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Application of Beetroot as Natural Coloring Pigment and Functional Ingredient in Dairy and Food Products

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A B S T R A C T

Food color is one of the parameters impacting food quality and consumer acceptance to a significant level. Synthetic food colors are being used in many food products which are a major concern to human health, having allergic and carcinogenic affects. Therefore, efforts are being made to use natural food colorants from natural sources such as turmeric, saffron etc. Beetroot is one such material which is a source of betalain and is a rich source of many bioactive and phytochemical compounds which are known to provide several health benefits. Beetroot has numerous medicinal properties such as anti-oxidant, anti-hypertensive, anti-microbial, anti-inflammatory, hepato-protective, anti-hyperglycaemic, anti-cancer and diuretic. Beetroot juice and extract has wide range of application in many beverages, dairy products, cereals jams, jellies, candies, ice cream, yoghurt, sauces and processed meats This paper reviews the health benefits of beetroot and the possibility of its usage as a source of natural color for dairy and food industry.

Introduction

Color of the food is the main feature regards to consumer attraction and it acts as an indicator of quality and acceptability (Azeredo, 2008). Over the last few decades a large number of synthetic colorant is used in food products as coloring ingredient of food industry which cause severe health problem to the consumer e.g. carcinogenic effect. The use of synthetic red colorants as additives in food have been restricted by official regulations of the EU and the USA due to their possible adverse effects on human health (Tsuda *et al.*, 2001). So, lots of efforts are going on for use of natural food (biocolorants) color like betalain (betanin and betacyanin) to be used in dairy and food product.

Beetroot is a root crop belonging to Chenopodiaceae family and is commonly used as a salad in Indian Meals as well as for preparation of many culinary dishes. Its juice is also known to be healthy for sports persons. Beetroot is rich in several other bioactive compounds that may provide health benefits, particularly for disorders characterized by chronic inflammation, it also significantly reduce systolic and diastolic blood pressure. Beetroot is a rich source of phytochemical compounds that includes ascorbic acid, carotenoids, phenolic acids and flavonoids. Beetroot is also one of the few vegetables that contain a group of highly bioactive pigments known as betalains. The functional bioactive compound and natural coloring pigment present in beetroot opens a new opportunity in dairy and food industry to developed natural colored based functional dairy and food products.

Beetroot varieties

Several beetroot varieties exist (Table 1), among those the most outstanding ones are the red (beetroot) and the white beet (sugar beet). Both are very rich in sugar which is much more assumable than that of the sugar cane. They are also very rich in starch. Both possess eatable roots and their leaves can be used as a vegetable. Being much more flavorful, the red beet is the one that is generally dedicated to human feeding as while the white one is dedicated fundamentally to the production of sugar or the animal feeding (Anonymous, 2015a).

Health benefits of beetroot

Recently, beetroot is gaining popularity as a 'super food' due to its health beneficial value. Some of the major health benefits of beetroot are as follow

Lower blood pressure and increased blood flow.

It is helpful in tumor reduction, decrease the risk of obesity and overall mortality, diabetes, heart disease and promotes healthy hair, increase energy, and overall lower weight.

Several parts of beet root has numerous medicinal properties such as anti-oxidant, anti-hypertensive, anti-microbial, anti-inflammatory, hepato-protective, anti-hyperglycaemic, anti-cancer and diuretic.

Beetroot juice improves oxygenation to the brain, slowing the progression of dementia in older adults.

Due to its high fiber content, it prevents constipation and promotes regularity for healthy digestive tract (Tulp and Bohlin, 2004; Anonymous, 2015c).

It helps to preserve brain function with nitrates that improve blood flow and beet having the ability to increase the production of Glutathione naturally in body, that compound helps to prevent colon cancer (Anonymous, 2015d).

Nutritional value of beetroot

The nutritional value of beetroot juice is very high due to its high content of carbohydrate, folate, fiber, iron, nitrate, manganese, potassium, vitamin C and in addition to that free fat, low in calories, inexpensive and beets are available throughout the year. Beets are fiber rich and have high concentration of antioxidant Vit. C, foliates, iron, manganese and magnesium (Table 2).

