Chemical composition, functional properties and processing of Beetroot —a review

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Abstract

Beetroot (*Beta vulgaris*) is botanically classified as an herbaceous biennial from *Chenopodiaceae* family and has several varieties with bulb colors ranging from yellow to red. Deep red-colored beet roots are the most popular for human consumption, both cooked and raw as salad or juice. Beetroots (Beta vulgaris) are rich in valuable, active compounds such as carotenoids (Dias et al., 2009), glycine betaine, (de Zwart et al., 2003), saponins (Atamanova et al., 2005), betacyanines (Patkaiet al., 1997), folates (Jastrebova et al., 2003), betanin, polyphenols and flavonoids (Vali et al., 2007). Therefore, beetroot ingestion can be considered a factor in cancer prevention (Kapadia et al.,1996). They have antimicrobial and antiviral effects (Strack, Vogt, & Schliemann, 2003) and also can inhibit the cell proliferation of human tumor cells (Reddy, Ruby,Lindo, & Nair, 2005). The use of betalains as food colorant is approved by European Union and betalains are labeled as E-162. Dried beetroots can be consumed directly in the form of chips as a substitute of traditional snacks, that are rich in trans fatty acids (Aro et al., 1998), or after easy preparation as a component of instant food (Krejcova et al., 2007).

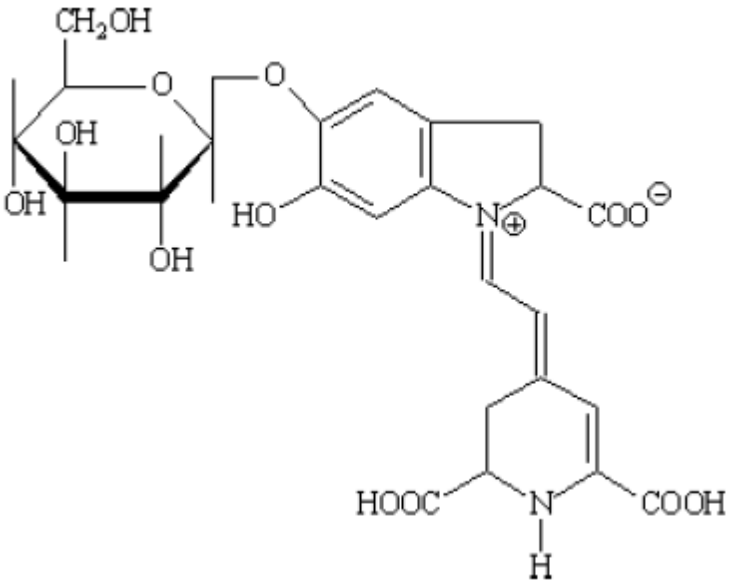
Key words:- Beetroot, betanin, osmotic,dehydration, pigments.

Introduction

Beetroot (*Beta vulgaris*) is botanically classified as an herbaceous biennial from *Chenopodiaceae* family and has several varieties with bulb colors ranging from yellow to red. Deep red-colored beet roots are the most popular for human consumption, both cooked and raw as salad or juice. There is growing interest in the use of natural food colors, because synthetic dyes are becoming more and more critically assessed by the consumer. But in food processing, as compared with anthocyanins and carotenoids, betalains are less commonly used, although these water-soluble pigments are stable between pH 3 and 7. To improve the red color of tomato pastes, sauces, soups, desserts, jams, jellies, ice creams, sweets and breakfast cereals, fresh beet/beet powder or extracted pigments are used (Koul *et al*. 2002; Roy *et al*.2004). It also contributes to consumers' health and wellbeing because it is known to have antioxidants because of the presence of nitrogen pigments called betalains, mainly comprise of red–violet-colored betacyanins (betanin,isobetanin, probetanin and neobetanin) and yellow–orange-colored betaxanthyns (Alard *et al*. 1985; Kaur and Kapoor 2002).

Chemical composition and functional properties:-

Chemical formula:--- Betanine: $C_{24}H_{26}N_2O_{13}$
Structural formula :-



Obtained from the roots of red beets (Beta vulgaris L var rubra) as press juice or by aqueous extraction of shredded beet roots; composed of different pigments all belonging to the class betalaine; main colouring principle consists of betacyanins (red) of which betanine accounts for 75-95%; minor amounts of betaxanthine (yellow) and degradation products of betalaines (light brown) may be present.

