



## Development and quality analysis of curcumin fortified soy base pineapple beverage

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### Abstract

Curcumin, the principle curcuminoid referred as pharmacological active constituent of turmeric has inherent potential to explore as a nutraceutical ingredient to formulate functional food product. Review base confirmation of curcumin efficacy potential as an anti-inflammatory and anticancer ingredient of food has renewed technological interest to justify its status as an active agent in formulation of functional foods. Present consumer demand base trend is waiting for functional beverage developed by using natural food crop base active ingredient to promulgate health benefits. Pineapple is a marvelous tropical fruit having extraordinary juiciness, coruscating flavor and enormous health benefits. Soya milk one of vibrant health food product getting popular among health conscious consumer in developing countries due to its high nutritional value. Functional beverages containing bioactive compound, fruit and soy milk not only suffice hunger, supply nutrient but also promote health and prevent diseases. Present investigation is undertaken to develop innovative curcumin enriched soy base pineapple beverage. Soy base pineapple beverage was standardized first by blending soymilk with different level of pineapple juice at and evaluated for sensory properties. Soy base beverage with 12% pineapple was organoleptically most acceptable and further selected for curcumin enrichment. Soy base pineapple beverage formulated by incorporating various level of curcumin was assessed for sensory and physicochemical characteristics. Organoleptic assessment shown 7.5mg/100g curcumin enrichment in soy base pineapple beverage is overall acceptable as compared to other levels. Ethical vision base planned clinical study to justify functional efficacy of curcumin enriched soy functional beverage against non-communicable diseases is in progress.

**Keywords:** curcumin, pineapple, soy beverage, sensory

### 1. Introduction

Curcumin, a principle turmeric polyphenolic compound exhibits antioxidant, anti-inflammatory, anti-carcinogenic, antimicrobial and hypoglycemic activity indicates curcumin's therapeutic potential against non-communicable diseases (Gupta *et al.*, 2013). It is a chief coloring substance in *Curcuma longa* and demethoxycurcumin (DMC), bisdemethoxycurcumin (BDMC) are two associated compounds altogether known as curcuminoid determines significance of the turmeric products (Kulkarni *et al.*, 2012). Major active component is curcumin and it has a distinctly earthy, slightly bitter and hot peppery flavour and a mustardy smell. The principal colouring components of curcumin exhibit a keto-enol tautomerism and possesses pleiotropic nature shows direct interaction with numerous signaling molecules (Gupta *et al.*, 2012). Curcumin is a symmetric molecule, also known as diferuloyl methane. The IUPAC name of curcumin is (1E, 6E)-1, 7-bis (4-hydroxy-3-methoxyphenyl)-1, 6-heptadiene-3, 5-dione, with chemical formula C<sub>21</sub>H<sub>20</sub>O<sub>6</sub>, and molecular weight of 368.38. It has three chemical entities in its structure: two aromatic ring systems containing o-methoxy phenolic groups, connected by a seven carbon linker consisting of an  $\alpha$ ,  $\beta$ -unsaturated  $\beta$ -diketone. (Kavirayani, 2014) [7]. Extensive research has demonstrated that persistent oxidative stress can lead to chronic inflammation and results in many chronic diseases including cardiovascular diseases, neurological diseases, pulmonary diseases, diabetes and cancers. Curcumin, a pleiotropic molecule relieves oxidative stress and interacts with numerous inflammatory molecular targets regulating inflammatory pathways related with most

chronic diseases. The antioxidant activity of curcumin is associated to its phenolic group (O-H and the C-H) and based on the H-atom abstraction from the phenolic group, not on the central CH<sub>2</sub> group in the heptadienone link. (Yan *et al.*, 2015) [15]. Pineapple (*Ananas comosus*) is one of the most prominent fruits by virtue of its pleasant aroma and exhilarating taste (Bartolome. *et al.*, 1995) [2]. High fiber in pineapple assists effective curing of constipation in addition to easy bowel movement. Besides major source of nutrients (carbohydrate, sugars, organic acids and minerals) it is low in cholesterol and fat contributing towards lower risk of cardiovascular disease. Vitamin C, a natural free radical scavenger in pineapple juice benefits to boost the immune system and prevent gum disease thus encourages healthy teeth. Pineapple juice contains considerable amount of manganese advantageous for the growth of healthy bones and tissues. Detoxification and anti-inflammatory spectrum of bromelain enzyme maintain digestive system and aids in menstrual disorder and sore throat relief (Ebabhamiegbeho *et al.*, 2016) [3]. The main bioactive components in pineapple are phenolic compounds, ascorbic acid,  $\beta$ -carotene, and flavonoids. Pineapple is rich sources of  $\beta$ -glucan, proteoglycan, lectin, polysaccharides, triterpenoids, dietary fibre, lentinan, steroids, glycopeptides, terpenes, saponins, xanthones, coumarins and alkaloid (Sahu *et al.*, 2017) [12].

