REVIEW ARTICLE

Guava-enriched dairy products: a review

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Received : September 2014 / Accepted : January 2015

Abstract Guava (*Psidium gujava*) is a worldwide popular tropical fruit with high content of vitamins and phytochemicals. The traditional therapeutic benefits of guava over metabolic disorders, gut infection, diabetes and obesity have been proven, but available processed guava products are limited only to biscuits, jams, jellies, marmalades etc. Guava contains immense bioactive potential and is a good source of dietary fiber which functions as a prebiotic. Its combination with probiotic fermented dairy food like yoghurt, curd and shrikhand will develop high value commodities to increase application of guava in the area of functional foods. This paper summarizes an extensive exploration for development of guava fortified fermented dairy foods, various dimensions of technological challenges and recent formulations designed for health benefits and consumer preference.

Keywords : Guava, fermented dairy food, prebiotic, processing, antioxidant

Introduction

Guava (*Psidium gujava L.*) is a popular fruit of tropical and subtropical countries. It belongs to the family Myrtaceae. Fruits are sweet in taste, with red or white flesh and many seeds within. Cheng (1983) has reported that guava fruit contains 80% moisture, 20% dry matter, 1% ash, 0.7% fat and 1.5% protein. It is a rich source of ascorbic acid (Vitamin C) and contains other nutraceutical components such as vitamin A (beta-carotene), vitamin B_1 (thiamin), B_2 (riboflavin), niacin and pantothenic acid. In addition, it also contains a fair amount of phosphorous, calcium, iron, potassium and sodium. The high level of antioxidant pigments like carotenoids and polyphenols as well as ascorbic acid present in guava increase its dietary value (Charles *et al.* 2006). These bioactive nutrients play a significant role in traditional therapies for various health problems related to lifestyle diseases like diabetes (type 2) and obesity (P´erez *et al.* 2008). The guava fruits are high in water content (84.9%) and low in content of carbohydrates (13.2%), fats (0.53%), and proteins (0.88%).

Many other important compounds such as hexanal (65.9%), γ-butyrolactone (7.6%), (E)-2-hexenal (7.4%), (E, E)-2,4-hexadienal (2.2%), (Z)-3-hexenal (2%), (Z)- 2-hexenal (1%), (Z)-3-hexenyl acetate (1.3%) and phenol (1.6%) are present in fresh fruit extract (Abreu *et al.*, 2006). Certain essential oils extracted from guava are 3-caryophyllene (24.1%), nerolidol (17.3%), 3-phenylpropyl acetate (5.3%) and caryophyllene oxide (5.1%). Jordan *et al.* (2003) isolated active aromatic constituent 3-penten-2-ol and 2-butenyl acetate from pink guava fruit. The strong odor of the guava is attributed to its carbonyl compounds. The popular use of guava as an anti-diarrhoeal medicine cures diseases like gastroenteritis, dysentery, colic pain of the intestine. Other medicinal properties of guava involve treatment of diabetes, hypertension and inflammation (Singh *et al*. 1993). Mitchell and Ahmad (2006a, b) studied considerable levels of bioactive compounds that impart health benefits in guava. The amount of phenolic compounds in guava is strongly dependent on the degree of ripeness, variety, climate, soil composition, geographic location and storage conditions, besides many other factors. More and more evidences suggest that high consumption of guava is strongly associated with reduced risk of developing chronic diseases such as cancer, diabetes, Alzheimer's disease, cataracts, and age-related functional decline (Conway, 2002). This suggests that changing the dietary behavior by way of increasing consumption of guava fruit can reduce the incidence of chronic

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diseases (Hernandez, 1971).

Although guava possesses enormous health benefits, a major drive in the research and development of guava as functional food is far behind than other exotic fruits (Heinrich *et al.* 1998). The fresh fruit is preferred for consumption but being seasonal limits availability of fruit throughout the year. Since the fruit is perishable, it cannot be stored for more than two days during peak season. The decaying fruits losses, expenses of handling raw produce through different stages, non availability of adequate and efficient equipment and machinery used in catchment areas, low level of entrepreneur urge, financial constrains, non-assurance of market, proper training on technology and fragmented value chain lead to drive major losses in economy. Higher the value addition, betters is the post harvest management and lower losses. Hence processed products such as puree, paste, canned slices in syrup or nectar are developed and marketed. Guava juice is a health drink used by the population worldwide and instant guava powder is available for formulated drinks, baby foods and other confectionary products. Hence the utility of guava as functional foods is increasing day by day. The health benefits of guava recommends consumption of all forms, fresh, frozen, canned, dried, and 100% juices of guava. Various guava products like guava fortified products, beverages and others need to be developed and technology for value addition should be increased. This can minimize the post harvest losses, avoid fruit glut in the market, and insure efficient utilization of astringent, highly nutritive fruits in the form of formulated foods with retention of nutrients and nutraceutical properties of fruits for maximum periods.