Beetroots (Beta vulgaris) are rich in valuable, active compounds such as carotenoids (Dias et al., 2009), glycine betaine, (de Zwart et al., 2003), saponins (Atamanova et al., 2005), betacyanines (Patkaiet al., 1997), folates (Jastrebova et al., 2003), betanin, polyphenols and flavonoids (Vali et al., 2007). Therefore, beetroot ingestion can be considered a factor in cancer prevention (Kapadia et al.,1996).).

Colors are important quality indicators that determine the Consumer acceptance of foods. In recent days market for application of synthetic colorants has decreased in favor of natural colorants (Fletcher, 2006). Betalains are water-soluble nitrogen-containing pigments, found in high concentrations in red beet (Beta vulgaris). Betalains consist of two sub--classes: betacyanins (red-violet pigments) and betaxanthins (yellow-orange pigments) (Delgado-Vargas, Jiménez, & Pedreno, M. A., & Escribano2000; Stintzing & Carle, 2004). They have antimicrobial and antiviral effects (Strack, Vogt, & Schliemann, 2003) and also can inhibit the cell proliferation of human tumor cells (Reddy, Ruby,Lindo, & Nair, 2005). The use of betalains as food colorant is approved by European Union and betalains are labeled as E-162.Betalains are particularly suited for use colouring food products (Von Elbe, Maing, & Amundson, 1974) (Cai, Sun, Schliemann, &Corke,2001). (Roy, Gullapalli, U.R., & R., 2004) Although anthocyanins are the most wide spread and mostly used natural pigments covering the red purple color range, betalains are more stable to pH and temperature. Betalains exhibit broad pH stability which are suited for low-acid foods where coloring with anthocyanins usally not possible. (Stintzing & Carle, 2004) For the yellow orange color range carotenoids are the natural pigments but due to poor solubility in water, betaxanthin could be used in application as yellow orange food colorants in situations (Azeredo, 2009). Betalain pigment mixtures can be used as a natural additive for food, drugs and cosmetic products in the form of beet juice concentrate or beet powder (Dörnenburg &Knorr, 1996).

Consumption of red beet which are rich source of antioxidants can contribute to protection from age-related diseases. According to Vinson, Hao, Su, and Zubik (1998) Žitňanová et al. (2006) red beet is one of the most potent vegetables with respect to antioxidant activity. Betacyanins are a group of compounds exhibiting antioxidant and radical-scavenging activities (Escribano, Pedreño, García-Carmona, & Muñoz, 1998; Pedreno & Escribano, 2000). They also inhibit cervical ovarian and bladder cancer cells in vitro (Zou et al., 2005). Red beet also can be used as antioxidants (Georgiev et al., 2010). Netzel et al. (2005) reported that the ingestion of a single dose of red beet juice resulted in an increase of antioxidant compounds including betalains in urinary excretion. Betalains and other phenolic compounds presented in red beet decreases oxidative damage of lipids and improves antioxidant status in humans. Antioxidant activity in red beet is associated involvement of

antioxidants in the scavenging of free radicals and consequently in the prevention of diseases like cancer, cardiovascular diseases (Delgado-Vargas et al., 2000). Antioxidant activity was also reported to enrich human low density lipoproteins by betalains which increase resistance to oxidation (Tesoriere, Allegra, Butera, & Livrea, 2004). According to Gentile, Tesoriere, Allegra, Livrea, and Alessio (2004) betalains exhibit anti-inflammatory effects, antiradical and antioxidant activity

Besides the colour pigments the juice or extract consists of sugars, salts and/or proteins naturally occurring in red beets. The solution may be concentrated and some products may be refined in order to remove most of the sugars, salts and proteins. Food grade acids (e.g., citric, lactic, L-ascorbic) may be added as pH controlling agents and stabilizers and carriers (e.g., maltodextrin) may be added as aids for manufacturing dry powders.

Processing of Beetroot

Fresh beetroots are exposed to spoilage due to their high moisture content. One of the preservation methods ensuring microbial safety of biological products is drying (Mathlouthi,2001). Dried beetroots can be consumed directly in the form of chips as a substitute of traditional snacks, that are rich in trans fatty acids (Aro et al., 1998), or after easy preparation as a component of instant food (Krejcova et al., 2007).