Soy milk is a fine, off-white resembling in both appearance and consistency to cow milk. Low cholesterol and lactose content, bone enhancing property and menopausal symptoms reduction capability of soy milk assist in prevention and reduction of heart disease and certain

cancers (Mbajiuka *et al.*, 2014) [9]. Soymilk has poor sensorial acceptability owing to the beany flavor. Hence incorporating fruit juices to mask the bitterness and “off flavor” is one of the best approaches to improve its quality. Being rich in flavor profile pineapple is one of best options to suppress the beany flavor and converting it to consumer acceptable product (Ebabhamiegbho, 2016) [3].

Present consumer demand base trend is waiting for functional beverage developed by using natural food crop base active ingredient to promulgate health benefits. Health benefit efficacy of curcumin is well known since ancient times. Soy beverages are nutritious and offer numerous health benefits but are characterized by beany flavor. Fruit incorporation can mask this beany flavor and enhances taste. Functional beverage containing bioactive compound, fruit and soy milk not only suffice hunger, supply nutrient but also promulgate health and prevent diseases. These health benefits are due to antioxidant compounds present in fruit as well as in milk and reduced the risk of many diseases. Some of which are cardiovascular diseases, cancer, diabetes mellitus, Alzheimer’s disease, cataracts and age-related functional decline (Muhammad *et al.*, 2013) [10]. Hence the present investigation is undertaken to develop innovative curcumin fortified soy base pineapple beverage to cultivate health benefit of curcumin, pineapple and soy milk.

## Methodology

### Ingredients

Turmeric, soybean and pineapple were procured from local market of Pune city. Other essential food-grade ingredients were purchased from a local market. The admissible solvents of desired purity were also collected from local suppliers.

### Equipment used

Experimental set up base required instruments such as open top weighing balance, vernier caliper, soxtron apparatus, hot air oven, kjeldhal apparatus, muffle furnace etc. were used from laboratory of MIT College of Food Technology, Pune

## Determination of physico-chemical properties

### 1. Moisture

Moisture content was determined by hot air oven method given by Ranganna (2005)

$$\text{Moisture content (\%)} = \frac{\text{Volume of water collected} \times 100}{\text{Weight of sample}}$$

### 2. Fat

Crude fat was estimated by using soxhlet apparatus as method described by Ranganna. (2005)

$$\text{Crude Fat (\%)} = \frac{\text{Weight of ether soluble material}}{\text{Weight of sample}} \times 100$$

### 3. Protein

Protein content was estimated by using microkjeldhal technique standardized by Ranganna (2005).

$$\text{Nitrogen (\%)} = \frac{(\text{Sample titre} - \text{Blank titre}) \times \text{Normality of HCL} \times 14 \times 100}{\text{Weight of sample} \times 1000}$$

$$\text{Protein content (\%)} = \text{Nitrogen (\%)} \times 6.25$$

### 4. Total Carbohydrates

Total carbohydrate content was estimated by using Anthrone method standardized by Ranganna, (2005).

### 5. Crude fibre

Crude fibre was estimated by using method standardized by Ranganna (2005). Crude fibre was determined by following formula.

$$\text{Crude Fibre (\%)} = \frac{\text{Loss in weight noted}}{\text{Weight of sample taken}} \times 100$$

### 6. Total ash

Total ash content was estimated by standard methods proposed by using Ranganna, 2005).

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

### 7. TSS

Total soluble solid were determined by using hand refractometer.

### 8. Determination of pH

pH of sample was measured by laboratory scale digital pH meter.

