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# Composition, Functional Properties and Application of Bottle Gourd in Food Products

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***Abstract***

*Bottle gourd has widespread use as a vegetable in India. It is very valuable for vegetarians since it contains several important constituents which are required for good health and wellbeing. Recently in India, interest in bottle gourd has been growing amongst consumers because consumption of bottle gourd has been associated with a number of benefits and may be regarded as a natural guard against diseases. In Ayurveda, bottle gourd is advocated for treatment of diabetes mellitus, hypertension, flatulence, cooling properties, liver diseases, weight loss and other associated benefits. The nutritive value of bottle gourd makes it a popular diet ingredient in making sweet curries, soups, jams, juices, beverages, cakes, ice creams and tea for value-addition. In this article, the literature available on functional properties, health benefits and applications of bottle gourd in various food products have been reviewed.*

***Keywords:*** *Bottle gourd, composition, properties, medicinal uses, application, dairy products*

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## INTRODUCTION

Bottle gourd belongs to the Cucurbit family (cucumber, squash, etc.) with the scientific name *Lagenaria siceraria* (Mol.) [1]. Bottle gourd is also known as Calabash, Doodhi, and Lauki [2] in different parts of India. It is yellowish green, having the shape of a bottle with whiter pulp. India, Sri Lanka, South Africa, Indonesia and Malaysia are the major bottle gourd producing countries in the world. The gourd vegetables are grown on 4.05 lakh hectares in world. The total area under bottle gourd cultivation in India was about 1.17 lakh hectares and total production was 1.43 lakh tonnes [3, 4]. Major bottle gourd growing states of India are U.P., Punjab, Gujarat, Assam, Meghalaya and Rajasthan. Bottle gourd fruits are available in varying shapes and sizes [4]. In recent years, bottle gourd has been used to treat diabetes [5]. Bottle gourd is one of the excellent fruits gifted by the nature to human beings having composition of all the essential constituents that are required for normal and good human health [6]. Bottle gourd has long been an important component of indigenous herbal medicines, particularly in Asia. Its leaves, seeds and flowers also have medicinal applications [7]. Its consumption is advocated by traditional healers for controlling diabetes mellitus, hypertension, liver diseases, weight loss and other associated benefits [8]. It is well known that bottle gourd is helpful in constipation, premature graying of hair, urinary disorders and insomnia which reflect significant health-promoting properties [9].

## TYPES AND VARIETIES

Cucurbitaceae family is commonly known as the gourd, melon or pumpkin family among which *Lagenaria* species is the most popular. The bottle gourd belongs to the genus *Lagenaria* that is derived from the word lagena, meaning the bottle [2]. Bottle gourd is variable in varying shapes and sizes. Bottle gourd varieties grown in India are Arka Bahar, NDBG 1, NDBG 4, PBOG 1, Phule BTG 1, Punjab Komal, Punjab Long, Punjab Round, Pusa Manjari, Pusa Meghdut, Pusa Naveen, Pusa Summer Prolific Long, Pusa Summer Prolific Round and Rajendera Chamatkar [4, 6, 10].

## CHARACTERIZATION OF BOTTLE GOURD

Genus *Lagenaria* to which bottle gourd belongs is characterized by following key features: The background color is either light green or dark green (as a solid color, as regular

 

or irregular stripes, and as an irregular blotch). The size varies from 2 to 12" diameter and from 4 to 40" length. The neck is seedless and generally is upto 15" in length and 1–2" wide. When the necks are wider they usually contain seeds and may have a see-containing bulge. The portion of fruit containing seed can be flat to round, cylindrical, club-shaped or long and narrow. The long, narrow forms are best for vegetables, and the round types serve as containers. These fruits may be long, oblong or round in shape depending upon the variety [10].

**Functional Properties**

According to the American Dietetic Association, "Functional Food" is defined as: any modified food or food ingredient that may provide a health benefit beyond the traditional nutrients that it contains [11–13]. However, in literature there is no consensus on the exact definition of the term "Functional food". Consumption of bottle gourd has been associated with a number of functional properties and health benefits: Anti-hyperlipidemic activity [14–19]; Analgesic and anti-inflammatory activity [14, 20, 21]; Diuretic activity [9, 14]; Anti-oxidant activity [22–25]; Immuno-modulatory activity [22, 26]; Hepatoprotective activity [22]; Cardioprotective activity [22, 23]; Antidiabetic activity [27]; Central nervous system activity [28]; Hypertensive activity [29]; Anticancer activity [30]; CNS depressant activity [31].

