers with its appearance. Browning usually impairs the color attribute together with sensory properties such as flavor and texture (softening). However, this process is sometimes desirable, as it can improve the sensory properties of some products such as dark raisins and fermented tea leaves (enzymatic browning) cause deterioration of food during storage and commercial or domestic processing. This review highlights the role of Naturally occurring substances as Antibrowning Agents and reviews the available literature reporting Antibrowning properties of a number of plants extracts.
Key words: Enzymatic Browning, Polyphenol oxidase, fruits, vegetables.

INTRODUCTION

Today consumer awareness enforced the food processing industries to focus on the freshness combined with minimally processed fruits and vegetables. Food product is chosen by the consumers with its appearance and color is a critical determinant for the appearance of fruits and vegetables. Hutchings summarized the expectations of people towards food[1]. Thus there is an increasing consumer trend to select food demonstrating good quality as described by good color, texture, and flavor, in addition to high nutritional value, microbial safety and convenience. In order to cope up the demand for quality, fruit and vegetable processors expend considerable efforts to improve product quality from the beginning to the end of the preservation process[2].

An important aspect faced by us is Browning reaction. It usually impairs the color attribute together with sensory properties such as flavor and texture. However, this process is sometimes desirable, as it can improve the sensory properties of some products. Browning occurs by 2 components: enzymatic and nonenzymatic oxidation. Specifically, reactions of amines, amino acids, peptides and proteins with reducing sugars and vitamin C (nonenzymatic browning, often called Maillard reaction browning) and quinones (enzymatic browning) cause deterioration of food during storage and commercial or domestic processing.

ENZYMATIC BROWNING

Enzymatic browning is one of the most studied reactions in fruits and vegetables during handling, processing and storage. The main enzyme involve in browning reaction is polyphenol oxidase (PPO, Ec 1.14. 18.1). The activity of PPO has been extensively studied and reported as the key factor in browning reaction[3]. PPO, also called tyrosinase, phenol oxidase, cresolase are copper containing enzyme, synthesized in plants and stored in chloroplast[4]. PPO catalyzes the O-hydroxylation of monophenols to O- diphenols, which are further catalyzed to produce O-quinones. Once formed, these quinones undergoes polymerization reactions leading to the production of black, brown or red pigments (Polyphenols) which is the cause of enzymatic browning in fruits and vegetables. A variety of fruits and vegetables, such as apple, pear, banana, peach, lettuce and potato, are especially susceptible to enzymatic browning during processing and storage. Browning not only has a negative effect on their appearance, but also may impair other sensory properties including taste, odour and texture, as well as nutritional value[5,6]. Unlike traditionally processed foods, fresh-cut products consist of living tissues and sustain substantial tissue injury during processing[7]. It is desirable to inactivate the PPO activity during preservation of foods. The understanding of browning and its control from harvesting to consumption is therefore important for minimizing losses and maintaining the economic profitability of the fruit and vegetable processors.

USE OF ANTI BROWNING AGENTS

Antibrowning agents that inhibit PPO activity are largely classified into two groups; reducing agents and enzyme inhibitors. Additionally, the enzyme inhibitors are divided into competitive and noncompetitive compounds[8]. The reducing agents such as Sulphites[9,10,] Sulfur-containing compounds[9], Ascorbic acid and its derivatives[10,11], Acidulants[12], Halide salts[11,12,13], Phenolic acids and substrate

analogs[14,15,16], Other sources as antioxidants[15,17,18].

Combination use of antibrowning agents:

The combined use of anti-browning agents often demonstrated additional or synergistic effects to inhibit discoloration of fruits and vegetables[19,20,21].

Browning of fresh cut fruits and vegetables can be controlled by ascorbic acid and its derivatives due to their reducing properties; however these effects are temporary. Long-term antibrowning effects can be achieved by sulphur dioxide and sulphites. Thus, these food additives are industrially used to inhibit PPO-induced browning reactions for a wide range of products sold as intermediate products to gastronomic business areas[22]. However, sulphiting can reduce the uptake of thiamine by degradation of the vitamin and lead to asthmatic reactions in sensitive individuals[22,23]. Hence, the replacement of such compounds is an important issue for the food industry. There are several approaches have been explored however owing to concern about the food safety only a few substances and methods have shown potential in food industry[24]. Thus, further investigation of alternative methods is required. One approach is the application of plant extracts to inhibit browning in fruits and vegetable products.