Utilisation of beetroot in dairy and food products

Beetroot Color is available in the form of powder which may be tray dried or spray dried and beetroot juice prepared by vacuum concentration (Table 3).

Table.1 Taxonomical classification of beetroot

Kingdom	**:**	**Plantae**
Subkingdom	**:**	Tracheobionta
Super division	**:**	Spermatophyta
Division	**:**	Magnoliophyta
Class	**:**	Magnoliopsida
Subclass	**:**	Caryophyllidae
Order	**:**	Caryophyllates
Family	**:**	Chenopodiaceae
Genus	**:**	Beta
Species	**:**	B. vulgaris

Table.2 Composition of beetroot

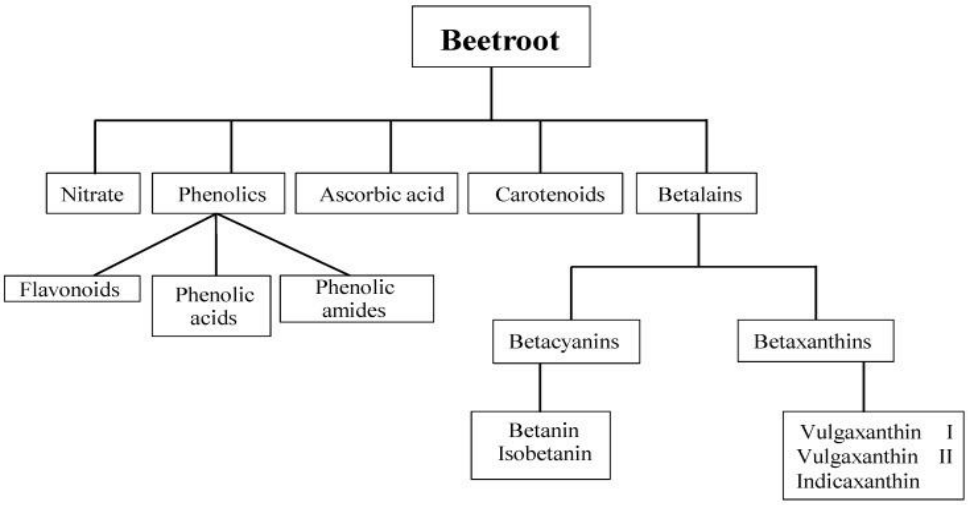
Constituent	Per cent	Constituent	Per cent
Water	87.5	Phosphorus	40 mg
Energy	43 kcal	Calcium	16 mg
Fat	0.17	Magnesium	23 mg
Protein	1.61	Iron	0.80 mg
Carbohydrates	9.56	Zinc	0.35 mg
Fibre	2.8	Vitamin C	4.9 mg
Potassium	325 mg	Vitamin B2	0.04 mg
Sodium	78 mg	Vitamin B6	0.067 mg
Vitamin A	36 IU	Folacin	109 mcg
Vitamin E	0.30 mg	Niacin	0.334 mg

