The Pharma Innovation Journal 2021; 10(10): 1871-1875

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 1871-1875

www.thepharmajournal.com
Received: 07-08-2021
Accepted: 09-09-2021

Evaluation of physicochemical and organoleptic properties of plant based beverage developed from chickpea

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Abstract
Chickpea milk is nutritious beverages prepared from chickpea by using 3 processing methods. The chickpea is having many health benefits like anti-cancer, low glycemic index and support cardio vascular health. The chickpea milk can be considered as a beverage with good amount of protein that is 3 to 4g in 100g. In the sensory evaluation boiled chickpea milk is more acceptable in terms of color, aroma, mouth feels and after taste in compared with raw and roasted chickpea milk. This can be considered as alternative to soy milk as it is having comparable nutritional profile with soy milk. According to the sensory evaluation the overall acceptability of roasted and raw chickpea was less when compared to that of boiled chickpea milk. Also, the boiled chickpea milk is showing good nutritional profile, even though the raw chickpea milk is having more protein comparatively. But in comparing the whole result boiled chickpea milk considered as better to other two mainly because of its acceptable taste with minimal beany flavor.

Keywords: cooked chickpea milk, roasted chickpea milk and raw chickpea milk

1. Introduction
Chickpea (*Cicer arietinum* L.), often known as gram, Bengal gram, or garbanzo bean, is South Asia's most significant food grain legume and the world's third most important after common bean and field pea. Chickpea was one of the first grain crops grown by humans, with evidence dating back to the eighth millennium BC in Middle Eastern archaeological sites. It is grown in about 57 countries throughout the world, in wide range of climatic conditions. Chickpea production is dominated by South and Southeast Asia, with 80 percent of the regional contribution (Singh *et al*. 2006; Merga *et al*. 2019) [13, 9]. According to FAO in 2019, India is the world's largest producer of chickpeas, contributing to 65 percent (9.075 million tonnes) of overall chickpea production.

Chickpeas are in high demand due to its nutritional profile. It is a significant component of diet for the people in semi arid tropics, of those individuals who cannot afford animal proteins or who choose to be vegetarian. Chickpeas are high in carbohydrates and protein, accounting for over 80% of the total dry seed mass when compared to other pulses. Chickpeas are low in cholesterol and high in dietary fibre (DF), vitamins, and minerals. Chickpeas are served roasted, boiled, salted, and fermented, and are used in soups and salads. These various methods of intake provide customers with vital nutritional and health benefits. Moreover, chickpeas are being studied as a functional food with beneficial properties (Jukanti *et al*. 2012) [5].

Chickpeas are a good food choice because of their health-promoting elements, which include protein, complex carbohydrates, dietary fibres, vitamins, minerals, carotenoids, isoflavones, phospholipids, and antioxidants. It is therefore considered as an essential component of a healthy diet because its regular consumption has been found to have protective effects against various diseases. Consumption of chickpeas has been linked to a number of physiological benefits, including the reduction of the risk of chronic diseases and cancer. The low glycemic index (GI) food of chickpea also plays important role in diabetic management. The consumption of chickpea with 33 GI value is suitable for diabetic people because of its slow release of glucose to the blood stream (Gupta *et al*. 2017) [4]. In type 2 diabetes patients, dietary sources with a lower GI may play a critical role in glycemic control and insulin secretion management. The consumption of chickpea is suitable for most of the population. So, aim of this paper is to develop a nutritious chickpea beverage using three different processing methods and compare its physicochemical and organoleptic properties.

2. Materials and Methods

The chickpea were procured from the local market of Thanjavur (Tamil Nadu). All other chemicals used for the experiments were of analytical grade purchased from Hi-media (Nasik, India).

