

# A Review on Indian Green Gold (Betel Leaves) And Its Novel Applications in Dairy Products

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## Abstract

Nowadays trend develop to use the natural ingredients in food for making the value-added food products. Different herbs, spices, medicinal plant etc. are widely used as it contains the different nutritional components. Betel leaf is also one of the medicinal plants which used for its invaluable properties. Several biologically active compounds are present in betel leaves which possesses many beneficial bioactivities and successfully used in commercial products. It is well-known that the dairy products act as a carrier to deliver the phytochemical and nutrients for health benefits in food system. By considering this view, food investigators trying to use the betel leaves in dairy products to make it healthier. So, this review presents the usefulness of betel leaves and explained the investigations of various researchers to established effect of betel leaves in antimicrobial, antioxidant and nutritional properties of novel dairy products.

**Keywords:** Betel leaves, Antimicrobial, Antioxidant, Nutraceutical, Novel dairy products.

## Introduction

The Betel is the leaf of vine from the family of Piperaceae. In India it is well known as "Pan" which plays an important role since ancient time. It is very known to worldwide and consumed frequently as mouth freshener. Betel leaf is a perennial, evergreen climber which grows in tropics and subtropics and mostly consumed in Asia and elsewhere in the world. Like India other major betel leaves growing countries are Sri Lanka,

Thailand and Bangladesh. The deep green heart shaped leaves are also known as Nagabali, Nagurvel, Saptaseera, Somptra, Tamalaku, Tambul, Tambuli, Vakshapatra, Vettilai, Voojanggalata etc. The vast economic potentiality of the crop can be adequately established by the fact that about 15-20 million people consume betel leaves in India on regular basis [1]. It is also playing a vital role in various ceremonies and auspicious occasions as an indicator of goodness. In India betel leaf is grown for local consumption and exports. The country has exported 6,159.39 MT of Betel Leaves to the world for the worth of Rs. 26.18 crores/ 3.55 USD Millions in 2020-21 [2]. Currently, there is a growing interest in using natural antibacterial compounds like extracts of herbs and spices into the food. Piper betel are rich in nutrients, antioxidant, phytochemical and nutraceuticals properties and hence utilized for development of novel food and non-food products [3].

#### Structural Description of Betel Leaf

The scientific name of betel vine is *Piper betel L.* belongs to the family Piperaceae, i.e., the Black Pepper family. Stems semi woody, climbing by means of short adventitious roots. Leaves are 10-20 cm long, broadly ovate, slightly cordate and often unequal at the base, shortly acuminate, glabrous, glaucous on both sides, bright green or yellowish, petiole stout 2.0-2.5 cm long. Male spikes cylindrical dense. Female spikes 2.5-5.0 cm long, pendulous. Fruits rarely produced, often sunk in the fleshy spike, forming nodule-like structures [4].

#### Chemical Description of Betel Leaf

Phytochemical analysis of the betel leaf showed presence of carbohydrate, protein, flavonoid, tannins and phenolic compounds. While piper betel extract showed the presence of carbohydrate, alkaloids, gum, oils steroids, glycosides, tannins, phenols, flavonoids, vitamins, organic acids and inorganic constituents. Aqueous extract of piper betel leaf was found to possess high concentration of flavonoids, tannins and phenols [5]. Following table shows the detailed chemical composition of betel leaves.

**Table 1: Chemical composition of betel leaves [6]**

Sr. No	Constituents	Approximate Composition
1	water	85-90 %
2	Protein	3-3.5 %
3	Fat	0.4-1.0 %
4	Minerals	2.3-3.3 %
5	Fiber	2.30 %
6	Chlorophyll	0.01-0.25 %
7	Carbohydrate	0.5-6.10 %
8	Energy	44 Kcal/100g
9	Essential oil	0.08-0.2 %
10	Iodine	3.4 µg/100g
11	Iron	0.005-0.007 %
12	Calcium	0.2-0.5 %
13	Potassium	1.1-4.6 %
14	Nicotinic acid	0.63-0.89 µg/100g
15	Vitamin C	0.005-0.01 %
16	Vitamin A	1.9-2.9 µg/100g
17	Thiamine	13-70 µg/100g
18	Riboflavin	1.9-30 µg/100g
19	Tannin	0.1-1.3 %
20	Nitrogen	2.0-7.0 %
21	Phosphorus	0.05-0.6 %

#### Medicinal Values of Betel Leaves

Betel leaf has been described from ancient times as an aromatic, stimulo-carminative (katu), astringent and aphrodisiac (kamagnisandipanam) [7]. In India piper betel leaves have been used in medicine and it is well known for its extensive use in Ayurveda. It is a traditionally used since antiquities as medicinally useful plant for curing diseases and most valuable home remedy for common illness. Some important medicinal values of betel leaf are given below

- Betel leaf is traditionally known to be useful for the treatment of various diseases like bad breath, boils and abscesses, conjunctivitis, itches, mastitis, mastoiditis, leucorrhoea, otorrhoea, swelling of gum, rheumatism, injuries.