Table.3 Utilisation of beetroot in dairy and food products

Author	Product	Description
Bandyopadhyay *et al.*, 2007	Carrot fortified milk	Studied the effect of beet root extract along with honey on quality attributes (acidity, pH, free fatty acid level and sensory) and carotene retention of carrot fortified milk product during storage at 30 °C.
Junqueira-Goncalves *et al.*, 2011	Cheese	Developed the Brazilian ham-flavored cream cheese using gamma-irradiated beetroot extract as the colorant.
Isabelle *et al.*, 2008	Cheese	Studied the effect of Beetroot betalains incorporated Petitsuisse cheese stored at 6±1 °C for 40 days in light-impermeable packaging on pigment stability by determining half-life time and percentage color retention.
Kavitkar *et al.*, 2017	Lassi	Utilized of beetroot extract as coloring agent in Lassi.
Kavitkar *et al.*, 2017	Flavored milk	Studied the effect of beetroot extract on color and sensory quality of flavored milk.
Manoharan *et al.*, 2012	Strawberry flavored ice cream	Utilized the beetroot juice as a natural coloring agent for ice cream and assess the sensory scored of the resultant product
Khade, 2015	RTS beverage	Studied on preparation and storage of ready to serve beverage from beetroot (Beta vulgaris L.) juice
Rachitha, 2016	Beverage	Formulate beverages by incorporating beetroot juice concentrate.
Jayalalitha *et al.*, 2012	Dairy Based Bio beverage	A dairy based biobeverage containing higher vitamin A and iron content was prepared with beetroot (*Beta vulgaris*) juice, carrot juice and dates extract.
Yoon *et al.*, 2005	Probiotic beet juice	Produced probiotic beet juice by *L. acidophilus* and other beneficial lactic acid bacteria
Flavera *et al.*, 2007	Proviva	Developed a probiotic food called Proviva using fermented oat meal gruel, lactic cultures and beetroot juice.
Damunupola *et al.*, 2014	Yoghurt	Studied on evaluation of quality characteristics of goat milk yogurt incorporated with beetroot juice.
Kamate andPadghan, 2018	Whey beverage	Utilized the beetroot extract for production of beetroot whey beverage by using 20 per cent beetroot extract in 80 per cent paneer whey on weight basis.
Vanajakshi *et al.*, 2015	A probiotic beverage	Developed probiotic beverage made with one part ofmoringa leaves paste and two parts of beetroot juice fermented with lactobacillus plantarum and enterococcus hirae.
Martinez *et al.*, 2015	Beetroot-orange juice powder	Developed beetroot orange juice powder by spray drying and studied its functional properties, color and betalain content.

Kakade *et al.*, 2015	Cereals based extruded product	Optimized the process of cereals based extruded product by utilization of beetroot leaves powder using RSM
Chaudhari and Nikam, 2015	Beetroot jelly	Standardized the process for manufacturing of beetroot jelly using 2 per cent pectin, 0.5 per cent citric acid and 61 per cent sugar.
Reddy *et al.*, 2014	RTE Snacks	Developed the extruded ready to eat snacks using corn, black gram, beetroots and tuber flour blends in a proportion of 60-80: 20:20 respectively and moisture was adjusted to 17-20 per cent.
Pinki and Awasthi, 2014	Cakes	Developed the value added cakes by incorporating beetroot powder and studied its Sensory and nutritional Value.
Durge *et al.*, 2014	Ice-cream	Utilized the prepared beetroot powder in ice-cream and evaluated its different properties
Singh and Hathan, 2013	Beetroot candy	Optimized the process for manufacturing of osmotically dehydrated beetroot candy using response surface methodology
Rachitha, 2016	Shrikhand, coconut biscuit, instant soup mix and besan burfi	Developed the lime beet juice, amla beet juice, shrikhand, coconut biscuit, instant soup mix and besan burfi using spary dried beetroot powder and vacuum concentrated beetroot juice concentrate.

Figure.1 Overview of potentially bioactive compounds in beetroot



Source: Clifford *et al.*, 2015

It has wide range of application in dairy and food product mainly as coloring agent and for production of value added functional food products. Beetroot extract is used in

beverages, dairy products, cereals jams, jellies, candies, ice cream, yoghurt, sauces and processed meats are summarized below.

In conclusion, beetroot is one of the oldest tuber root known to mankind and is used as therapeutic and functional food ingredients from ancient times. It is used as natural food coloring and functional food ingredients in many dairy and food products. Several research studies have shown that beetroot has numerous medicinal properties such as anti-oxidant, anti-hypertensive, anti-microbial, anti-inflammatory, hepato-protective, anti-hyperglycaemic, anti-cancer and diuretic. It also holds potential in therapeutic treatment for several pathological disorders. Beetroot is a rich source of wide range of functional compounds which opens a new door to food scientists and food industry for development of value added functional foods.

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