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RESEARCH ARTICLE

Feasibility of Bitterness Reduction in Bitter Gourd (*Momordica Charantia*) Dried Powder By Blanching, Enzyme, and Wall Material

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Abstract

Momordica charantia, commonly known as bitter gourd has been traditionally used to treat diabetes and its complications. Several medicinal properties of the bitter gourd have been studied such as anti-diabetic, anti-ulcerogenic, antimutagenic, antioxidant, anti-tumour, anti lipolytic, analgesic, abortifacient, anti-viral, hypoglycemic and immunomodulatory. Medicinal value of bitter melon has been attributed to its high antioxidant properties due in part to phenols, flavonoids, isoflavones, terpenes, anthroquinones, and glucosinolates, all of which confer a bitter taste. However, oral consumption of bitter gourd products could be a problem due to the bitter taste. Bitter taste should be eliminated. ß-cyclodextrin is one of the most common materials used in microencapsulation process. ß-cyclodextrin comprises seven units of glucopyranose. An attempt studied the feasibility of bitterness reduction in bitter gourd dried powder by treatment of blanching (100°C in 10s; 95°C in 15s, 90°C in 20s, 85°C in 25s), enzyme (florosil 2g/100ml and naringinase 8 mg/100ml), and wall material (ß-cyclodextrin, sodium alginate, carrageenan, pectin). Reduction of bitterness and enhancing palatability are obviously observed by treatment of *Momordica charantia* dried powder by blanching 100°C in 10s, enzymatic treatment with florosil (2g/100ml) + naringinase (8 mg/100ml) and spray drying at inlet temperature 155°C, out let temperature 85°C, feed rate 15 ml/min with ß-cyclodextrin 0.5% as wall material.

Keywords: *Momordica charantia, Dried powder, Bitterness, β-cyclodextrin.*

Introduction

Bitter gourd (*Momordica charantia* Linn.) belongs to the family of Cucurbitaceae and known as one of the bitterest fruits. It is tropical and subtropical climber [1]. Bitter gourd fruits consist of glycosides, saponins, and alkaloids, reducing sugars, resins, phenolic constituents and free acids [2]. Bitter gourd has good demand due to its special culinary taste and it is also considered to be a good source of dietary fibers.

The immature fruits of bitter gourd can be fried, deep-fried, boiled, pickled, juiced, and dried to drink as tea [3]. Bitter gourd is anti-diabetic, stimulant, stomachic, laxative, blood purifier and control diabetes. It's antidotal, antipyretic tonic, appetizing and antibilious [4].

Bitter taste is a major problem in the food and pharmaceutical industries due to its negative hedonic impact on ingestion [5, 6]. Taste masking is defined as a perceived reduction of an undesirable taste that would otherwise exist. The ideal solution to reduce or inhibit bitterness is the discovery of a universal inhibitor of all bitter tasting substances that does not affect the other taste modalities such as sweetness or saltiness [7, 8].

One of the major problems of masking of off-taste is the complex mixture of sensations. The ingestible is not only perceived as bitter, but is also astringent and/or sour. Each modality is transuded by different molecular sensing systems in the mouth, and the sensation consciously recognized is again a difficult mixture to separate into individual taste qualities [9]. Encapsulation is a process in which flavors, nutrients, oils, proteins, or probiotic bacteria are enveloped into a starch, protein, or lipid carrier matrix for preservation, masking, or delivery of the encapsulated agent. Cyclodextrins are cyclic oligosaccharides produced by the degradation of starch resulting from intramolecular transglycosylation reactions caused by cyclodextrin glucanotransferase enzyme. There are several types- α-cyclodextrin which have six glucose molecules in the ring, β-cyclodextrin which have seven glucose molecules in the ring, and γ-cyclodextrin, which have eight or more glucose units [10].

The height of the cyclodextrin cavity is the same for all three types but the diameter varies with the number of glucose units. Small molecules are included in α-cyclodextrin, whereas larger molecules are included in γ- cyclodextrin.γ-cyclodextrins have greater internal cavities, are more water soluble, and allows for the inclusion to be more bioavailable [11].