**Table 2: Betel leaf bioactives with its uses [3]**

Sr.No	Betel Leaf Bioactives	Uses
1	a-Pinene	Anti-inflammatory and antibiotic Camphene fragrances and food additive for flavoring use Sabinene Antimicrobial properties
2	A-Terpinene	Cosmetics and food
3	Myrcene	fragrances and food additive
4	B-Phellandrene	Cosmetics and personal care
5	B-Ocimene	Perfume Terpinolene Perfumes and food additive
6	Cis-sabinene	Anti-Infective Agents
7	Camphene	fragrances and food additive for flavouring use
8	Sabinene	Antimicrobial properties
9	Terpineol-4	disinfectants
10	Safrole	Beverages and candy preparation
11	Eugenol	Antiseptic and anesthetic
12	Iso-safrole	Fragrance
13	B-Bourbonene	Flavour and fragrance agents
14	B-Elemene	Antiproliferative effect, chemotherapy for cancer treatment
15	Methyl Eugenol	Fragrance ingredient
16	Caryophyllene	Antioxidant, anti-inflammatory, anti-cancerous
17	Aromadendrene	Antioxidants and anti-ageing
18	B-Farnesene	natural insect repellent
19	A-humulene	Anti-inflammatory, effective in reducing platelet activating factor
20	Methyl isoeugenol	Flavour and fragrance agents
21	Germacerene-D	Analgesic and anti-inflammatory properties
22	B-Selinene	Antibacterial characteristics
23	A-Selinene	Aroma
24	A-Farnesene	Plant defense
25	Hydroxychavicol	Antimutagenic effect
26	Eugenyl acetate	Anti-virulence significance
27	A-Cadinene	Anticancer activity
28	Germacerene-B	Antimicrobial and insecticidal properties
29	E-Nerolidol	Flavouring property
30	Spathulenol	Antibacterial activity
31	Globulol	Antimicrobial activity
32	Chavibetol	Aromatic compound with a spicy odour
33	Allylpyrocatechol Diacetate	Antimicrobial activity
34	1,8-Cineol	treatment of inflammatory diseases

- The Indian traditional system of medicine has identified the leaves with digestive and pancreatic lipase stimulant activities, eases constipation and reduces gastric pain.
- The leaves are credited with wound healing property.
- The fresh betel leaves possess antimicrobial, ringworm, antifungal, antiseptic and anthelmintic effects.
- It stops ear ache and nose bleeding.
- It treats headache and improves alertness.
- It provides cure for acne and other skin disorders.
- It used extensively in treating arthritis and orchitis.
- Betel leaf juice is credited with diuretic properties. Its juice, mixed with dilute milk and sweetened slightly, helps in easing the passage of urine.
- Piper betel showed hypotensive, cardio tonic, smooth and skeletal muscles relaxant actions.
- The leaves are nutritive and contain anti-carcinogens showing promise for manufacturing of a blood cancer drug.
- Leaves considered being useful in treating bronchitis and dyspnoea.
- The leaves were chewed by singers to improve their voice.
- Leaves are used in eye drops for eye injury/infection and as a baby lotion for the new born.
- Essential oil from leaves of this plant has been used for the treatment of respiratory catarrhs and antiseptic.
- Leaf extract is reported to inhibit male reproductive competence. The leaves possess antifertility on male rats<sup>51</sup> and antimotility effects on washed human spermatozoa.
- In folk medicine root is used as long-lasting female oral contraceptive
- The users believe that chewing the 'pan' improves their efficiency and stamina.
- If 6 betel leaves are combined with little bit of slaked lime is said to be is equal to 300ml of cow's milk. Betel leaves are good source of vitamin B and carotene. Betel leaves are given to women after childbirth to increase the secretion of milk
- It offers possibilities of use in drug delivery through buccal mucosa bypassing the gastric route.