### 9. Determination of titrable acidity (%)

The acidity was determined by the procedure as reported by Ranganna (2005)

$$\text{Titrable Acidity as citric acid (\%)} = \frac{\text{Titre} \times \text{N of alkali} \times \text{Volume made up} \times \text{Equivalent weight} \times 100}{\text{Volume of sample taken} \times \text{Weight of sample taken} \times 1000}$$

### 10. Determination of ascorbic acid

Ascorbic acid content was assessed by 2, 6 dichlorophenol-indophenol visual titration method standardized by Rangana (2005)

### 11. Determination of colour

Colour of beverage samples were evaluated by Lovibond tintometer

## Processing technology of soymilk

Soybean were sorted and cleaned to remove stones and damaged, deformed seeds. Then the dry soybeans were washed and soaked in water (1:3W/V) with addition of 0.3% sodium bicarbonate to remove the bitterness and anti-nutritional factors (trypsin inhibitor) for 12 hours at room temperature. It was then drained and blanched for 30 minutes at 87°C. The soybeans were washed and dehulled manually. The soybean seeds were ground in blender with hot water in ratio of 1:10 (beans to water on a weight basis) and filtered to remove the okara. The milk was then pasteurized at the temperature 71°C for 15 seconds and subsequently bottled and stored at ambient and refrigeration temperature.

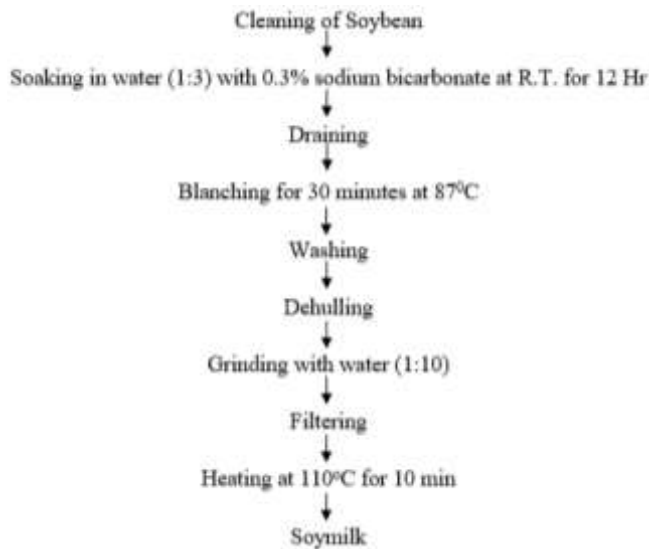


Fig 1: Processing technology of soymilk

**Extraction of pineapple juice**

Fresh well mature pineapple (*Ananas comosus*) fruit was washed and peeled with stainless steel peeler to remove peel. The crown, rind, eyes and core was removed and sliced into irregular shapes with a knife for easy juice extraction. The pulp was prepared by using fruit juice processor followed by filtration through muscline cloth to get partially clarified juice. This prepared juice is further utilized to formulate beverage.

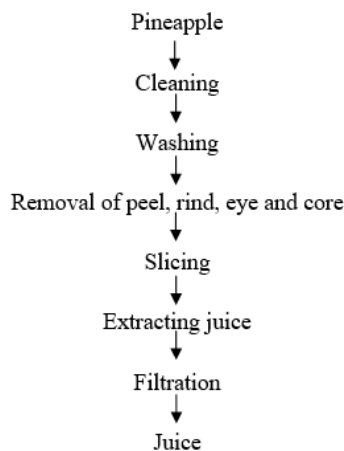


Fig 2: Extraction of pineapple juice

**Processing technology of curcumin fortified soy base pineapple beverage**

Soy milk is added with different level of pineapple juice, sugar, emulsifier and preservative Mixture is blended well. Heating is carried out at 83°C for 10 min and filled in sterilized glass bottle. It is cooled to obtain soy pineapple beverage. Soy beverage with 12% pineapple juice level was found to be most acceptable compared to other samples. Hence the said level is further selected for curcumin enrichment. Different level of curcumin (0, 2, 5, 5, 7.5, 10 mg/100g) is added and mixed well. Soy milk is added with pineapple juice (12%), sugar, and preservative. It is blended well with curcumin and tween 80. Heating is carried out at 83°C for 10 min and filled in sterilized glass bottle. It is cooled and curcumin enriched soy

Pineapple beverage is obtained.