Dietary fiber potentials of Guava

Guava is identified as a source of natural antioxidant compounds and antioxidant dietary fiber (DF) by analyzing its DF content and the antioxidant activity of associated bioactive compounds (Jime´nez-Escrig *et al.* 2001). The selection of suitable sources to provide new DF products with high antioxidant capacity derived from natural associated compounds could be useful to achieve a better antioxidant status along with the recommended higher DF intakes. DF rich foodstuffs and DF concentrates are popular in the food market, but the antioxidant capacities of these items are negligible. The antioxidants present in guava, such as phenolic acids, flavonoids, anthocyanins and tannins, among others, have been frequently associated with health benefits. Historically, these exotic fruits have been considered a rich source of some essential dietary micronutrients and fibers, and more recently they were recognized as being an important source of a wide array of phytochemicals that individually, or in combination (Martinez *et al.* 2012). Recently, the concept of antioxidant dietary fiber (AODF) has been introduced and the main characteristics of guava as natural product are that they are rich in both DF and polyphenolic compounds.

Value addition of fermented dairy products

Dairy products such as fermented milks are most popular food of probiotics. They are live microorganisms which when administered in adequate amount confer health benefits. The most common strains of probiotics bacteria are from genus Lactobacillus and Bifidobacterium which are tailored into dietary formulations at global level. (Ram and Bhavadasan, 2002). While transferring the probiotics the emphasis for prolonged survival of probiotics in the food matrix is priority. Probiotic bacteria must remain viable in the food carriers and survive the harsh condition of GI tract, with a minimum count of 106 CFU/ g-1 (Kumar and Mishra, 2003). The traditional dairy foods like yoghurt, curd, milk beverages and many more are innovated and manufactured as new probiotic dairy products (Singh, 2001). A technology driven development of value added fermented dairy products by is gaining importance.

Guava juices blended with whey beverages

Guava is frequently used in various indigenous medicinal practices in different countries. The preparations of guava extract traditionally are in the form of infusion, decoctions, tinctures etc. In order to increase the level of guava as dietary supplement adjoining food matrix are required. To combat the scarcity researches have focused in the development of different formulations retaining the functional characteristics and nutraceutical properties of guava for fortification like milkshakes and other low fat calorie beverages (Menezes *et al.* 2012). Conversion of whey into soft beverages is one of the most attractive avenues for utilization of whey for dairy industry. Singh *et al.* (1999) developed beverage from paneer whey and guava. Here product diversification using whey as a partial replacement of water without much change in quality is quite (Divya and Kumari, 2009). Seveda (2011) used *Saccharomyces cerevisiae*, for Guava must fermentation and optimization of guava vine production. Low alcoholic naturally carbonated fermented beverage of guava and lemon was formulated from yeast isolate *Clavispora lusitaniae* (Sahota *et al.* 2010). Another example of whey beverage is mango milk drink (Chauhan *et al.*, 2013) a product that contains lactic acid bacteria along with whey and mango juice. Other similar products are whey protein and tomato juices (Rajoria, 2011). Such beverages may be beneficial for the people suffering from gastro-intestinal tract disorders and can be used as therapeutic soft drinks.

Guava yoghurt

Sweet fruit yoghurt is preferred by children, adolescents and the aged. Hence, there is great scope to popularize yoghurt, particularly fruit yoghurt. There is very limited work on yoghurt

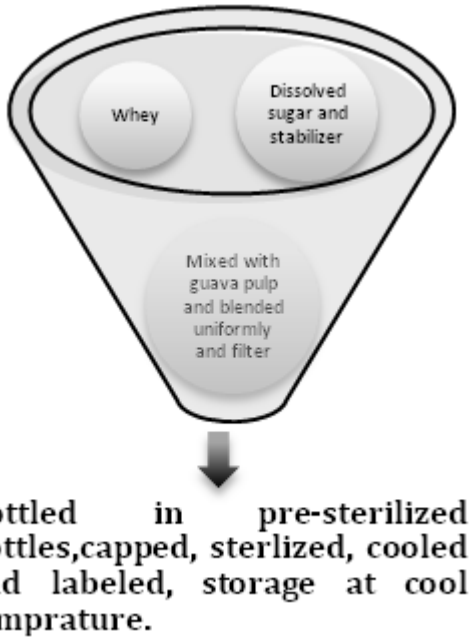

Figure 1: Process flow chart for the preparation of whey based guava beverage (Singh *et al.*, 1999)

in India. However, there is excellent potential for yoghurt in India. Guava fruit yoghurt was prepared using starter culture of *S. thermophilus* and *L. bulgaricus* in cow's milk with addition of 5% guava pulp and 6% sugar the desired flavor and texture and nutrient component were better than plain yoghurt (Walkunde *et al.* 2009).