- The fruit of Piper betel employed with honey as a remedy for cough.
- Phenol-rich leaves of P. betel show high antioxidant activities and because of its anti-oxidant properties, it has been used as a chemo preventive agent.
- Other pharmacological activities like antiulcer, antidiabetic, immunomodulatory, cardiovascular and anticancer were demonstrated in last two decade

Consumption of betel leaf is usually in the form of betel quid which consists of areca nut, lime and some spices with or without tobacco. Long term consumption of betel quid with tobacco is known to cause adverse health effects, mainly carcinomas. In addition to oral cancer, it is also known to induce chromosomal aberrations and tumours in the pharynx and oesophagus. However, consumption of betel leaf alone does not induce cancer and has invaluable health benefits due to its tremendous medicinal properties and hence proves that it is "Green Gold" [8,9,10,11].

## Applications of Betel Leaves

Betel leaf has been reported remarkable properties by various scientists which indicate a promising industrial future.

- The leaves are very nutritive and contain substantial number of vitamins and minerals. The leaves also contain the enzymes like diastase and catalase and significant amount of all the essential amino acids except lysine, histidine and arginine, which are found only in traces; hence it has great potency to entry to the nutraceuticals.
- Due to high phenolic content in the leaf, the plant poses high antioxidant activity. Its oil is used as an industrial raw material for manufacturing of tonics, food additives etc.

The worldwide functional food and beverages market esteem was 129.39 billion US Dollar in 2015 and is developing at a rate of about 8.6% every year. Different specialists have explored the food applications of betel because of the established impact of their antimicrobial, antioxidant, colour, flavour, and dietary perspective.

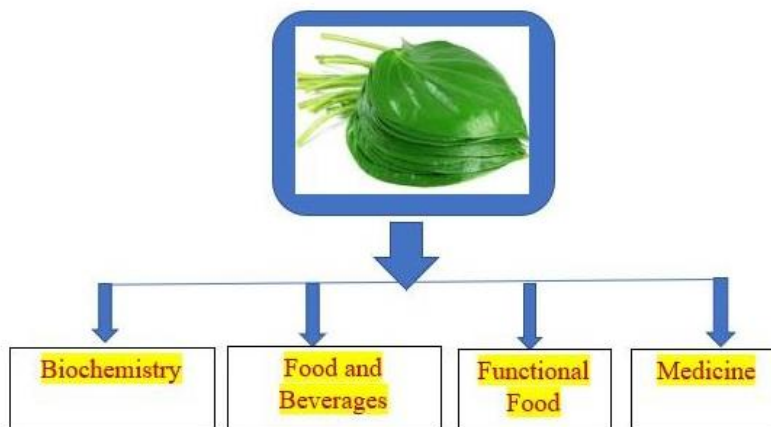


Figure 1: Wide applications of betel leaves

- Essential oil obtained from leaf extract may be commercialized by used as active pharmaceutical ingredient in different oral care product like toothpaste, mouthwash, mouth fresheners to get maximum result against dental pathogens [12,13].

#### Applications of Betel Leaves in Various Food Products

Betel leaf is utilized in culinary preparations in different cuisines. Betel leaf and essential oil obtained from its extract has many unique properties which can oil be utilized for development of products. Accordingly, at IIT, Kharagpur a few novel food products like cup cake, suji halwa, Chocolate and Biscuit have been developed with using essential oil of betel leaves ranging from 0.01 to 0.5% [10] The development of papad and khakhra from dehydrated betel leaves (*piper betel L.*) powder is carried out by Varnekar *et al.* [14,15]. The dishes in India like Veeledhele chithranna, Paan Ice cream, Paan ki chat, Paan ki Ladoo, Paan shots, Tamalapaku Pakoda and Paan chocolates, Betel leaf milk shakes etc. can be manufactured by using the betel leaves [11]. Yardi and Navgharwala. [16] can also developed Probiotic beverage by using whey protein concentrate and betel leaves extract. Addition of herbs and spices or its extracts to different dairy industry should discover innovative ways to improve the functionality of traditional dairy products which might deliver important value and potential effects for consumers [17].

#### Novel Application of Betel Leaves in Dairy Products

The applications of betel leaves have been investigated by various researchers in the dairy products and observed the effect of its presence on nutritional, physicochemical and sensory properties following novel products.

