Onion
A natural alternative to artificial food preservatives

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ABSTRACT: Consumer demand of minimally processed foods without synthetic preservatives has led to a growing interest in their replacement for more natural alternatives. Onion is widely used as a food ingredient and it is known as a good source of bioactive compounds, such as sulphur-containing compounds and flavonoids with well known health beneficial effects, antioxidant and antimicrobial capacities. Consequently, onion has been proposed as a promising and safer source of food preservatives. The overall aim of the present review is to analyze its potential use as a food ingredient by reporting evidence of onion antioxidant and antimicrobial activities, as well as discussing some concerns in relation to its stability and effectiveness as a food preservative.

INTRODUCTION
Protection of food from microbial or chemical deterioration has traditionally been an important concern in the food industry. Chemically synthesised preservatives have been classically used to decrease both microbial spoiling and oxidative deterioration of food (1). However, in recent years, consumers are demanding partial or complete substitution of chemically synthesised preservatives due to their possible adverse health effects. This fact has lead to an increasing interest in developing more “natural” alternatives in order to enhance food shelf-life and safety (2).

In recent decades, special attention has been focused on spices and aromatic vegetables which are commonly employed as food ingredients. In spite of the fact that they are usually used as flavouring agents to enhance the aroma or the taste of a great variety of foods, it is also well known that spices are a good source of natural antioxidant and antimicrobial compounds (3).

It is generally agreed that onion (Allium cepa, L.), which is one of the most widely distributed vegetables, is a good source of natural compounds with beneficial health effects (4, 5). Several reports have ascribed these biological effects to the presence of volatile sulphur-compounds, such as thiolsulfinates and phenolic compounds. Onions are a rich source of dietary flavonoids with average values ranging from 270 to 1917 mg of flavonoids per Kg of fresh weight, depending on the variety of onion. They are mainly represented by the flavonols quercetin and kaempferol, which are presumably more stable. Flavonols quercetin and kaempferol are commonly present in notable amounts in onion (4, 3’- or 4’-glycosilated forms, it is considered that their respective aglycones are more active because the free presence of their 3-hydroxyl group seems to be critical to exert their antimicrobial activity (11). It is generally agreed that onion flavonoids exert their antibacterial activity by inhibiting DNA, RNA and protein biosynthesis, as well as perturbing the functions of the cytoplasmatic membrane (10). In vitro studies have reported that onion flavonoids can effectively inhibit the growth of gram positive bacteria associated to food spoilage, such as Bacillus cereus, B. subtilis, Staphylococcus aureus, Micrococcus luteus and Listeria monocytogenes, while the gram negative bacteria Escherichia coli and Pseudomonas aeruginosa seem to be more resistant (6, 10, 12). Yeasts, such as Candida albicans are highly resistant to the inhibitory effect of onion flavonoids (6, 9, 13). These different resistant patterns...
are related to differences in fungus, yeast and bacteria cell wall, membrane and protein synthesis (14).

ANTIOXIDANT ACTIVITY

A great number of publications have reported the antioxidant capacity of onion and onion extracts in vitro. In spite of the fact that the antioxidant capacity of onions can be partly attributed to the presence of sulphur-containing compounds (15), flavonoids seem to have a higher contribution on onion antioxidant properties. Several studies have reported that onion flavonoids, especially quercetin and its glycosides, have high radical-scavenging activity, whereas its reducing activity is lower than that of other phenolics (3, 16). Furthermore, there is a direct correlation between the presence of flavonoids in onion and its antioxidant capacity (3, 16). Subsequently, differences between onion varieties and cultivation conditions have an important impact not only on the total phenolic content of onions, but also on its antioxidant capacity. Therefore, it is generally agreed that coloured varieties such as red or intense yellow varieties are richer sources of antioxidant compounds than white onion varieties (4).

TRENDS IN FOOD CONSERVATION AND TECHNOLOGY

Onions and onion by-products have been proposed as food ingredients which can be added to food preparations to enhance their shelf-life preservation. Nevertheless, there are some concerns regarding its use in food conservation. Firstly, the stability of onion antimicrobial and antioxidant compounds during storage until its further use as a food ingredient is an important issue. Some authors have studied the effect of different conservation treatments in onion phenolic content and antioxidant capacity. Roldan et al. (17) reported that after the pasteurization of onion by-products at 100ºC, their bioactive compounds and antioxidant capacity remained mainly intact. Thus, this represents a better option for stabilising onion by-products than sterilizing at 115ºC due to the possible formation of caramelized products. Minimal losses of onion antioxidant capacities have also been reported in frozen and canned onions during long periods of time (up to 8 months) especially under the presence of ascorbic acid (18).