Guava Shrikhand

The current consumers' interest towards reduced or low-fat products that contribute to decreased risks of chronic-degenerative diseases encourages the development of probiotic low-fat foods like shrikhand, which is a semi solid soft, sweetish sour fermented dairy product. It is a popular delicacy in Gujarat, Maharashtra and Karnataka. The protocol of shrikhand preparation started by heating skim milk followed by cooling at 30°C in a batch pasteurizer, adding lactic acid bacteria (LAB) starter culture and mixing well with a mixer. The temperature of pre sterilized storage vat was maintained at 37°C and incubated for 8-12 h. After the curd was properly set, the contents were transferred to another vessel through a clean, wet muslin cloth. To this chakka, sugar and guava powder were added and it was thoroughly kneaded or mixed either manually or mechanically to a homogeneous consistency. It is usually packaged in polystyrene cups and stored under refrigerated condition (Kumar, 2011).

Guava mousse and smoothies

Darlila *et al.* (2013) reported that probiotics viability and sensory analysis of dairy based smoothie containing guava pulp has overall acceptance from the consumers without any affect on probiotic viability due to addition of fiber content of guava. Aerated dairy creams and desserts like mousses are emerging as interesting food systems to study the effects of the incorporation of probiotic cultures and functional ingredients like prebiotics (Aragon Alegro *et al.* 2007). Due to its large production and consumption, guava is an excellent flavouring agent for dairy desserts (Zietemann and Roberto, 2007). The presence of fructo oligosaccharides in guava exert a protective effect as prebiotic food ingredients, improving the survival and activity of probiotic bacteria during the storage of probiotic foods, as well as the passage through the gastrointestinal tract GIT (Donkor *et al.* 2007). A synbiotic food product, guava mousse formed by addition of prebiotic guava fruit and probiotic *Lactobacillus acidophilus* increased the nutrients of functional foods (Flavia *et al.*, 2010).

Technological challenges in processing

The production of guava pulp as powder undergoes the process of heat infusion, spray drying and freeze drying (Chauhan *et al.* 2013). Since guava juice is very delicate in flavor and usually pink or yellow in colour according to the variety used. The drying operations need to be carefully designed to preserve the quality and colour. Several methods are used for production of guava powder, but the most successful methods include freeze drying, foam mat drying and spray drying. The freeze drying process was successful to convert guava juice into powder but was not economically cost effective (Chopda and Banrett, 2004). Hence spray drying techniques have been applied for guava powder (Tashtoush *et al.* 2007). The spray drying is one step process having short dehydration time and controlled pressure in comparison to freeze drying, vacuum drying and tunnel drying which minimizes heat damage (Bhandari *et al.* 1993). The thermal sensitivity and hygroscopic nature of fruit components gives rise to wall deposition problems and hinders handling procedures. A suitable carrier such as maltodextrin or glucose syrups facilitate drying of fruits juices (Ahlawat *et al.* 2009). This micro-encapsulation of carrier agents provides longer shelf life and protection against light, oxygen and other type of environmental degradation. It also increases solubility, and improves the handling and flow properties of the core material. Micro-encapsulation protocol has to be optimized so that it does not affect the rheological properties of fruit powder (Jafari *et al.* 2008). However production of fruit powders by spray drying leads to problems in their functional properties such as stickiness and solubility (Bhandari *et al.* 1993). More research work is required to establish the technical difficulties for processing of guava (Patil *et al.* 2014).

After processing guava remains a good source of vitamin C, high lipid content, ash content and dietary fiber these are

essential ingredients useful for food industry. During the manufacture fortified dairy products the shelf life and storage of products are increased by certain cryoprotectants that change the nucleation patterns to reduce the ice crystal sizes further it maintains viability of the probiotic microorganism during the frozen storage. The whey based products are manufactured by addition of stabilizers coupled with heat processing of the ingredients and homogenization in the manufacture of fermentable cultured dairy drink. Steric repulsion between the casein micelles may be introduced to prevent flocculation. For the development of a new product with addition of concentrated fruit juice, rheological parameters are an essential aspect for the industrial manufacture which suffers some process errors such as pumping, stirring and transport in pipelines. The steps in the manufacture of fermented dairy beverages include selection of a milk base with low total solids and low proteins, selection of additives such as fruit juice concentrate, colors, artificial sweetener, sugar stabilizers, etc. taking into consideration their interactions with fermented milk components.

Guava is used in various indigenous systems of medicinal purposes. The multiple disease ameliorating properties of guava, have discussed in this review. Such properties have been further explained by several studies for specific bioactivity of phytochemicals extracted from guava including clinical studies. The fruit juices have been proven to prevent diabetes and other metabolic disorders. Interestingly this lends pharmacological credence for designing value added products. Further research is required to develop cheaper technologies for innovative guava enriched dairy foods. Consumer awareness should also be considered as an important factor while designing new food products. Since sensory analysis and likeability of products increase the market demand, studies aimed at understanding consumer's needs in relation to the traditional formulations and special dietary supplements for guava enriched fermented dairy foods are also recommended.

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