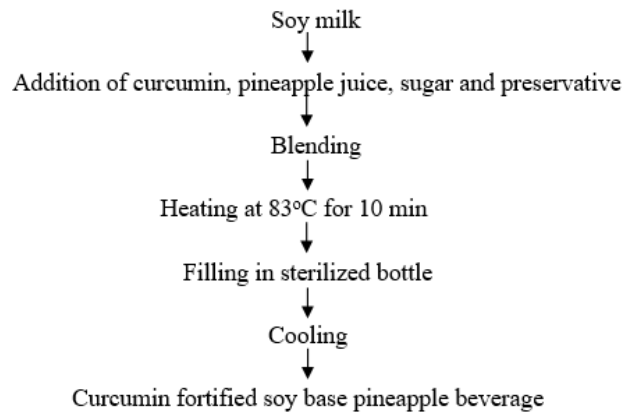


Fig 3: Processing technology of curcumin fortified soy base pineapple beverage

**Organoleptic evaluation**

The organoleptic characteristics (colour, flavor, texture, taste & overall acceptability) were assessed by semi-trained judges using nine point hedonic scales method standardized by Amerine (1965) [1].

**Result and Discussion**

**Chemical analysis of raw material**

The data on proximate analysis of soy milk and pineapple juice is depicted in Table 1 justified their contribution as base ingredient (soy milk) and supplementary ingredient (pineapple juice).

Table 1: Chemical parameters of soy milk and pineapple juice

Parameters	Soy milk	Pineapple pulp
Moisture (%)	89.10	85.34
Carbohydrate (%)	2.12	13.90
Crude Fat (%)	2.14	0.24
Protein(g/100g)	4.21	0.51
Ash (%)	0.41	1.83
Reducing sugar (%)	0.49	4.10
Non reducing sugar	0.50	7.20
Total sugar (%)	1.99	11.30
Crude Fiber (%)	1.46	0.43
Ascorbic acid(mg/100g)	Nil	20.5
TSS(°Bx)	5.12	10.1
pH	6.39	3.61
Acidity (%)	0.17	0.4

\*Each observation is an average of three determinations.

It is evident from table that the soy milk consist of 89.10% moisture, 2.12% carbohydrate, 2.14% fat, 4.21% protein, 0.41% ash, 1.99 % total sugar, 1.46 % crude fiber. Soy milk was richer in protein, fat and ash contents and poorer in vitamin C. More or less similar findings were also reported by kale *et al.* (2012) [6] and Sakhale *et al.* (2012) [13] for soy milk. The data from table indicates that pineapple juice contains 85.10 % moisture, 13.9% carbohydrate, 0.51% protein, 0.24% fat, 1.83% ash, 10.1 °Bx TSS, 0.4% titrable acidity, 3.61 pH and 20.5 mg/100g ascorbic acid were found most feasible for the production of acceptable beverage. The values of soymilk and pineapple juice parameters are in good agreement with Ikya *et al.* (2013) [5] Yadav *et al.* (2016) [14].

**Sensory assessment of curcumin fortified soy base pineapple beverage**

The data pertaining to sensory parameters viz colour, Mouth

feel, taste, flavour and appearance and overall acceptability of soy pineapple beverages formulated by varying curcumin level by 9 point hedonic scale is depicted in Table 2

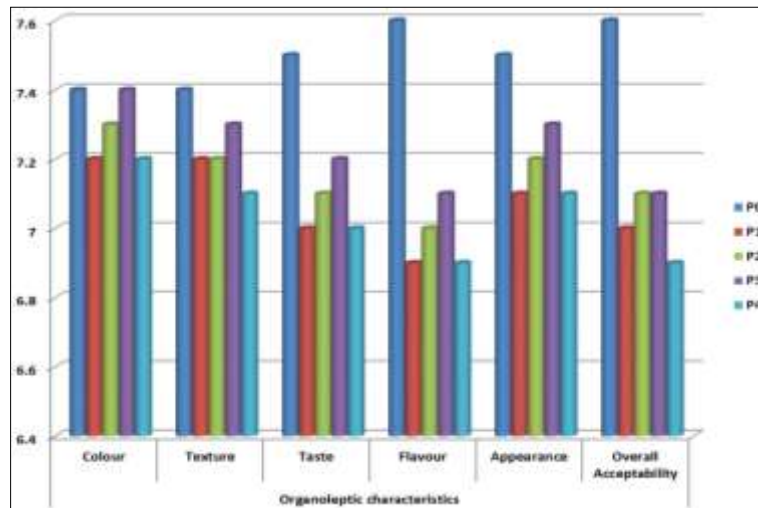
**Table 2:** Sensory evaluation profile of curcumin fortified soy pineapple beverage