β- cyclodextrin form inclusion complex with other molecule by non-covalent bond and complex stability becomes better with the availability of electron-donor character of the substituent's [16]. β- cyclodextrin can make a stable complex from with the guest molecule that is less polar than water or less hydrophilic [12]. The use of β- cyclodextrin was expected to give limonin stability against light, pH, and heat, as well as mask their bitterness when added to food system or consumed by consumer.

Several researches mentioned to application of β- cyclodextrin in bitterness reduction. Use of β-cyclodextrin polymer at 1 g of polymer/50 mL of juice in a continuous flow fluid-bed or a batch process lowered the major bitter components limonin, nomilin, and naringin in grapefruit juice and limonin and nomilin in navel orange juice by about 50% [13].

β-Cyclodextrin polymer and XAD-4 and XAD-16 resins were used in a pilot-scale fluidized bed process to reduce bitterness from naringin and limonin in grapefruit juice and limonin in California navel orange juice. For β-cyclodextrin polymers cross-linked with epichlorohydrin, naringin reduction in grapefruit juice ranged from 18 to 61% and limonin reduction ranged from 28 to 67%.

Limonin reduction in navel orange juice ranged from 29 to 55%. Bitterness reduction in grapefruit juice from XAD-16 resin was 55-58% for naringin and 90-97% for limonin; with navel orange juice limonin was reduced 93%. For grapefruit juice debittered with XAD-4 naringin reduction was 32-38%, and for both grapefruit and navel orange juice limonin reduction was 58% [14].

β-cyclodextrin at 0.4% is able to reduce the bitterness of a 0.05% caffeine solution by about 90%.The α- and the γ-cyclodextrins are much less active and higher concentrations of β-cyclodextrin taste sweet. In the same study, the authors demonstrated that the bitterness of various plant extracts such as artichoke or gentian can be selectively reduced by β-cyclodextrin [15].

A polymer-supported cyclodextrin using chitin as base was also successfully tested as a bitter masking agent [15]. The use of insoluble β-cyclodextrin polymer for the reduction of limonin in Thai tangerine juice by batch, column and fluidized bed processes were studied and compared. Direct correlation between complexation of limonin and amount of β-cyclodextrin polymer was observed.

Using 3g % β-CD polymer at room temperature, limonin reduction by the batch and column processes were 70 and 94% respectively. In a fluidized bed column (50 × 3cmi.d.) under the condition of 15g β-cyclodextrin polymer with a feed flow rate of 100mL/min at room temperature, the initial efficiency of debittering was about 90% and gradually decreased [16]. A research determined the effect of limonin core to coating ratio on limonin microencapsulation efficiency and its stability in pH 4 and 7 solution.

Encapsulant used was β cyclodextrin with core to coating ratio 1:10 and 1:20. Microencapsulation process was conducted using freeze dryer. Results revealed that limonin microencapsulation with core to coating ratio of 1:10 had efficiency of 68.14 %, while that with ratio of 1:20 had efficiency of 80.52% [17]. Healthy or functional food often contains phytochemical that has bitter taste.

Thus, it is important to reduce bitterness due to consumer sensory perception [12]. Oral consumption or addition of limonin to food system could be a problem due to the bitter taste. Bitter taste can be masked by the application of encapsulation using polymer, cyclodextrin, lipid, or surfactant [12].

Microencapsulation does not only help masking bitterness of bioactive compound but also help protect them from damages caused by oxygen, heat, or light [18]. The effectiveness of phytochemical compound antioxidant activity depends on bioactivity, stability, and bioavailability of these compounds, which could be overcome with encapsulation technology [19].

Microencapsulation process commonly uses spray dryer or freeze dryer. Bioavailability of bioactive compound and organoleptic characteristics in freeze dried microencapsulated product were better since the minimum use of heating compared with spray dried microencapsulated product [20].

Bitter gourd contains bitter chemicals like charantin, vicine, glycosides and karavilosides. The aim of this work was to study the feasibility of bitterness reduction in bitter gourd dried powder by treatment of blanching, enzyme, and wall material.

Material and Method

Material

Bitter gourd (*Momordica charantia* Linn.) was collected from Soc Trang province, Vietnam. Bitter gourd was stored at 8 °C and transferred quickly to laboratory for experiment. Bitter gourd was blanched in different temperature and time (100°C in 10s; 95°C in 15s, 90°C in 20s, 85°C in 25s). After that, the juice was extracted by using single screw juice extractor. After the extraction of juice, different agents (Florosil, naringnase, ß-cyclodextrin, maltodextrin) have been added (100 mg/litre) into juice and kept for 5 h at 48°C. Then it would be pasteurized (75±2 °C for 20 min) and spray dried (inlet temperature 155°C, out let temperature 85°C, feed rate 15 ml/min) into powder.