**Therapeutic Value of Bottle Gourd**

In India, bottle gourd is advocated for treatment of diabetes, hypertension, flatulence, liver diseases, weight loss and other associated benefits. It is also known for its cooling properties and is widely used in Ayruveda to treat various ailments.

Bottle gourd pulp is considered to be cooling, diuretic, and antilithic in China. Bottle gourd seeds are used as a remedy for treatment of painful teeth and gum ulcers [32]. It is used to treat anasarca-ascites, beri-beri and its anti-swelling properties are useful in treating abdominal swelling and swelling of the feet [33]. It forms an excellent diet being rich in vitamins, iron and minerals. Bottle gourd contains tri terepenoide cucurbitacins B, D, G, H, two sterols viz. fucosterol and campesterol, aerpene byonolic acid (an allergic compound), flavone-C glycosides and (a ribosome inactivating protein) lagenin and is used as a curative plant for mental health disorders. Bottle gourd contains a high choline level along with required metabolites/metabolic precursors for brain function. It has vitamins, minerals and amino acids that are present in it for the synthesis of neurotransmitters [6]. Hence, bottle gourd is a vegetable with a good source of carbohydrates, vitamin A, vitamin C, and minerals etc. Bottle Gourd may be fried, boiled, or stuffed with the tender fruits used for making sweet meals [1].

A study on Gujarat earth quake victims suffering from mental disorders like depression, stress, and manic disorders were extremely significant; were treated with shade dried bottle gourd powder capsules [6]. The approximate content iron of in bottle gourd with and without peel is 11.87 and 2.33 mg/100 g respectively [9]. Thus, it can be seen that most of the iron is concentrated in the peel. Bottle gourd contains almost 96% moisture and is rich in calcium, phosphorous and dietary fibers. The choline content of bottle gourd is around 1.6% on dry matter basis which has influence on nervous system functioning, as it is precursor to acetylcholine [34–36].

It contains cucurbitacins, fibers, polyphenols and two sterols namely campesterol and sitosterol [37]. The dietary fiber present in the bottle gourd makes it a very useful vegetable in preventing digestive disorders such as constipation and piles. A positive correlation has been found between fiber consumption and the reduction of coronary heart diseases and diabetes incidence [38]. Bottle gourd juice is used traditionally as a medicine for treating acidity, indigestion and ulcers besides being a good thirst quencher.

Bottle gourd has high therapeutic values and was recommended to be consumed on a daily bases. It possesses glycemic responses in diabetic subjects and could be used in the dietary management of diabetic [39]. It is conventionally used as a nutritive agent having cardio-protective [22] and diuretic effect. The fruit is found to be antidote to certain poisons and scorpion stings, and also has alternative

purgative, and cooling effects. The fruit is believed to have ability to relieve pain and is effective against fever, and hence found useful in treatment of asthma and other bronchial disorders. They are also good source of natural antioxidants [2, 14, 37, 40,]. Bottle gourd contains two sterols namely campesterol and sitosterol [36]. No cholesterol is there. 100 g of edible portion of the bottle gourd contains 0.3 mg niacin, 12 mg ascorbic acid, 87 mg potassium, 12 mg calcium and 37 mg phosphorus [35]. Potassium is the most abundant mineral followed by phosphorus and calcium [34]. The approximate content iron of in bottle gourd with and without peel is 11.87 and 2.33 mg/100 g respectively [9]. Thus, it can be seen that most of the iron is concentrated in the peel. Instead of consuming vitamin pills or tonics, a slice of gourd, a slice of melon and a handful of pumpkin seeds are enough for maintaining our health. A cup of watermelon juice in the morning, mixed green salad of gourd slices (two pieces of melon, two pieces of gourd, four pieces of snake gourd, one piece of bitter gourd and some cuttings of cucumber) are suffix to prefix for good health [6].