#### Milk

Milk is a highly nutritious and complete food that provides almost all the nutrients for the growth and maintenance of the human body. On the other hand, it is a suitable medium for the growth of almost all spoilage and pathogenic organisms. The preservation of milk in the tropical countries like India is a major bottleneck especially where refrigeration facilities are limited and increased environmental temperature. Since milk is perishable, special measures and considerations are necessary to ensure that it reaches the market in an acceptable condition. Currently, there is a growing interest in using natural antibacterial compounds like extracts of herbs and spices to preserve food [18]. The use of natural spoilage preventing compounds from herbs and spices are recommended used ginger, garlic, turmeric, betel vine and Aloe vera extracts to prevent premature spoilage. Honey and plant derived phenols also used as a natural preservative. So, an interest is going on to use natural products-based preservative to prevent spoilage of milk before cooking. In the different studies a natural product like betel extract is used and tested as milk preservative agent.





**Fig 2: Value added dairy products by application of betel leaves**

Phenols and polyphenols are water-soluble compounds that can be easily mixed with milk. In the study, carried out by Sivkumar *et al.* [19] used betel leaf extract to extend the shelf life of raw milk and find out that, addition of 0.5% betel leaf extract (v/v) to row milk remained acceptable up to 11 hours of storage at 37°C.

A study was undertaken by Baskaran1 *et al.* [20] give an alternative preservation technique to extend the shelf life of the raw milk. The investigation interpret that the

development of the acidity was controlled by the addition of the betel leaves extract as it has the higher anti-microbial property and it controls the growth of the lactic acid bacteria.

The study conducted by Dhasarathan *et al.* [21] showed that, in the betel extract phenolic compounds are present in large amount. So, phenol enriched betel leaf extract exhibited good spoilage prevention action. The compounds do the action of inhibiting the fermentation process in the milk so that the lactose to lactic acid fermentation occurs in the reduced rate of the consumption. Thus, the work on the microbial spoilage of dairy products and prevention of spoilage was found to be possible by the use of leaf extract of Piper betel.

### Dahi

In India, fermented milk products account for about 9% of total milk production. Dahi is the most widely consumed fermented dairy product on the Indian subcontinent, with the majority of people eating it with their daily meals. The lactic acid bacteria present in fermented milk products, they have been linked to various human health advantages. Herbal extracts are becoming increasingly popular as a way to extend the shelf life it. Betel leaves are one such material that has preservation properties due to their antibacterial and antioxidant content. Furthermore, these chemicals are widely available at all times of the year, are inexpensive, and are used by individuals for various purposes.

The study was conducted by Shivkumar *et al.* [22] to develop a dahi with good flavour, texture, appearance, palatability, and acceptance. The study was designed to determine the physic-chemical, organoleptic and textural qualities of dahi prepared with betel leaves extract. Standard method was followed to prepare dahi with betel leaves extract at a concentration of 0.5%. Prepared dahi was stored under refrigerated condition and subjected to various physico- chemical and sensory analysis at periodic interval. The parameters studied include pH, titratable acidity, textural properties (firmness and consistency) and sensory analysis. The result revealed that pH of control decreased from 4.40 to 4.03 whereas treatment was 4.23 up to the 7 days of storage.

Titrateable acidity for control increased from the beginning to 7th day of storage whereas for the treatment showed controlled increase at the end of the storage period. Dahi prepared with 0.5% betel leaves extract had showed reduced firmness and consistency compared to the control. Sensory evaluation (overall acceptability) scored similar value for control and treatment. From this study, it was concluded that 0.5% aqueous betel leaf extract added dahi was superior to control on the 7th day of storage at refrigerated temperature.

### Shrikhand

Shrikhand is a nutritious indigenous fermented dairy product from western India which is semisolid and sweetish-sour in taste. It is well-known for its flavour, taste, pleasant quality, and therapeutic properties [12]. A study was conducted by Yadav *et al.* [23] to develop a Goat milk shrikhand blended with sapota pulp and betel leaf extract.

The study indicated that sensory score of goat milk shrikhand blended with sapota pulp and betel leaf extract were increased significantly after various processing treatments. The highest mean value of color & appearance score was recorded in the sample of T3 (8.25) and lowest was recorded in the sample of T0 (7.10). All treatment was significant which may be ascribed to addition of sapota pulp and betel leaf extract in treatments. The highest mean value of flavor & taste score was recorded in the sample of T3 (8.55) and lowest was recorded in the sample of T0 (7.51). Similarly, the highest mean value of consistency score was recorded in the sample T3 (8.10) and lowest was recorded in the sample of T0 (7.39). Likewise, the highest mean value of overall acceptability score was recorded in the sample of T3 (8.47) and lowest was recorded in the sample of T0 (7.50). It may be concluded that the Goat milk shrikhand blended with sapota pulp and betel leaf extract can be successfully prepared by using standardized milk, sapota fruit pulp, sugar and betel leaf extract. Goat milk shrikhand made with sapota pulp and betel leaf extract in treatment T3 was best in sensory evaluation and also received highest score in sensory evaluation (colour and appearance, flavour and taste, consistency and overall acceptability).