Figure 1: Bitter gourd (*Momordica charantia* Linn.)

Researching Method

Effect of Blanching Temperature and Time to Bitterness of Bitter Gourd Juice

Bitter gourd was blanched in different temperature and time (100°C in 10s; 95°C in 15s, 90°C in 20s, 85°C in 25s). After that, the juice was extracted by using single screw juice extractor. Sensory evaluation would be conducted to estimate the bitterness reduction.

Effect of Florosil and Naringinase to Bitterness of Bitter Gourd Juice

After blanching, the juice of bitter gourd was extracted by using single screw juice extractor. The 100ml of juice after extraction was exposed to florosil (activated magnesium silicate) at the rate of 2g/100ml with constant stirring for 2min. Florosil was removed by sedimentation and the juice was filtered through Whatman filter. As long as the florosil treatment, after the extraction of juice, naringnase was added (8 mg/100ml) into juice and kept for 5 h at 48°C.

Then it would be pasteurized (75±2 °C for 20 min). Sensory evaluation would be conducted to estimate the bitterness reduction.

Effect of Wall Material to Bitterness of Bitter Gourd Dried Powder

After blanching, the juice of bitter gourd was extracted by using single screw juice extractor. Juice of bitter gourd would be treated with florosil (2g/100ml) and naringinase (8 mg/100ml). Then this juice would be spray-dried into powder (inlet temperature 155°C, out let temperature 85°C, feed rate 15 ml/min) with the support of different wall materials (ß-cyclodextrin, sodium alginate, carrageenan, pectin) in the same concentration 0.5%. Sensory evaluation will be conducted to estimate the bitterness reduction.

Sensory Evaluation

The sensory attributes were carried out by selected panel of judges (9 members) rated on a nine point hedonic scale.

Statistical Analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Effect of Blanching Temperature and Time to Bitterness of Bitter Gourd Juice

Bitter gourd was blanched in different temperature and time (100°C in 10s; 95°C in 15s, 90°C in 20s, 85°C in 25s). After that, the juice was extracted by using single screw juice extractor. Sensory evaluation would be conducted to estimate the bitterness reduction. Results revealed in table 1. From Table 1, the bitterness in bitter gourd could be effectively eliminated by blanching at 100°C in 10s so this value was selected for further experiments.

Table 1: Effect of blanching temperature and time to bitterness (sensory) of bitter gourd juice

Blanching	No blanching	100°C in 10s	95°C in 15s	90°C in 20s	85°C in 25s
Sensory score	1.23±0.01^{e}	6.79±0.02^{a}	5.43±0.01^{b}	4.78±0.03^{c}	3.25±0.00^{d}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Effect of Florosil and Naringinase to Bitterness of Bitter Gourd Juice

After blanching, the juice of bitter gourd was extracted by using single screw juice extractor. The 100ml of juice after extraction was exposed to florosil (activated magnesium silicate) at the rate of 2g/100ml with constant stirring for 2min. Florosil was removed by sedimentation and the juice was filtered through Whatman filter. As long as the florosil treatment, after the extraction of juice, naringnase was added (8 mg/100ml) into juice and kept for 5 h at 48°C. Then it would be pasteurized (75±2 °C for 20 min). Sensory evaluation would be conducted to estimate the bitterness reduction. Results revealed in table 2. From table 2, the bitterness in bitter gourd could be effectively eliminated by Florosil (2g/100ml) + Naringinase (8 mg/100ml) so this value was selected for further experiments.

Table 2: Effect of florosil and naringinase to bitterness (sensory) of bitter gourd juice

Treatment	Control (100°C in 10s)	Florosil (2g/100ml)	Naringinase (10 mg/100ml)	Florosil (2g/100ml) + Naringinase (8 mg/100ml)
Sensory score	6.79±0.02^{c}	7.12±0.03^{bc}	7.48±0.02^{b}	7.95±0.00^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Effect of debittering techniques on the chemical characteristics of stored kinnow juice was examined. Five different debittering methods viz, lye, florosil, naringinase, lye and florosil, florosil and naringinase were used for the debittering of kinnow juice.