**Medicinal Uses**

Various medicinal use of bottle gourd has been described in literature [2, 8, 14, 17, 22, 32, 37, 39, 41–46]. The bottle gourd (*Lagenaria siceraria)*, belongs to family *cucurbitaceae*, and is used in appliance of pharmaceuticals and dietary formulations [47]. Bottle gourd (*Lagenaria siceraria*) contains 96.1% water, so is light on the stomach and aids digestion. It helps in losing weight quickly, because of its high dietary fiber and low fat and cholesterol content [9, 48, 49].

**Composition and Nutritional Value**

The approximate (%) compositon of bottle gourd is: Moisture: 94.5±0.06; Protein: 1.2±0.06; Fat: 0.2±0.02; Carbohydrate: 3.75±0.03; Fiber: 0.7±0.01; Ash: 0.5±0.01; Energy(Cal): 15±0.12. Bottle gourd flesh (devoid of seeds) contains 14.2–32.3% cellulose on a dry weight basis [50]. Bottle gourd contains almost 96% moisture and is rich in calcium, phosphorous and dietary fibers. The edible portion of the bottle gourd contains 0.3 mg niacin, 12 mg ascorbic acid, 87 mg potassium, 12 mg calcium and 37 mg phosphorus per 100 g [35]. Potassium is the most abundant mineral followed by phosphorus and calcium [34].

It contains cucurbitacins, fibers, polyphenols and two sterols namely campesterol and sitosterol [37]. The dietary fiber present in the bottle gourd makes it a very useful vegetable in preventing digestive disorders such as constipation and piles. A positive correlation has been found between fiber consumption and the reduction of coronary heart diseases and diabetes incidence [39]. It is a vegetable with a good source of vitamin A, vitamin C, and minerals [1, 45]. It forms an excellent diet being rich in vitamins, iron and minerals. The approximate content iron of in bottle gourd with and without peel is 11.87 and 2.33 mg/100 g, respectively [9]. The amino acid and vitamin content of bottle gourd fruit and seed portion is presented in Tables 1 and 2 respectively.

***Table 1:*** *Amino Acids Present in Bottle Gourd (Parle et al., 2011)[ 9].*

| Sr. No. | Amino Acids | Fruit (g/100g of Dry Ghiya) | Seeds (g/100g of Dry Ghiya) |
|---|---|---|---|
| 1. | Tryptophan | 0.003 | 0.431 |
| 2. | Threonine | 0.018 | 0.903 |
| 3. | Isoleucine | 0.033 | 1.264 |
| 4. | Leucine | 0.036 | 2.079 |
| 5. | Methionine | 0.004 | 2.079 |
| 6. | Cystine | _____ | 0.551 |
| 7. | Pheynylalanine | 0.015 | 1.222 |
| 8. | Valine | 0.027 | 1.972 |
| 9. | Arginine | 0.14 | 4.033 |
| 10. | Histidine | 0.004 | 0.681 |

***Table 2:*** *Vitamin Content of Bottle Gourd.*

| Sr. No. | Vitamin | Fruit (mg/100g of Dry Ghiya) | Seeds (mg/100g of Dry Ghiya) |
|---|---|---|---|
| 1. | Vitamin C | 10.100 | 1.900 |
| 2. | Thiamin | 0.029 | 0.210 |
| 3. | Riboflavin | 0.022 | 0.320 |
| 4. | Niacin | 0.320 | 1.745 |
| 5. | Vitamin B6 | 0.040 | 0.224 |
| 6. | Pantothenic acid | 0.152 | 0.339 |
| 7. | Vitamin E | 16.02 | 1.000 |