2.1 Preparation of cooked chickpea milk

For the preparation of cooked chickpea milk, the raw chickpea was soaked for 12- 16 hours, then the soaked water was removed and chickpea was washed in water. Then the grains were cooked in a household pressure cooker with distilled water at 80°C for 30 minutes and the cooking water was discarded to reduce antinutritional compound. After that the cooked chickpea with filtered water in the ratio (1:4) (1 part of raw chickpea: 4 parts of water) was grinded in colloidal mill for 10 minutes. The resulting slurry was filtered through a muslin cloth to obtain chickpea extract and the materials trapped in the muslin cloth were disposed (Rincon *et al*. 2020; Loi, Eyres, and Birch 2019) [12, 7].

2.2 Preparation of Roasted chickpea milk

Roasted chickpea milk is prepared by, in the first step the raw chickpea is soaked for 12-16 hours. Then the chickpea is washed with water and excess water is drained. Then the chickpea is spread on a clean surface to remove surface water. Then the chickpea is roasted in a pan at 80 °C for 20 to 25 minutes. After roasting the chickpea is grinded in colloidal mill for 10 minutes with 1:5parts of water. As moisture content is reduced at the time of roasting, more water is added for smooth grinding. Then the slurry is filtered as before (Navicha *et al*. 2017) [10].

2.3 Preparation of Raw chickpea milk

For the preparation of raw chickpea milk, the raw chickpea was soaked for 12- 16 hours. Then the chickpea is grinded with water in 1:4 ratios in colloidal mill. The resulting material is pasteurized at 60 °C for 30 minutes. Then the material is filtered through muslin cloth to obtain chickpea milk. (Kishor *et al*. 1941) [6]

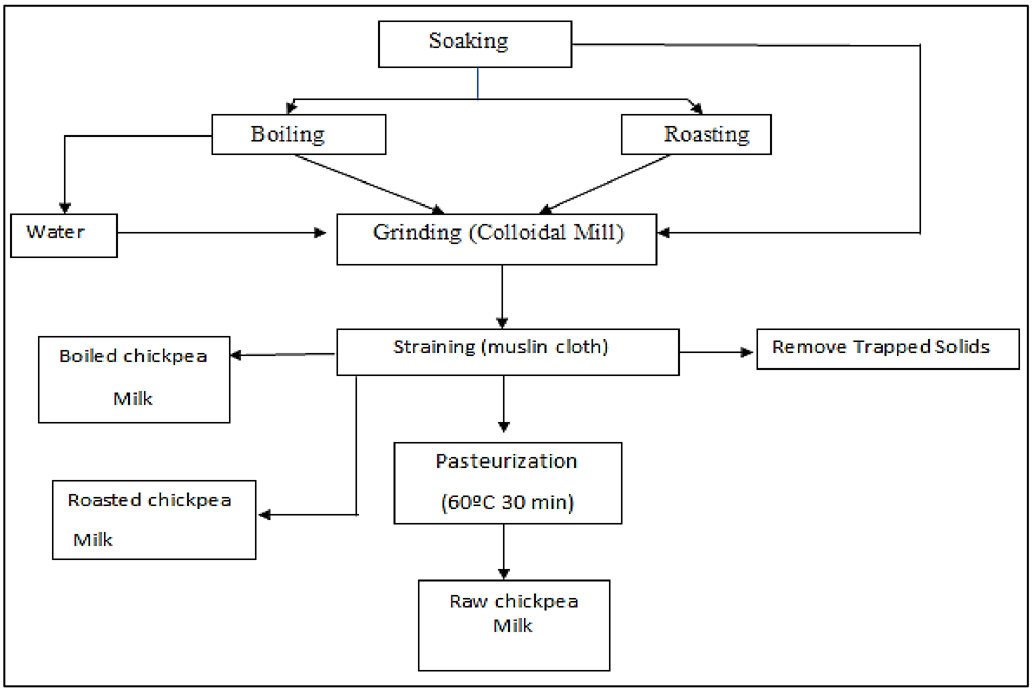

Fig 1: Processing flow chart of chickpea milk

2.4 Proximate chemical composition

The moisture, fat, ash, protein and carbohydrate content of chick pea milk was done according to (AOAC, 2005) methods.