Sample code	Organoleptic characteristics					
	Colour	Texture	Taste	Flavour	Appearance	Overall Acceptability
P <sub>0</sub>	7.4	7.4	7.5	7.6	7.5	7.6
P <sub>1</sub>	7.2	7.2	7.0	6.9	7.1	7.0
P <sub>2</sub>	7.3	7.2	7.1	7.0	7.2	7.1
P <sub>3</sub>	7.4	7.3	7.2	7.1	7.3	7.2
P <sub>4</sub>	7.2	7.1	7.0	6.9	7.1	6.9

\*Each observation is an average of three determinations.

P<sub>0</sub>- 0 % curcumin, P<sub>1</sub>- 2.5mg/100g curcumin, P<sub>2</sub>- 5mg/100g curcumin P<sub>3</sub>- 7.5mg/100g curcumin P<sub>4</sub>-10mg/100g curcumin The table reveals that colour (7.4), mouth feel (7.3), taste (7.2), flavour (7.1) appearance (7.3) and overall acceptability (7.2) score are highest in P<sub>3</sub> samples as compared all other beverages. Least sensory score are

obtained by P<sub>4</sub> may be due to high curcumin contribute to somewhat after taste to beverages. From the overall acceptability rating, it was concluded that curcumin could be incorporated up to 7.5mg in the formulation of soy pineapple beverage without affecting their sensory quality to produce acceptable and high functional efficacy value.



**Fig 4:** Sensory evaluation profile of curcumin fortified soy base pineapple beverage samples

**Physico-chemical assessmet of curcumin fortified soy base pineapple beverage**

The data on physic- chemical attributes of curcumin

enriched soy base pineapple beverage samples were analyzed and presented in Table 3.

**Table 3:** Physico-chemical parameters of of curcumin fortified soy base pineapple beverage

Sample	Parameters							Colour	
	TSS	pH	Acidity	Reducing Sugar	Total sugar	Ascorbic acid	Red	Yellow	
P <sub>0</sub>	13.1	3.78	0.222	5.12	10.28	3.92	1.2	0.1	
P <sub>1</sub>	13.2	3.77	0.233	5.27	10.31	3.83	13.1	0.1	
P <sub>2</sub>	13.3	3.73	0.237	5.34	10.29	3.72	20.7	0.2	
P <sub>3</sub>	13.4	3.69	0.235	5.26	10.22	3.78	29.8	0.3	
P <sub>4</sub>	13.5	3.68	0.248	5.26	10.19	3.87	38.2	0.5	

\*Each observation is an average of three determinations.

It is evident from the table TSS values are increasing with increase in curcumin level from 13.2 to 13.5°Bx. This may be due to natural assembling of sugar with curcumin which also help to improve stability of curcumin in beverages. pH values are decreasing from 3.77 to 3.68 and acidity is increasing from 0.233 to 0.248. Reducing sugar was increased (5.12 to 5.26) and total sugar content (10.28 to 10.19) is decreased slightly with progressive increase in curcumin level. Colour values for R and Y are in the range

of 1.2 to 38.2 and 0.1 to 0.3 respectively.

**Conclusion**

Curcumin, as a pharmacological molecule base active food ingredient has commercial potential against risk indices of human diseases. In present study, sincere efforts were made to formulate and develop consumer acceptable curcumin enriched soy pineapple beverage. The 0.0075% cutting edge fortification driven enrichment of soy base pineapple

beverage justified overall acceptability cumulative score (7.2). Ethical vision base planned clinical study to justify functional efficacy of curcumin enriched soy functional beverage against non-communicable diseases is in progress

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