Secondly, it is questionable whether onion bioactive compounds would remain stable after their processing and addition as food ingredients to processed or cooked foods or preparations. Great attention has been focused on processing at high temperatures as it is an important factor which can induce significant changes in the concentration, antioxidant properties and bioavailability of onion bioactive compounds (19). It has been described that peeling of onions significantly decreases their total flavonoid content and antioxidant capacity (approximately half the starting level) due to the fact that an important amount of flavonoids is concentrated in the outer parts of the onion (20). Nevertheless, further processing by blanching, moderate microwave heating, frying with either rape-seed oil or butter has a lower influence on total phenolic or flavonoid content (21-23). In contrast, it has been described that after treatments at high temperatures such as roasting (180ºC), quercetin glycosides (mainly quercetin-3,4'-O-diglucoside and quercetin-4'-O-monoglucoside) are strongly degraded leading to their deglycosilation and the formation of the quercetin aglycon (19, 22). The quercetin aglycon is heat stable, thus explaining the slight effect of heat treatment on onions’ total phenolic content (19). Even so, this is not the case of boiling at 100ºC as it can significantly decrease onion flavonol content and its capacity to inhibit lipid peroxidation due to the solubilisation of flavonols in
boiling water [24, 25]. Since the biodisposibility of the quercetin aglycon is known to be lower than that of its glycosilated forms, it is questionable whether cooking treatment can negatively affect the nutriceutical properties of onion in supplemented foods [26]. However, it seems reasonable to think that it may enhance the preservative effect of onion-by-products as it is well known that quercetin aglycon has higher antioxidant and antimicrobial activities and is resistant to most home-processing and cooking methods due to the free presence of its C-3 hydroxyl group [11].

Some recent studies have evaluated the potential effectiveness of onion or its bioactive compounds as natural preservatives. It has been described that the addition of onion hydrolyzed powder can be effective in delaying the lipid oxidation in oil-in-water emulsions which can be considered a good model of food emulsion, such as mayonnaise and margarine [16]. Special attention has been focused on the utility of onion as a natural ingredient to delay the deterioration of meat products as it is well known that the preservation of its palatability, taste, colour and flavour without adding synthetic preservatives is highly demanded by customers. Some authors have reported that the addition of onion powder to pork or beef refrigerated meat delayed the formation of primary and secondary oxidation products [27] and inhibited the growth of spoilage microorganisms, such as Enterobacteriaceae [12, 27]. In addition, the effect of juice extracts from onions on lipid oxidation and sensory quality in refrigerated turkey meat contributed to improve the sensory quality of the products, and provided protection against oxidation during cooking and refrigerated storage [28]. Furthermore, onions have been described as being a good additive to decrease the formation of nitrogen heterocycles, such as polycyclic aromatic hydrocarbons and azarenes, which can be formed during cooking practices and are especially problematic as it has been suggested that they can act as human carcinogens [29].

Finally, onion bioactive compounds can also be useful anti-browning agents preventing other vegetables and fruits from the deterioration associated to the post-harvest process [17]. As a matter of fact, it is possible to incorporate onion oleoresins to edible films in order to reduce both peroxidase and polyphenoloxidase activities in minimally processed vegetables [30].

On balance, onion can be considered a good food preservative, especially in fresh or minimally processed foods. The food industry has traditionally used physical (i.e. dehydration or heat treatment), chemical (i.e. antimicrobials or antioxidants) and biological (i.e. fermentation) technologies in order to avoid food deterioration. Nowadays these technologies are still valid, although the combination of different treatments, rather than the application of a single intensive treatment, is considered more appropriate to conserve the nutritional integrity of food and its organoleptic properties. Consequently, onion can play a crucial role when conveniently combined with other food preservation technologies.

CONCLUSION

It is well known that onion is a good source of bioactive compounds. Sulfur-containing compounds are the main responsible contributors to its antibacterial and antifungal activity. Nevertheless, its addition to food is limited to its strong odour and flavour, thus increasing interest has been focused on onion flavonoids which are more stable and show both antioxidant and antimicrobial activity. Onion flavonoids are considerably stable in refrigerated storage and are moderately resistant to most home-processing and cooking methods due to the thermostability of quercetin, its most abundant flavonol. Addition of onion or onion extracts to processed foods can reduce their microbial and oxidative deterioration, thus enhancing its preservation.

Therefore, although artificial additives can be more effective as food preservatives, it can be concluded that there is a real possibility of using onions as more ‘natural’ and safer preservatives. Onions can be a good ingredient not only to enhance the organoleptic properties of food but also to increase its nutriceutical properties, as well as its shelf-life by reducing its oxidative and microbial deterioration.

REFERENCES AND NOTES