The moisture was determined in 2 steps. In first step the sample is heated in an oven at 50 °C until constant mass. Then, 2 g of each sample was taken heated in an oven at 105 °C until constant mass. The protein content of samples were determined by using Kjeldahl method and to the estimated total nitrogen, 6.25 was multiplied to get a total nitrogen basis. The fat content is estimated by using petroleum ether extraction method. Ash content of sample was determined by igniting, two grams of sample placed in the crucible in a muffle furnace at 550 °C for 3 hours or more until light grey ash was obtained and taking initial and final weight. To obtain the total carbohydrates by difference, the amount of moisture, fat, protein, and ash content was subtracted from 100.

2.5 Color

The Hunter Lab colorimeter (Hunter lab color flex EZ setup 32) was used for measuring the color of wine samples. A white tile and black tile were used as reference tile for calibrating the equipment. The color value was explained in terms of L*, a*, and b* values. The L* value indicated lightness or darkness. Redness and greenness indicated by a* value. Blueness and yellowness can be explained by b* values.

2.6 Total soluble solids content and pH

Total soluble solids content (TSS) was measured in a table refractometer using two to three drops of each homogenized sample. The results were expressed in °Brix. The pH was determined by directly measuring in a digital pH-meter.

2.7 Sensory analysis

Nine points hedonic scale was adopted for sensory evaluation of chickpea milk samples for aroma, taste, mouth feel after taste, appearance, and overall acceptability. Point 9 indicates extremely like; 8 very much like; 7 moderately like; 6 slightly like; 5 neither like nor dislike; 4 slightly dislike; 3 moderately dislike; 2 very much dislike; 1 extremely dislike). A panel of 30 panelists was chosen for sensory analysis.

2.8 Statistical analysis

All studies were carried out in triplicate, and all findings were expressed as mean ± standard deviation. For statistical analysis, Minitab® 17.3.1 program was used. One-way variance analysis (ANOVA, with tukey comparison) with a confidence level of 95% and significance level α= 0.05 was performed.

3. Results and Discussion

3.1 Proximate chemical composition

Chickpea milk is taken as alternative pulse milk as it is having good nutritional properties when compared with soy milk which is already popular in market. Chickpea milk is having good amount of protein, carbohydrate and minerals. The protein content value ranged from 3.18 to 4.20 (from table 1). The row chick pea milk is having more protein content compared to other methods because the loss of protein due to heat is minimal. The protein content in roasted chickpea milk is less as more dilution is used at the time of grinding (1:5). As water is lost at the time of roasting, and grinding process need minimal amount of water more dilution is done (Lopes *et al*. 2020) [8]. In a similar study on chickpea it is indicated that cooking decreases the protein content but there is a increase in protein digestibility (Clemente *et al*. 1998) [3].

The lipid content values varied between samples; however, it is not statistically different among the different methods. Chickpea milk is not a good source of fat. As other plant milks available in market and other studies the moisture content value varies between 90.63 to 92.02 (from table 1). The raw chickpea milk is good in terms of nutrition content compared to other two that is boiled chickpea milk and roasted chickpea milk (Wang, Chelikani, and Serventi 2018) [14].

Table 1: Chemical composition of the chickpea milk made using different processing methods (g/100g).

Samples	**Moisture**	**Protein**	**Ash**	**Fat**	**Carbohydrate**
Boiled chickpea milk	91.83±0.24	3.96±0.12	0.25±0.02	0.19±0.01	3.74±0.27
Roasted chickpea milk	92.02±0.38	3.18±0.20	0.24±0.01	0.20±0.03	4.35±0.25
Raw chickpea milk	90.63±0.13	4.20±0.23	0.25±0.05	0.26±0.02	4.64±0.33

3.2 Color, **Total soluble solids content and pH**

The color value was explained in terms of L*, a*, and b* values. The L* value indicated lightness or darkness. Redness and greenness indicated by a* value. Blueness and yellowness can be explained by b* values. The significance of quantitative color evaluation in food quality cannot be overstated. Visual judgments of food color are closely related to customer or taster ratings and serve as a benchmark for comparisons of instrumental measurements, such as those conducted in this study.