### Ghee

Ghee is a type of clarified butter fat that has been produced and utilized in India from antiquity. It is used in Ayurveda as a therapeutic agent and also for religious rituals. It is popular in India because of its nutritional attributes and characteristic flavor and aroma and is considered as sacred food. The oxidative rancidity in ghee is one of the severe problems thereby affecting the sensory characteristics and loss of nutritional quality. Several workers have carried out exhaustive work to improve the stability of ghee against auto oxidation by altering processing parameters, by using proper packaging practices and storage conditions, addition of milk components and use of antioxidants. A number of natural antioxidants have been added during food processing and have elongated the shelf life and oxidative stability of stored products. Synthetic antioxidants (e.g., TBHQ, BHA and BHT) are widely used as food additives, but their application has been reassessed because of possible toxic or carcinogenic components formed during their degradation. Betel leaf extract has a promising anticarcinogenic. Piper betel leaves also contain significant number of antioxidants like hydroxychavicol, eugenol, ascorbic acid and  $\beta$  carotene belonging to the propenylphenol group [24]. The presence of phenol and phenolic (Chavicol, Chavibetol, Chavibetol acetate and eugenol) in the Piper betel leaves may be credulous to be responsible for its antioxidant activity. Considering the nutritional, therapeutic and antioxidant properties of Piper betel leaves it is planned to use the Piper betel leaves in the preparation of ghee.

Attempt was made by Shingala *et al.* [24] for evaluating the effect of stage of addition of herbs on cholesterol content in ghee. Four replications were conducted in stage 1, the highest cholesterol reduction was observed in betel leaves (14.16%). The selected herbs in the present study were able to lower down the cholesterol content of the ghee in the range of 11.77 to 17.46%. The finding of the research may be useful in production of low cholesterol ghee with relatively chapter rate.

Another study was carried out by Kubade *et al.* [25] to develop protocol for utilization of Piper betel leaves in

ghee with increased shelf-life. The various levels of Piper betel was added in ghee viz., 1.0 (L1), 1.5 (L2) and 2.0 (L3) per cent. the level was optimized on the basis of sensory evaluation and physico chemical properties. It was found that the ghee prepared by the addition of the Piper betel leaves @ 1.5 per cent obtained maximum scored for all the sensory qualities among other two level under study. In trial the results showed that the flavour, texture, colour and freedom from suspended impurities score of ghee was recorded maximum for ghee prepared by using Piper betel leaves of 1.5 (L2) per cent level. Also, moisture, free fatty acid, peroxide value, TBA value, Conjugated diene was recorded maximum score for ghee prepared by using Piper betel leaves of 1.5 (L2) per cent level. Consumers as a whole liked the product 'moderately' to 'very much' with an average score of 7.70.

### **Khoa**

Khoa is one of the most important heat desiccated product which is used as the base material for a large variety of sweet delicacies. It has a limited shelf life of less than a week under ambient condition. Also, it is more prone to chemical and microbial spoilage irrespective of the storage conditions due to its high moisture content So, attempts have been made to preventing the growth of microbes and oxidative rancidity under refrigerated and ambient storage of khoa. Different worker used potassium sorbate as a chemical preservative to extend the shelf life of khoa. The major cause of khoa spoilage is not only by microbial action but also oxidation of fat which is responsible for producing rancid flavor. Now interest is growing toward the use natural antimicrobial and antioxidant compounds like extracts of herbs and spices for preservation of food. These natural preservatives are gaining importance in recent years because of little or no harmful effects. Betel leaves (Piper betel) are also known to contain significant number of antioxidants like hydroxyl chavicol, eugenol, ascorbic acid and beta carotene.