It was concluded that naringinase enzyme was best among all treatments given for removal of bitterness and also had not much effect on characteristics of stored juice [21]. Florosil (activated magnesium silicate) has been shown to reduce limonin without adversely affecting its nutritive quality [22].

Effect of Wall Material to Bitterness of Bitter Gourd Dried Powder

After blanching, the juice of bitter gourd was extracted by using single screw juice extractor. Juice of bitter gourd would be treated with florosil (2g/100ml) and naringinase (8 mg/100ml).

Then this juice would be spray-dried into powder (inlet temperature 155°C, out let temperature 85°C, feed rate 15 ml/min) with the support of different wall materials (β-cyclodextrin, sodium alginate, carrageenan, pectin) in the same concentration 0.5%. Sensory evaluation will be conducted to estimate the bitterness reduction. Results revealed in table 3. From table 3, the bitterness in bitter gourd dried powder could be effectively eliminated by ß-cyclodextrin 0.5%.

Table 3: Effect of wall materials to bitterness of bitter gourd dried powder

Wall material	β-cyclodextrin 0.5%	Sodium alginate 0.5%	Carrageenan 0.5%	Pectin 0.5%
Sensory score	8.63±0.03[a]	8.35±0.00[b]	8.17±0.01[bc]	8.03±0.02[c]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Sodium alginates were suggested for reduction of unpleasant off-tastes caused by tea catechins [9]. The chitin derivative, chitosan, at a concentration of 0.4 to 1.2% in water, is also able to reduce bitterness of caffeine and various plants extracts but also exhibits a strong astringency. Sulfated polysaccharides, such as carrageenan, were used to reduce the undesirable taste of amino acids mixtures (e.g., L-histidine, L-isoleucine, L-leucine, L-methionine, L-phenylalanine, L-tryptophan, and L-valine, each at 10%). In a ratio of 9:1 carrageenan/amino acid cocktail, e.g., in beverages, the bitterness of an aqueous solution of such a mixture was reduced to 1 (weak bitterness) compared to 9 (strong bitterness) for the neat amino acid cocktail [23].

The astringency of various tea catechins at 100 ppm was reduced using pectin at concentrations <0.1% [24]. Cyclodextrins (CDs) are naturally occurring molecules composed of glucose units linked by ß (1-4) linkages, arranged in bucked shape with a central cavity. These oligosaccharides, produced from starch, are composed of six, seven and eight glucose units, α, ß, and γ cyclodextrins (CDs), respectively. Native cyclodextrins are available in large volumes and are food quality. It is the three-dimensional structure of these molecules that makes them so important.

These starch derivatives are non-toxic ingredients; they are not absorbed in the upper gastrointestinal tract, however they are completely metabolized by the colon micro flora. They meet the requirements for neutrality in terms of odour and taste since,

In fact, although cyclodextrin molecules are composed of glucose units, α- and ß-cyclodextrin do not taste sweet at all, whilst γ-cyclodextrin has only a slightly sweet taste. In addition, the fact that cyclodextrins occur in the form of a colourless powder makes them easy to process.

Conclusion

Cyclodextrins have a predominant hydrophobic character hole, or cavity, in the centre, large enough to accommodate, trap or include other molecule(s). When this happen a cyclodextrin complex or inclusion compound is formed. These complexes or compounds can be described as a nanoencapsulation at molecular level. Food ingredients formulated with cyclodextrins are stabilized against oxidation and heat.

They are unaffected by shear forces and readily dispersible for use in liquid products. Bitter gourd is a very wonderful vegetable not only providing nutrition but also offering several components which show medicinal properties against a wide number of diseases.

This bitter fruit can be used for preparing many mouth watering healthy products. Bitter gourd juice blended with citrus juice, chips, dehydrated rings, pickle etc. are some of the nutritious products which people can make at the household level. Bitter gourd is also one of the discarded vegetables by people, just because of its bitter taste as it contains a bitter compound called momordicin Sensory quality attributes such as taste, colour and flavour determines food selection. As the consumer rejects bitter or astringent taste therefore bitterness should be reduced by giving appropriate treatments.

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