The color values are measured in basis of L*, a* and b* value (given in table 2). There is significant difference in color among the three samples. According to the processing methods there is more difference in L* value that is lightness or darkness. Compared to boiled and roasted chickpea milk, raw chickpea milk color is brighter i.e. 82.07 L* value. The boiled chickpea milk color is more yellowish- orange compared to the roasted and raw milk so it's having more a*value 1.70 (fig 2). The lightness was less to roasted sample as at the time of roasting tint of brown color is imparted to the chickpea. So, the roasted chickpea is having yellowish brown color with b* value 22.87 (Rincon, Braz Assunção Botelho, and de Alencar 2020) [12].

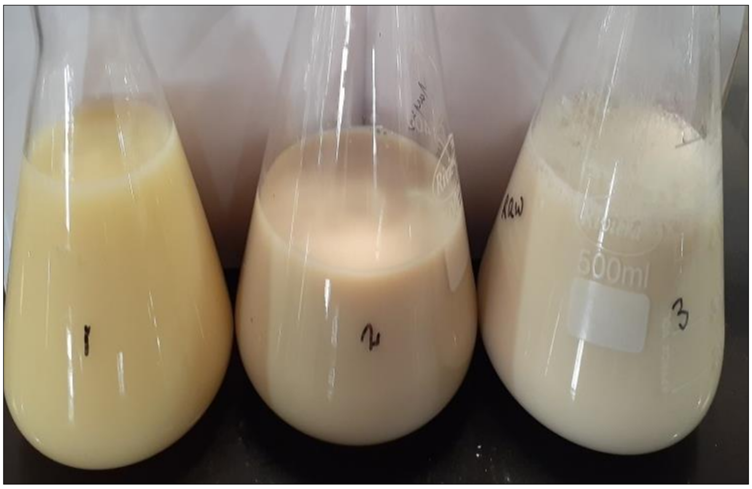

Fig 2: chickpea milk prepared by different methods. 1-Boiled chickpea milk, 2-Roasted chickpea milk and 3- Raw chickpea milk

The pH values of raw, roasted and boiled milk were similar, and they were not a statistically different. The pH value of samples ranged between 6.97 to 7. 37 indicating that it is having neutral pH (from table 1). The neutral pH is suitable for microbial growth so at the time of storage chance of contamination is more (Jin and Kirk 2018). The TSS value is having variation between samples; the raw chickpea milk is having more TSS i.e. 7.3ºbrix (from table 2). The raw milk is grinded and filtered without heating and the solids trapped in muslin cloth are less compared to heat processed as heating will gelatinize the starch molecules and they will absorb water. So, more particles will be removed and gelatinization may reduce TSS value of boiled and roasted chickpea milk (Purwanto and others, n.d.).

Table 2: Data of color measures, total soluble solids and pH of chickpea milk prepared in different methods

	Color				
Samples	**L***	**a***	**b***	**TSS(ºbrix)**	**pH**
Boiled chickpea milk	74.80±0.11	1.70±0.04	20.84±0.15	4.82±0.41	7.07±0.06
Roasted chickpea milk	70.76±0.04	0.57±0.02	22.87±0.18	4.68±0.22	6.97±0.16
Raw chickpea milk	82.073±0.583	0.33±0.02	14.73±0.6	7.3±0.15	7.37±0.12