*(Parle et al., 2011 [9]).*

**Properties of Bottle Gourd Seed**

The seeds of bottle gourd contain enormous phyto-chemicals, vitamins, minerals, amino acids and omega fatty acids. If properly utilized the seeds can contribute in solving the problem of malnutrition and also serve as raw material for agro-based industries [22, 38, 39, 51]. The approximate composition of seed kernel is 2.47% of moisture, 30.72% of protein, 52.54% of fat, 8.3% carbohydrate and 4.43% of ash. The fibre content is around 1.58%. Seeds have a coating called testa. Raw bottle gourd seed husk contains 9.85% protein, 2.1% fat, 41.62% total fiber, 1.9% ash and 36.15% carbohydrate while roasted bottle gourd seed husk contains 8.7% protein, 1.7% fat, 39.33% total fiber, 2.57% ash and 41.29% carbohydrate [39]. It is fortified in the pan bread as a source of fiber [39]. The oil extracted from the seeds has pale yellow colour and is commonly used for hair care [24, 52]. The ethanolic extract obtained from the seeds has a potent anthelmintic activity against tapeworms which is comparable to the effect of piperazine citrate [53]. Hassan et al. reported that bottle gourd seed is a potential source of protein, lipid, micro and macronutrients [51]. The moisture and other contents of whole seed are (17.5±0.21%) and (5.80±0.83%) respectively, while the dehulled portion has a good amount of crude protein (35.0±0.48%) and crude lipid (39.22±1.48%). The seed coat contains high amount of crude fibre (59.05±0.98%). The percentages of essential and non-essential amino acids in dehulled seeds, whole seeds and seed coats were 44, 41, 51 and 56, 59, 49 respectively. The essential amino acid content of dehulled seeds was found to be higher than WHO/FAO/UNU requirement. Threonine, lysine and lysine were found to be the most limiting amino acids in whole bottle gourd seeds.

Chinyere et al. analyzed the nutritive value of *Lagenaria sphaerica* (Wild Bottle Gourd) from South-Eastern Nigeria [54]. They found that the nutritional value of their seeds was similar to those of curcubitacae (Melon) seeds. The moisture (7.92%), crude fibre (3.65%) and ash (2.68%) contents were similar to those of peanuts, sesame and sunflower but its carbohydrate level is (14.22%) was found to be lower. They reported that the *Lagenaria sphaerica* seed is rich in protein (23.48%) and minerals (73.12%). The seeds contained high lipid levels (44.54%) similar to those found in other oilseeds. Linoleate (18.2) was the most abundant fatty acid (62%). Ojiako and Igwe analyzed and reported the nutritional and anti-nutritional composition of *Lagenaria siceraria* seeds from Nigeria [55].

When defatted seed flours of *Lagenaria siceraria* (calabash and bottle gourd) were fractionated into seed flour and its protein fraction, it was found that Glutamic acid (139–168 mg/g protein) was the most abundant amino acid followed by aspartic acid (89.0–116 mg/g protein) in both the seed flours and their protein fractions. The total essential amino acid in protein rich fraction ranged from 45.8 to 51.5%. The seed flours contained sufficient essential amino acids required by growing school children and adults. The authors opined that the seed has potential as protein supplement in cereal based complementary diets or in the replacement of animal proteins in conventional foods (Ogunbusola et al., 2010) [56].

**Properties of Bottle Gourd Peel**

The peels of bottle gourd have been shown as good sources of minerals and antioxidants. Various workers have reported the composition of bottle gourd peels [9, 57].

Mohankumar and Prasadini evaluated certain physico-chemical properties of whole, pulp and skin of organic and conventional bottle gourds respectively [57]. The raw, boiled and steamed skin of both the bottle gourd varieties contained high calcium (12.5 mg) content. The phosphorus content of raw boiled and steamed skins was higher compared to that of pulp and whole of bottle gourd. Conventional boiled skin showed a high iron content (11.25 mg). Skin of bottle gourd showed highest scavenging activity (84.86%) than the whole and pulp (20.73%). The dietary constituents and mineral contents of bottle gourd with and without peel are presented in Tables 3 and 4 respectively.

***Table 3:*** *Dietary Constituents of Bottle Gourd.*

| Sr. No. | Constituents | With Peel (g/100 g of Dry Ghiya) | Without Peel (g/100 g of Dry Ghiya) |
|---|---|---|---|
| 1. | Total sugar | 5.87 | 8.29 |
| 2. | Reducing sugar | 5.22 | 7.92 |
| 3. | Non-reducing sugar | 0.65 | 0.29 |
| 4. | Starch | 1.31 | 1.57 |
| 5. | Crude fiber | 4.45 | 3.40 |
| 6. | Neutral detergent fiber | 22.71 | 21.16 |
| 7. | Acid detergent fiber | 16.26 | 15.67 |
| 8. | Hemicellulose | 6.45 | 5.58 |
| 9. | Cellulose | 16.07 | 16.40 |
| 10. | Lignin | 0.193 | 0.167 |