Adam Figiel(2010)concluded dehydration of Beetroot cubes by convective drying in hot air at 60^{o}C and by the combination of convective pre-drying (CPD) until moisture content 1.6, 0.6 or 0.27 kg/kg db and vacuum-microwave finish drying (VMFD) at 240, 360 or 480 W. The control samples were obtained by freeze-drying (FD). The drying kinetics of beetroot cubes was described with an exponential function. VMFD significantly reduced the total time of drying and decreased drying shrinkage in comparison with convective method. Critical moisture content divided the temperature profile of samples during VMFD into increasing and falling periods. At the falling temperature period a significant increase in the colour parameters L*, a* and b* was found. VM treated samples as well as FD ones exhibited lower compressive strength, better rehydration potential and higher antioxidant activity than those dehydrated in convection. Increasing the microwave wattage and decreasing the time of CPD improved the quality of beetroot cubes dried by the combined method.

The application of osmotic dehydration to fruits, and to a lesser extent to vegetables, has received attention in recent years as a technique for production of intermediate moisture foods and shelf-stable foods, or as a pretreatment prior to drying in order to reduce energy consumption and heat damage (Jayaraman and Das Gupta, 1992).

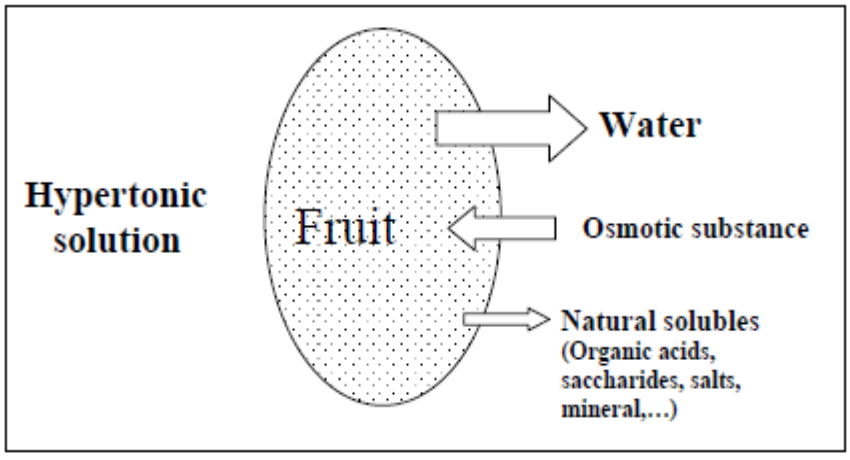


Figure 1 Schematic demonstration of osmotic dehydration process(Lewicki and Lenart, 1995)

Lenart (1996) deduced four main advantages of using osmotic dehydration:

1. Reduction of heat usage, hence negative changes of color and aromatic substances are diminished in subsequent drying.
2. The cell membranes are not absolutely resistant to osmotic substance, assuring a small flow of sugar into the cell, causing a sweeter taste of the dehydrated food.

3. Osmotic dehydration as a pretreatment provides shorter drying time and increases the dryer's potential.
4. Energy consumption is smaller at a rate of 20-30 % when compared to convective drying.

Bhupinder singh et al.(2013) optimized osmotic dehydration of beetroot candy by response surface methodology, the experiments were conducted according to Central Composite Rotatable Design (CCRD) with three variables at five levels. The low and high levels of the variables were 35 and 55°C for osmotic solution temperature, 30 and 60°Brix for sucrose solution concentration, 30 and 180 min for duration of dipping in osmotic solution, respectively. The fruit to solution ratio was kept 1:4 (w/w) during all the experiments. The optimum conditions for osmotic solution concentration, temperature and process duration were 60°Bx, 55°C and 180 min, respectively.

The beetroot, apart from consumption in its fresh form, is also a valuable vegetable used in the food industry to produce dried and frozen food, non-concentrated and concentrated juices as well as natural colorants (betalains) used as additives in food manufacturing. In many countries there is a growing interest in foods preserved in natural ways. Lactic fermentation is one of the methods of natural preservation and thus production of foods with the highest nutritive value. There are three main types of vegetable juice fermentation: spontaneous fermentation caused by the natural micro flora of a particular raw material; fermentation directed by the addition of a starter culture; and controlled fermentation involving the introduction of starter cultures to a thermally-preserved (by pasteurization) raw material[Karovičová & Kohajdová, 2003].

Beetroot peel contained higher antioxidant compounds thus promising a more intense utilization of the peels in food and nutraceuticals. Beetroot pigment is used commercially as a food dye. It changes colour when heated so can only be used in ice-cream, sweets and other confectionary, but it is both cheap and has no known allergic side-effects. Beetroot itself, of course, is a common salad ingredient – when cooked, vinegar is added to the water to lower the pH.

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