3.3 Sensory analysis
Chickpea milk prepared by three different methods was used for sensory evaluation which included raw, boiled and roasted chickpea milk. Five sensory attributes were selected and thereby used for this study, namely, color, aroma, mouth feel, aftertaste and overall acceptability. The 9-point hedonic scale was used for evaluating the samples. Thirty semi-trained panelists in the age group of 20 to 30 were used for this study. An initial study was conducted wherein raw milk, boiled milk and roasted chickpea milk was given as such to semi-trained panelists. Since majority of the panelists did not express much liking to the milk as such, to enhance consumer acceptability 2g chocolate powder and 5g sugar was added to each sample(100ml) to make it more palatable. The raw chickpea milk was found to have a strong beany flavor and taste, so it was having least score for flavor and overall acceptability i.e. 5.43 and 5.56. When compared to the other samples, it was less preferred by the panelists. The flavor of the roasted chickpea milk was acceptable than raw milk because the roasting operation had minimized the beany flavor of the product. The overall acceptability of roasted and raw chickpea was less when compared to that of boiled chickpea milk because by the addition of chocolate flavor and sugar the boiled milk masked the beany flavor and taste compared to other two (fig 3). The color and consistency of the boiled chickpea milk was very good as stated by the panelists in comparison with the other samples. The major attribute involved in making boiled chickpea milk more palatable was the after taste and mouth feel as stated by the panelists as it was masking beany flavor but in other two i.e. raw and roasted chickpea milk intense beany flavor was retained in mouth after taste (Abou-dobara 2016) [2].

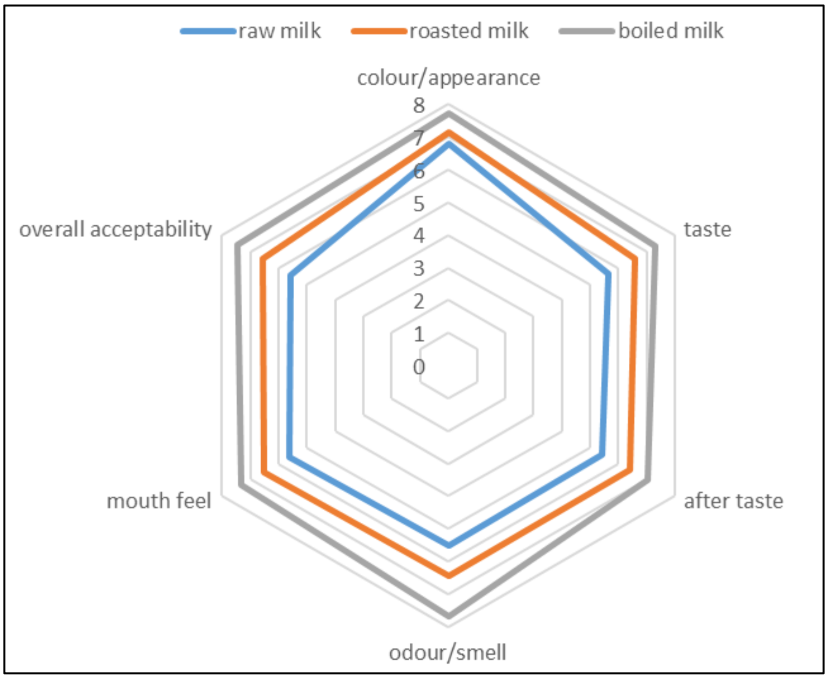

Fig 3: Sensory evaluations of 3 types of chickpea milk

4. Conclusion
In this study we have discussed about different methods of chickpea milk preparation. Chickpea milk was prepared after boiling, roasting and raw (pasteurized). The chickpea milk is nutritious drink with around 3.5 to 4 g of protein per 100g of milk and less beany flavor which can be used as a good source of protein. According to sensory evaluation panelist boiled chickpea milk is having better palatability and over acceptability compared to other samples. So that can be used in further studies and for commercial purposes. The other two methods can be improved by making some changes in processing method or by adding some steps to eliminate beany smell and taste like removal of off odour etc.

5. Author contribution statement
Vallath Aarcha: Research work, Writing - original draft and Editing. Shanmugam Akalya: Conceptualization, Reviewing, Editing and Supervision. Rawson Ashish: Reviewing and Editing.

5.1 Declaration of interest
The authors declare no conflict of interest.

6. Acknowledgement
The authors would like to thank Ministry of Food Processing Industries, Government of India for supporting this work (Q-11/10/2021-R&D).

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