*Source: Mohankumar and Prasadini (2011) [57].*

***Table 4:*** *Mineral Content of Bottle Gourd.*

| Sr. No. | Minerals | With Peel (mg/100 g of Dry Ghiya) | Without Peel (mg/100 g of Dry Ghiya) |
|---|---|---|---|
| 1. | Iron | 11.87 | 2.33 |
| 2. | Phosphorous | 240.33 | 187.33 |
| 3. | Potassium | 3320.00 | 3356.67 |
| 4. | Zinc | 3.77 | 3.47 |
| 5. | Magnesium | 162.33 | 146.33 |
| 6. | Copper | 0.19 | 0.24 |
| 7. | Sodium | 27.88 | 36.68 |
| 8. | Manganese | 0.26 | 0.31 |

*(Source: Mohankumar and Prasadini (2011) [57]; Parle et al., 2011 [9]).*

## EFFECT OF PROCESSING

Calabrese et al. studied the technological and qualitative aspects of calabash gourd during processing [58]. Slices of 1 cm thickness were blanched for 0, 30, 60, 90, 120, 150, 180 and 240 sec in boiling water at 100°C. Peroxidase and polyphenol-oxidase activity were evaluated in relation to blanching period. They found that total enzymatic inactivation of blanched samples was obtained in 180 sec. To set the technological parameters for deep freezing, slices one cm thick were blanched for different times and then deep frozen. To obtain ready to use product, fresh slices 1 cm thick were dipped for 90 sec in ascorbic or citric acid solution at 0.2–0.5 and 1% concentration and stored in sealed plastic bags at 4 ºC for 15 days. Blanching treatments influenced the slices' colour and the sensorial traits; frozen slices 90 sec blanched and stored up to 6 months were more appreciated than others. In the ready to use product, significant changes in colour did not appear for 6 d stored samples; while differences were observed for longer storage; these results were confirmed by panel test [59]. The Vitamin C content of conventional and organic bottle gourd is presented in Table 5.

***Table 5:*** *Vitamin C Content of the Selected Bottle Gourd Varieties.*

| Processing Methods | Parts Used | Conventional (mg) | Organic (mg) |
|---|---|---|---|
| Raw | Whole | 5.90 | 5.90 |
| | Pulp | 2.95 | 2.95 |
| | Skin | 8.85 | 8.85 |
| Boiled | Whole | 2.95 | 2.95 |
| | Pulp | 2.95 | 2.95 |
| | Skin | 2.95 | 5.90 |
| Steamed | Whole | 2.95 | 2.95 |
| | Pulp | 2.95 | 2.95 |
| | Skin | 2.95 | 2.95 |

*(Source: Mohankumar and Prasadini (2011) [57].*

Mohankumar and Prasadini reported that boiling and steaming of bottle gourd resulted in a reduction in vitamin C content [57]. Total phenolic content of organic boiled skin extract had more antioxidant activity (19.86 mM of GAE) because of processing.

In an experiment conducted by Patil et al. bottle gourds (Pusa Naveen variety) were stored in three different conditions viz. Zero energy cool chamber (ZECC) at 22.36–24.73°C and 92.66–97.36% RH, room temperature (26.83–34.03°C and 50.33–73.66% RH) and basement storage (24.62–32.17°C and 52.11–75.33% RH) using different packaging materials viz., Polyethylene bag (100 gauge and 2% vent), CFB box, News paper, Polyethylene (100 gauge and 2% vent) + CFB box, News paper + CFB box and Control (without packaging) [60]. It was found that percentage loss in weight, total soluble solids and acidity increased at slower rate and maximum shelf life was obtained using ZECC storage conditions using polyethylene bag (100 gauge and 2% vent) + CFB box packing.

## APPLICATION OF BOTTLE GOURD IN FOOD PRODUCTS

Among various vegetables grown in India, bottle gourd (*Langenaria siceraria*) has a high place in diet as it is rich and the cheaper source of nutrients. Bottle gourd used for consumption needs to be non-bitter [7, 61]. The nutritive value of Bottle gourd makes it a popular diet ingredient in making sweet curries, soups, jams, juices, beverages, cakes, ice creams and tea for value-addition [6]. Bhatooru, siddu, marchu, seera, chilra, manna, aenkadu, sepubari, patande, doo, baari, dosha, malpude, babroo, bedvin roti, madrah, tchati, churpa, sura, chhang, kinnauri, angoori, chulli, lugri, arak/ara, rak, chukh and pickles (e.g. brinjal, lingri, bidana, peach, pear, plum, tomato, bottle gourd, etc.) made from different fruits and vegetables, etc. are some of the popular traditional products that are unique to the tribal and rural belts of Himachal Pradesh. However, the production of these foods and beverages is largely limited to the household level [62].