Phytochemicals with antibrowning properties

Due to the lifesaving and therapeutic properties, plants have been used by native people from ancient times. Herbal constituents are adventitious over synthetic alternatives. Phytochemicals in the extracts of various plants are capable of treating fruits and vegetables against browning. Some of the bioactive components from plants have been investigated and have shown potential to cure browning of fruits and vegetables. Apple slices treated with pumpkin seed extract showed greatest inhibition of browning [24]. The inhibition of tyrosinase by lariciresinol glycosides from species of Lamiaceae found that diglycosides are less potent inhibitors than glycosides, probably because of a lack of free hydroxyl groups[25]. Promising results have been obtained with rhubarb juice, pineapple juice, and green tea extract, which were all able to prevent discolouration of cut surfaces of apples[26,27,28]. It was shown that onion extract can inhibit browning of pears and attributed it to the thiol-containing compounds[29]. Isoflavones from soy hypocotyl extract also act as an inhibitor of apple PPO[24]. Tyrosinase inhibition by isoflavones that are contained in soy was also demonstrated it was found that daidzein, glycitein, daidzin, and genistin act as competitive inhibitors that reversibly inhibit the monophenolase activity of mushroom tyrosinase[30]. The antioxidative properties of hibiscus (*H. sabdariffa*) flavonoids (e. g. hibiscitrin, gossytrin, quercetrin, sabdaretin, and gossypetin-8-, -7- and -3-glucosides) and anthocyanins (e. g. cyanidin-3-diglycosides and cyanidin-3,5 bismonoglucoside) might explain the PPO inhibition[31]. The potential anti-browning properties of dried papaya latex, water extract of Moringa seeds, pectin and lemon juice in D. alata chips showed significant results. Evaluation of the antibrowning (inhibition of PPO activity) effect of Cysteine (Cys) , Ascorbic acid (AA), citric acid (CA), sodium metabisulphite (SMB) alone or in combination, at three different pH (3.5,4 and 4.5) in banana (M. paradisiaca), apple (M. pumila), and mushroom (A. bisporus). The most effective PPO inhibitors were AA and SMB and in combination with CA and Cys in all the samples tested. One group of scientists proved the effectiveness of some spices and 4-hexylresorcinol as anti-browning agents in to-mato juice and apple slices, respectively[32,33,34]. Five essential oils (EO) extracted from lemon grass (*C. citratus*), basil (*O. basilicum*), rosemary (*R. officinalis*), sage (*S. officinalis*), and clove (*E. aromatica*), were investigated for their inhibitory effect against polyphenoloxidase (PPO) enzymatic browning,the results showed that apple juices treated with essential oil (EO) extract from lemon grass, clove and rosemary had a posi-tive effect towards the inhibition of PPO activity and reducing browning as compared to untreated, basil and sage treated juices, at room temperature (25°C) and at refrigerator (4°C) [35]. The addition of heated onion extract exhibited a stronger inhibitory effect on cassava leaf polyphenol oxidase than the fresh onion extract[36]. Various volatile compounds, including thiols, were present in *Allium* species, such as onion and are reported to inhibit PPO[37]. The screening for tyrosinase inhibition of the methanol extracts prepared from the aerial parts of 33 Turkish *Scutellaria* species was done out of these 8 species displayed moderate inhibition on tyrosinase[38]. The effects of pineapple juice (PJ), pineapple shell extract (PSE), and rice bran extract (RBE) on the browning process in banana slices and puree, compared with citric acid solution at pH

3.8 (pH) and distilled water (DW), were investigated by measuring the color changes. RBE-treated banana slices had lower browning value than those treated with PJ, PSE[39]. Recently, some of the prenylated flavonoids were isolated from the *A. heterophyllus* and *A. incisus* wood as antibrowning agents[40,41]. Several studies have shown that mango seed kernels contain various phenolic compounds including gallotannins, epicatechin, and condensed tannin-related polyphenols[42,43,44]. Refluxing in acidified ethanol extract of sun-dried mango seed kernels was characterized by the highest total phenolics content and tyrosinase inhibitory activity[45].

CONCLUDING REMARKS:

Following reports on the antibrowning potentials of plant extracts, efforts to identify the causative agent behind it was initiated. There is an array of reports on the various phytochemical constituents of different plant extracts. Among the role of various Phytochemicals in the management of browning the potential of various chemicals have been validated. The object of this review article was to gather and present an up-to-date display of chemical constituents and biological activity of natural sources used against enzymatic browning. PPO is regarded to play a critical role during food handling, storage, and commercial or domestic processing. In particular, in plant foods it causes undesirable enzymatic browning, especially in bruised or cut fruits and vegetables, which subsequently leads to a significant decrease in nutritional and market values. The information offered in this review should help to provide leads to the ultimate goal of developing new antibrowning agents. Still much focus has not been given on the studies of antibrowning agents for vegetables for example Pulses. Pigeon peas are most commonly used as a pulse crop. When used as a"vegetable," the pea is picked when the seeds have reached physiological maturity, just before they lose their green color. At this stage apart from green colour they are nore nutritious by virtue of more digestible protein and less flatulence producing sugars. Hence attempt need to be executed to preserve greenness through application of antibrowning agents.

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