International Journal of Chemical Studies

P-ISSN 2349–8528
E-ISSN 2321–4902
IJCS 2015; 2(6): 54-56

Received: 15-02-2015
Accepted: 12-03-2015

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Quality characteristics of tomato (*Solanum lycopersicum*) as a fortifying ingredient in food products

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Abstract
Tomato (*Solanum lycopersicum*) is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. The objective of this paper is to review nutritional benefits of tomato, its different bioactive components and their application in food products. Tomato and tomato products are very beneficial to our health as they decrease the risk of many diseases, such as cancer, asthma, heart disease etc. The whole fruit of tomato i.e pomace, seed and tomato solids have many nutraceutical benefits and is extensively used in food processing industry either as raw or in powder form. Many bioactive components are present in tomato, such as lycopene, oleoresin, carotenoids etc. Tomato is very popular for high content of antioxidant compounds and antioxidant activity. It is preserved mainly by drying (tray drying, freeze drying) and encapsulation process. We have tried to focus on to get the answer, which one is better in food application, lycopene supplementation or direct tomato powder fortification in food products.

Keywords: tomato, nutritional benefit, bioactive component, lycopene, application, preservation

Introduction
Tomatoes (*Solanum lycopersicum*) are one of the most widely used and versatile vegetable crops. They are consumed fresh and are also used to manufacture a wide range of processed products (Madhavi and Salunkhe 1998) [11]. Tomatoes and tomato products are rich in health-related food components. United States, Turkey, Italy, and Spain are the leading tomato growing countries (Jumah *et al*. 2004) [7]. The advantages of using tomato by-products as food ingredients are noticeable both to reduce environmental pollution and to provide an extra-income for producers (Lavelli and Scarafoni 2012) [10]. Tomato can be consumed as raw or as an ingredient in many dishes, sauces, salads, and drinks. Factors influencing the considerable increase in tomato consumption include consumer awareness of benefits such as preventing cancer and chronic diseases (Lana and Tijskens 2006) [9]. This beneficial effect is due to the action of antioxidant compounds, which reduce oxidative damage in the body (Beecher 1998) [2]. Tomatoes are rich in lycopene (87%) and other carotenoids such as carotene, phytoene, phytofluene, lutein and L-ascorbic acid. Lycopene is a carotenoid that can be incorporated into foods with the purposes of conferring both color and functional characteristics (Nunes and Mercadante 2007) [13]. Lycopene has attracted attention due to its biological and physicochemical properties, especially related to its effects as a natural antioxidant. Lycopene does exhibit a physical quenching rate constant with singlet oxygen almost twice as high as that of beta-carotene (Shi and LE Maguer 2000) [16]. Several food technology studies have been carried out to optimize the processing and storage of the tomato products by preventing the heat and oxidative damage on the antioxidants (Shi *et al*. 1999) [15]. Tomatoes are not as sweet due to its lower sugar content then other edible fruits. Tomatoes are low in calories and a good source of vitamins A and C, the flavor, texture, and cooking characteristics of tomatoes depend on the variety, growing method, local environment, and handling techniques used during and after harvest (Parnell *et al*. 2004) [14]. Most of the tomatoes are processed for its juice, ketchup, sauce, paste, puree and powder. Flavor characteristics of tomatoes are an important purchasing criterion (Krumbein *et al*. 2004) [8]. Researchers have reported that lack of flavor of tomato is associated with various storage

treatments, e.g., modified atmosphere (HO 1996, Hobson 1988, Maul *et al*. 2000) [5, 6, 12]. Dried tomato products (i.e., tomato halves, slices and powders) are in high consumption as compared to other tomato products due to their excellent properties (Arslan and Ozcan 2011) [1]. Tomato solids in powder form have many advantages, including ease of packing, transportation and mixing, and no drum-clinging loss (Giovanelli *et al*. 2000) [4].

Nutritional benefits of tomato derivatives

The by-products of tomato processing (skin) contain a very high amount of lycopene. In particular, tomato skin has 2.5 times higher lycopene level than the pulp (Shi *et al*. 1999) [15]. The use of dried tomato skin in powder form are proposed as an addition to refined oils for carotenoid solubilization in view of upgrading low quality oils, in the formulation of ketchup, in dry fermented sausages, and in beef hamburgers (Benakmoum *et al*. 2008, Calvo *et al*. 2008, Farahnaky *et al*. 2008, Garci´A *et al*. 2009) [3, 17, 18, 19].

Seeds are the major part of the pomace, and they are, 34% protein and 30% lipid (weight basis). Seed proteins have been extracted to produce protein concentrate (Savadkoohi and Farahnaky 2012) [20]. Studies on nutritive value of tomato seed proteins *in vivo* could not be found, however, reports involving the use of microorganism and enzymes are available. Canella and Castriotta (1980) [21] reported that the tomato-seed protein is a mixture of globulin, albumin, prolamine and glutelin components. Tomato-seed protein components are adsorbed at oil-water (o/w) interfaces and reduce the interfacial tension considerably.

Tomato pomace is an inexpensive by-product of tomato manufacturing, contains almost 75% water and the cost of shipping tends to be very high (due to its weight). Tomatoes contain a solanine-like alkaloid (saponin) called tomatine which have medicinal properties such as antibiotic, anticancer, anti cholesterol, anti inflammatory and anti pyretic affects (Calvo *et al*. 2008) [17].

Application

Tomato, either as a whole or as powder form has several uses in different food industries to prepare cookies, snacks, jelly, sauce, ketch up etc.

The tomato powder used in soups, instant sauce premixes, ketchups, sambar and rasam mix, puddings, bakery products, health foods, sweets, biscuits, baby foods, confectioneries, snacks etc.

– They are also used in the preparation of recipes *viz*., tomato dosa, soup, rice and burfi and compared with fresh tomato recipes. As the powder is in the concentrated form, it gave attractive appearance, color and taste to the recipes.

– Tomato skin powder was incorporated into refined oils for carotenoid solubilisation in view of upgrading low quality oils. The use of skin powders in the formulation of ketchup, improves its textural properties (Shu *et al*. 2006) [22].

Lycopene was used for preventing heart disease, (atherosclerosis) and cancer of the prostate, breast, lung, bladder, ovaries, colon, and pancreas.

– Lycopene is also used for treating human papilloma virus (HPV) infection, which is a major cause of uterine cancer.

– Some people also use lycopene for cataracts and asthma.

Conclusion

Tomatoes are the most valuable and are the most commonly used crops in many food dishes. They are very much beneficial to our health due to their antioxidant properties. Tomato contains high concentration of lycopene, Lascorbic acid, oleoresin, phenol, flavonoids and carotenoid. Dietary intake of tomatoes and tomato products decreases chronic diseases, cardiovascular diseases and also reduces certain risk of cancer. Various tomato products are made from tomato skin, seed, pomace and are very much useful in our diet. Now -a-days tomato in powder form are mainly used due to their excellent nutrient properties in the formulations of ketchup, soups, sauces and they can also act as a natural colorant. Tomato powder can easily be handled, preserved and stored, have low transportation cost. The shelf life of tomato powder is much more than raw tomatoes. Hence, tomato is very useful for our body due to its great antioxidant properties, health effects, and in enzymatic metabolism. It is always better to use tomato powder than only lycopene for the purpose of food fortification.

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