Bottle gourd can be used for pickles, chutney, juice and making sweets like halva. Immature bottle gourds are consumed as summer squash and also added to curries and moist flesh is used to make glaze for cakes [7]. Kofta is most popular preparation having bottle gourd [63]. The jelly prepared from bottle gourd pectin possesses good strengthening properties. Tutti frutti is also prepared from bottle gourd [64, 65].

### Bottle Gourd Juice

Deore et al. prepared bottle gourd juice from healthy fruits of uniform size and color which were peeled off and cut into small pieces [66]. The juice was extracted in a juicer and filtered through two layers of muslin cloth. Blended juice of basil and bottle gourd was found to be acceptable for 6 months and was microbiologically safe [67]. Whey based beverage prepared from pineapple and bottle gourd juices in combination with edible extract of herbal medicinal plants like *Mentha arvensis* has been reported to have excellent nutritional properties as well as therapeutic, prophylactic, antibacterial and organoleptic

properties. 10 ml each of pineapple and bottle gourd juice and 8 g of sugar were fixed per 100 ml of the herbal beverage. Whey quantity varied from 68 to 72 ml for 100 ml of the beverage [68]. Sawate et al. prepared an acceptable quality ready-to-serve beverage using 15% bottle gourd juice [69]. The bottle gourd juice had 15% total soluble solids and 0.32% acidity. Blanching was used to effectively extract the juice and retention of the natural and fresh colour of juice. The extracted juice had a good amount of potassium, iron and ascorbic acid. The shelf life of the developed bottle gourd RTS beverage under refrigerated conditions was found to be two months and one month at ambient conditions of storage.

A processing technology for manufacture of bottle gourd RTS beverage has been developed [68]. Several frozen and ready to use (RTU) products from fruits and vegetables containing bottle gourd as an ingredient have been reported [59].

Kaur and Aggarwal compared the effect of different chemical additives on the storage stability of bottle gourd juice [70]. They reported that potassium metabisulphite @ 3000 ppm proved to be a better preservative than Na-benzoate for the stability of physicochemical and phytochemical parameters and maintaining the antioxidant activity of the bottle gourd juice when stored in glass bottles at room temperature for 6 months. The vitamin C content of bottle gourd juice decreased from 3.92 to 2.44 mg/100 g at 0 day and 6 months of storage respectively.

Bottle gourd, basil and lemon juice in combination were used in preparation of honey based nectar. From amongst, the different blends evaluated it was found that use of a blend consisting of 50% bottle gourd juice, 25% basil leaf juice and 5% lemon juice resulted in the most acceptable product. The prepared product from selected blend was rich in antioxidant activity (84.84%) and phenols (5 mg/ml). The authors claimed that this product has low glycaemic index and could be successfully stored for a period of six months [71].

**Bottle Gourd Sweets**

Bottle gourd has been used in combination with milk solids in a number of indigenous traditional dairy sweets. Lauki Halwa, a vegetable based milk sweet is a popular dessert in North India [72]. Products like gajar (carrot) halwa, dudhi (bottle gourd) halwa, kheer, basundi and tomato ketchup were successfully prepared using SSHE and their quality as determined by sensory evaluation declared to be excellent [73].

Dalal standardized a process for manufacture of a healthy bottle gourd halwa (similar to burfi) [74]. Gupta and Reddy reported that kapoorkand prepared by using 70:30 milk to bottle gourd ratio and 12% sugar registered highest scores for all the sensory attributes [75]. Low-salt, low-fat and high-fibre chicken nuggets can be developed with the use of a salt substitute blend and bottle gourd without affecting their acceptability [76]. Blending of vegetables such as bottle gourd, medicinal plants, and spices in appropriate proportions for the preparation of natural vegetable based nutritive beverages [77]. When bottle gourd pectin is used in jelly making, it results in a Jelly having good strengthening properties [78].