The study was undertaken by Shivkumar *et al.* [26] to assess the effect of betel leaves extract on the physico-chemical, sensory and antioxidant properties of khoa made from cow's milk and stored under room tempera-

ture. The physicochemical properties like pH, T.A, fat, FFA, sensory and antioxidant properties were evaluated periodically at an interval of 3 days upto 9 days. The result revealed that sensory evaluation of khoa was not influenced by the presence of 0.5 % aqueous extract of betel leaves up to 9 days of storage period with an overall acceptability score of 6.83. The physicochemical properties of khoa showed an increasing trend in acidity and decrease of pH as the storage period progresses. The FFA levels were well within the prescribed limit because of antioxidant properties exhibited by the aqueous extract of betel leaves restricted the production of FFA compared due to antioxidant property of betel leaves.

### **Ice-cream**

Ice cream is one of the most popular frozen dairy products. It is a highly popular, palatable, nutritious and commercially important dairy product. It is a valuable accompaniment to the normal diet for all age groups especially for children. Ice cream could be made more nutritious and health beneficial by adding herbs and other protein rich ingredients. Thus, the ice-cream prepared from addition of some herbs may improve the nutritive quality. Piper betel Linn (Piperaceae) is a natural herb which is valued for its medicinal and therapeutic properties and widely used as a post meal mouth freshener due to strong pungent aromatic flavor.

The study was conducted by Bhoite *et.al.* [27] found that the leaves of Piper betel of Calcutta variety used in the combination of form of paste + pieces @ 3 per cent level (w/w) of ice-cream mix was significantly superior than the other two varieties, forms and levels respectively under study. Also, the results of consumer acceptance trial were found satisfactory (more than 50% rating excellent and very good). Hence, the ice-cream prepared using PBL of Calcutta variety, paste + pieces form and 3 per cent level is recommended for commercial production.

### **Flavoured Milk**

Flavoured milk is a sweetened dairy drink with cow's or buffalo's milk by adding colourings, artificial or natural flavourings and sweetener that make more appetizing, especially to children. Flavoured milks are also



prepared by adding various types of herbs to provide therapeutic value to the flavoured milk. Considering the increasing demand, nutritional, therapeutic and post meal mouth freshener property of Piper betel is used in flavoured milk.

The study was undertaken by Kambale *et.al.* [28] with object to optimize the levels of Piper betel leaves for developing flavoured milk and to study the sensory qualities as well as physico-chemical properties of Piper betel flavoured milk. Initially fresh cow milk was standardized to 2% fat and aqueous extract of piper betel leaves (PBLE) of different varieties were prepared. The level of PBLE and sugar were optimized using CCD of RSM. It was found that the flavoured milk prepared by the addition of the PBLE of Calcutta variety had obtained maximum score for all the sensory qualities among other two varieties under study. In RSM trial the results showed that the colour and appearance, sweetness and overall acceptability score of milk was recorded maximum for formulation, having 5 per cent PBLE and 10 per cent sugar. The best solution exerted through the software, contained PBLE and sugar at 5.15 and 10.30 per cent, respectively. The validation of the prediction was done by actual observations recorded for sensory score. The optimized formulation had 8.49, 8.50, 7.40, 8.30 and 8.15 score for colour and appearance, flavour, consistency, sweetness and overall acceptability, respectively. Consumers as a whole liked the product 'moderately' to 'very much' with an average score of 7.70.

### Whey Based Mango Beverage

Whey beverages which are also having good nutritional value. Whey is obtained from paneer or cheese after pressing it. It is high source of protein which are important for body build up. whey as a beverage in human nutrition, especially for therapeutic purposes. Nowadays there are so many research is done on the whey beverage with addition of herbs.

The study was conducted by Mugale *et.al.* [29] found that beverage prepared from 12 per cent mango juice, 7 per cent sugar, 2 per cent betel leaves distillate, 76 per cent whey quite acceptable to the consumer. Whey contains

about half of the milk solids in which nutritional components such as lactose, protein and minerals, high amount of antioxidant in mango increases the deliciousness and nutritional value of the product. The Addition of betel leaf distillate in which contain active ingredients like chavicol and eugenol provides preventive and curative properties to the product along with its extended shelf life. Effect of betel leaves distillate concentration on sensory characteristics of fresh beverages Sensory characteristics.

## Conclusion

This review highlights the great potential of medicinal and nutritional value occupied by betel leaves. The antioxidant, antimicrobial and anticancer components present in it, proves that it is more valuable. Due to these health benefits betel leaves have been utilized in various dairy products which are chemically stable and sensory acceptable. However, such applications are limited and there is potential to enlarge its uses. Also, there are numerous technological challenges that have to be carried out to develop value added dairy products enriched with betel leaves. Moreover, more research is needed to improve the existing method and to develop the procedures for new novel dairy products.

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