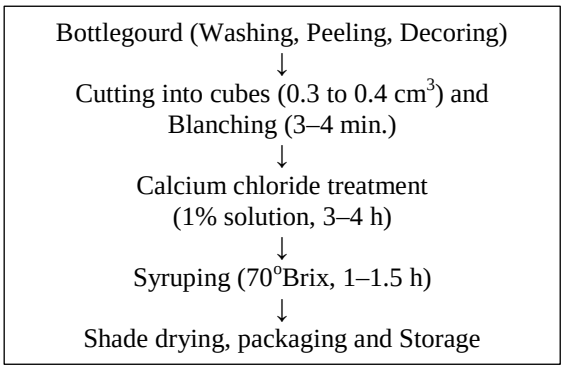


***Fig. 1:*** *Preparation of Tutti Frutti from Bottle Gourd.*

*(Source: Babar, 1996 [63]; Desai and Musmade, 1998 [78]).*

Babar prepared tutti frutti from bottle gourd using different methods viz. slow syruping, single operation (boiling in sugar syrup) and slow syruping with 1% $CaCl_2$ [64]. The flow chart for preparation of tutti frutti is presented in Figure 1. He reported that good quality tutti fruti can be prepared by slow syruping process and can be preserved in polyethylene bags for at least 3 months without affecting the quality.

The chemical composition of tutti frutti was 20.3% moisture, 68.66% Brix TSS, 7.01 mg/100g ascorbic acid, 0.23% acidity and 65.45% total sugars.

Sawate et al. studied the influence of incorporating dried bottle gourd powder on quality of bottle gourd candy [35]. Shreds from bottle gourd were prepared and then subjected to pretreatments like unblanched, blanched in hot water at 80–85°C for 3 min and immediately cooled followed by sulphitation. Sulphitation was done by steeping shreds in 1% KMS (potassium metabisulphite) solution for 15 min. After pretreatment shreds were dried in cross flow cabinet drier at 50–55°C for 3 h. It was concluded from the study that blanching and sulphitation reduces drying time and improves physical and organoleptic properties of powder.

**Dairy Products**

Vegetable kheer prepared by using milk, bottle gourd cubes is the most suitable nutritional supplement with longer shelf life than common rice kheer. Manufacture of bottle gourd kheer by boiling 25% by weight bottle gourd cubes and 16% sugar in milk produces an acceptable quality kheer. This kheer stored in glass bottles at 2–4$^{o}$C has a shelf life of 5–6 days. If preservative @ 3 ppm is added then this kheer remains acceptable for 18–20 days. Similarly, it was in case of pumpkin kheer [79].

Gupta and Reddy standardized the process for preparation of kapoorkand using two levels of ratio milk to bottle gourd i.e. 60:40 and 70:30 with sugar i.e. 12 and 16% [75]. Kapoorkand prepared with 70:30 milk to bottle gourd ratio, resulted in significantly lower product yield and lower moisture content and higher fat and protein compared to kapoorkand prepared with 60:40 milk to bottle gourd ratio,. Kapoorkand prepared with lower level of sugar i.e. 12% sugar had a lower product yield and higher moisture, fat, protein and titratable acidity when compared to product prepared with 16% sugar. Kapoorkand prepared by using 70:30 milk to bottle gourd ratio; and 12% sugar registered highest scores for all the sensory attributes. A gradual decrease in moisture percentage and increase in titratable acidity was observed in all formulations of kapoorkand at both storage temperatures.

Lauki kheer consists of light greenish yellow, shredded and cooked bottle gourd interspersed in slightly viscous milk. Grated bottle gourd, which becomes tender during cooking, imparts a characteristic crunchy texture to the product. Milk and other ingredients provide a creamy product consistency. In North India, particularly in Kashmir, rice flour and custard powder are also added to make the product creamier and smoother. For preparation of lauki kheer about 50 g rice (washed and soaked in water for 3 h) is crushed lightly, added to 1 l boiling milk and cooked till the rice is tender. To this is added 250 g sugar and cooking is continued till the milk thickens. On the other hand 250 g of seedless bottle gourd is grated and steamed for 15 min. After draining the steamed tender bottle gourd is mixed in milk mixture and cooked for another 15 min. Finally khoa (110 g), cardamom powder (1 to 2 g) and custard powder (5 g dispersed in 15 ml water) are added to the mixture and cooked for another 5 min. At the time of serving, the top surface is garnished with silvered pistachio and flavoured with 1 tsp kevra essence [72].

A vegetable based milk sweet; lauki halwa is popular in North India. For preparing lauki halwa, ghee is melted in a pan and grated bottle gourd 2.5 kg is fried in it for about 20 min untill light brown. Sugar (250 g) is added and mixed thoroughly with fried grated gourd. Other ingredients such as khoa (500 g) and cardamom powder are added with constant stirring till free fat starts separating and uniform lump is formed [72].

Kalakand, an important indigenous dairy product is a partially desiccated milk based sweet prepared from acidified milk with caramelized flavour and granular texture. When Kalakand was prepared by addition of 5% bottle gourd pulp it had significantly ($P<0.05$) higher scores for colour and appearance, flavour, body and texture and overall acceptability compared to Kalakand prepared by addition of higher rates of bottle gourd pulp viz. 10 and 15%. The control samples of Kalakand had significantly higher sensory score for all parameters than Kalakand

samples prepared by using 10 and 15% bottle gourd pulp. However, control and Kalakand with 5% bottle gourd pulp doesn't differ significantly from each other and both are comparable. Kalakand samples prepared by addition of 5, 10 and 15 % bottle gourd pulp were also liked considerably by the panelists. The authors were of the opinion that value addition of Kalakand by using bottle gourd pulp could be done by replacing milk maximum up to 15% with bottle gourd pulp [80].

Ghule et al. [81] assessed the chemical composition, sensory evaluation and microbial quality of bottle gourd *Pedha*. *Pedha* was prepared from buffalo milk with constant level of sugar (30% by weight by *Khoa*) and different levels i.e. 0, 5, 10 and 15% of bottle gourd pulp by weight of *Khoa*. The product prepared using 5% bottle gourd pulp was found most acceptable on the basis of overall acceptability. They reported that nutritious, palatable and low cost *Pedha* can be prepared by blending 5% bottle gourd pulp with 95% buffalo milk *Khoa* on weight basis.

**Bakery Products and Snacks**

Roasted whole bottle gourd seed (BGS) meal and roasted BGS kernel meal were added to white pan bread and cupcakes at concentration of 10, 15 and 20%. Analysis of the physico-chemical and sensory properties of both products revealed the optimal level of BGS addition to be 10%. Roasted bottle gourd seeds can be used as a source of protein, oil and fiber in bakery products [38]. Sharma et al. prepared fiber enriched biscuits using 80% wheat flour and 20% bottle gourd pulp fiber (BGPF) [82]. The acceptability of bottle gourd pulp powder (BGPP) enriched biscuits was not significantly different when compared to standard wheat biscuits. BGPP enriched biscuits were able to reduce the glycemic response to a similar extent in both healthy participants and individuals with impaired glucose tolerance.

Katare and Sharma formulated a fiber enriched Namkeen Sev, an Indian snack by incorporating dried bottle gourd pulp powder as a source of fiber [83, 84]. Results of the study indicated that addition of dried bottle gourd pulp powder @ 20% was acceptable.

## MISCELLANEOUS

Low-salt, low-fat and high-fibre chicken nuggets were developed using a salt substitute blend and bottle gourd. Bottle gourd (*Lagenaria siceraria* L.) was incorporated in low-salt, low-fat chicken nuggets at three different levels, i.e. 50, 75 and 100 g/kg. It was found that inclusion of bottle gourd at higher levels decreased ($P<0.05$) flavour and texture scores. However, incorporation of bottle gourd @ 50 and 75 g/kg did not affect their acceptability [76].

## COMMERCIAL PRODUCTS

Some of the companies manufacturing bottle gourd products are Sarvaayush Ayurved and Herbals, Maharastra, India (bottle gourd powder); Yacca Food Products, Haryana, India. (amla bottle gourd Juice blend) during summer; Taj Frozen Foods India Pvt. Ltd. (frozen and fresh vegetables bottle gourd).

## CONCLUSION

Bottle gourd is one of the wonderful vegetables gifted by nature to human beings. It contains almost all essential constituents that are required for good health and wellbeing. Consumption of bottle gourd has been associated with a number of health benefits and can be regarded as a natural protector against diseases.

Inclusion of bottle gourd in our daily diet will promote health and well-being therefore; there is a need to develop new functional dairy products to reflect consumer interest in health (e.g. utilizing vegetable source with phytochemicals) and natural ingredients.

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