

Formulation and Analysis of Nutrients, Antioxidants and Phytonutrients in Millet Barfi Using Finger and Barnyard Millets Incorporated With (*Cardiospermum Halicacabum* and *Ocimum Tenuiflorum*)

Ayyappadasan Ganesan¹, Rubavathi Subbiayan¹, Ilakiya M²,
Karthikeyan Ganesan²

¹Department of Biotechnology, K.S. Rangasamy College of Technology, Tiruchengode – 637 215, Tamil Nadu, India

²Manufacturing Division, Vishra Agro Sales, Virudhunagar, Tamil Nadu, India

Corresponding Author: Rubavathi Subbiayan

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ABSTRACT

Barfi has a high nutritional value such as calcium and proteins with higher biological value. It also provides almost all necessary essential oils to maintain good health. In this study, Barfi was prepared with calcium rich millets and antioxidant-rich medicinal plants in different concentrations. The millets such as *Eleusine coracana* and *Echinochloa esculenta* was used to prepare barfi. *Eleusine coracana* is the ragi in Indian region which contains a high amount of calcium, a protein with well-balanced essential amino acid composition along with Vitamin A, Vitamin B and phosphorous. *Echinochloa esculenta* is a Japanese millet with good source of highly digestible protein and the least caloric dense compared to all other cereals. The herbals used in this study to enhance the millet barfi was *Cardiospermum halicacabum* and *Ocimum tenuiflorum*. The phytochemical and the antioxidant activity of the herbal extracts were performed before inducing them into the barfi. The formulation of the millet barfi was done in the manmade traditional technique. The nutritional tests in terms of fat, protein, and the physiochemical properties such as pH, moisture content of the barfi were also analyzed. The shelf life of the millet barfi enhanced with plant extracts was analyzed through microbial analysis. These

parameters were tested in the storage interval of 0, 5, and 10 days which was stored at the refrigerator. The study aims to prepare the calcium-rich unpolished millet barfi enhanced with herbs.

Keywords: Millet Barfi, *Eleusine coracana*, *Echinochloa esculenta*, *Ocimum tenuiflorum*, Antioxidant, Physiochemical

INTRODUCTION

Development of the new products contains more nutrients required for the growth and development with higher acceptability can contribute in alleviating malnutrition. Millets are traditional spices, including pearl millet, proso millet, finger millet, foxtail millet, barnyard millet, little millet, and kodo millet, which is rich in polyphenols. It is considered as a sustainable raw material that was used as a replacement for cereals. (Devi et al., 2014), (Dayakar et al., 2017). They are nutri-cereals that are known to have high nutrient content which includes calcium, proteins, essential fatty acid, dietary fiber, vitamins, and minerals (Amadou et al., 2013). Millets are traditionally subjected to different processing methods like milling, soaking,

cooking, roasting, germination, and fermentation (Wang et al., 2022). Incorporation of Foxtail millet in burfi may contribute to several physiological benefits as it helps in laxation, digestion, treatment of anaemia and increases bone strength. In addition, it helps in weight loss, reduces cholesterol, anti-cancer activity, and control diabetes. Most cereals contain considerable amounts of vitamins, fiber, proteins, and minerals (calcium and iron), and are gluten-free.

Finger millet is a short, profusely tillering plant with characteristic finger-like terminal inflorescences, bearing small reddish seeds. (Adhikari et al., 2012). It is rich in Amino Acids which are vital in normal functioning of body and are essential for repairing body tissues and contains Tryptophan, Threonine, Valine, Isoleucine and Methionine amino acids. (Kumar et al., 2016). Barnyard millet is a good source of highly digestible protein and the least caloric dense compared to all other cereals. A serving of barnyard millets (25g, raw) gives 75 calories and 1.5g of protein. The carbohydrate content of barnyard millet is low and slowly digestible, making the barnyard millet a low glycemic index food (Trivedi et al., 2017).

Ocimum tenuiflorum emits a spicy scent when bruised. It has a variety of biological/pharmacological activities such as antibacterial, antiviral, antifungal, anti-protozoal, anti-malarial, antidiarrhoeal, analgesic, antipyretic, anti-inflammatory, antiallergic, antihypertensive, cardio protective, anticoagulant activities etc., (Bandita deo et al., 2013). *Cardiospermum halicacabum* is commonly found as a weed throughout India, used as a vegetable as well as traditional medicine for rheumatism, lumbago, and nervous diseases and as demulcent in orchitis and in dropsy. It is used in rheumatism, lumbago, nervous diseases, and as a demulcent in orchitis and in dropsy (Kumaran et al., 2006).

Incorporation of *Cardiospermum halicacabum* and *ocimum tenuiflorum* in barfi can increase the nutritional value of food and it exerts health benefits on

humans. Extracts obtained from *Ocimum tenuiflorum* and *Cardiospermum halicacabum*, which has high nutritional value and rich in antioxidant. These herbs exhibit anti-arthritis, anti-cancer, antimicrobial, antioxidant properties. So, the plant extract incorporated in Barfi consumption decreases arthritis especially osteo arthritis. *Cardiospermum halicacabum* and *ocimum tenuiflorum* incorporated millet barfi is rich source of calcium. It is also rich in source of nutrients, amino acids, vitamins, and minerals. In this paper, phytochemical activity of the herbal extract and the antioxidant activity of the herbal extracts was analyzed before incorporating into the millet barfi. This paper aims to prepare the calcium-rich millet barfi.

MATERIALS AND METHODOLOGY

Collection and preparation of raw materials and plant extraction.

Millets (Finger millet and Barnyard millet) are collected from Theni District. The medicinal herbs (*Cardiospermum halicacabum* and *ocimum tenuiflorum*) also collected from in and around Tiruchengode area, Namakkal districts of Tamil Nadu. They were collected and stored at room temperature for further studies. Leaves and stems of *Cardiospermum halicacabum* and *ocimum tenuiflorum* was collected and washed thoroughly with tap water, rinsed with distilled water and shade dried. The shade-dried plant and materials were grounded to fine powder. Methanol extract was obtained by extracting 30 g of the plant powder with 300 ml of methanol. The extract thus obtained was filtered, evaporated and dried extract was stored at 4°C in an airtight chamber.

Processing of millets

Millets require the primary processing machinery for the process of dehulling and dust removal. The machine was supplied by Vishra Agro Sales, Virudhunagar for the removal of the millet husk.

Phytochemical screening of leaf extracts

The extracts were subjected to Phytochemical analysis. Phytochemicals are the chemicals produced by plants through by primary or secondary metabolism. The phytochemical compounds are Carbohydrates, Protein, steroids, flavonoids, Terpenoids, Alkaloids, Tannins, Saponins and Glycosides (Thite et al., 2013), Rubavathi et al., 2020.

Antioxidant activity

The antioxidant activity of the herbal plants was analysed by the DPPH and FRAP assay based upon the methodology of Ayyappadasan et al., 2017, Rubavathi et al., 2020. Extracts solution of 20, 40, 60, 80 and 100 µg/ml were prepared using their respective solvents for both standard and sample. Ascorbic acid was used as a standard.

$$\% \text{ inhibition} = \frac{A_{\text{Control}} - A_{\text{Sample}}}{A_{\text{Control}}} \times 100$$

Antimicrobial activity of plant extracts

Wells were cut from the agar with a sterile borer and 100 µl extract solution of different concentration (40 µg/ml, 60 µg/ml, 80 µg/ml and 100 µg/ml) were delivered into the wells. The inoculated plates were incubated at 37°C for 24 hours. The antimicrobial activity was evaluated by measuring the diameter of the inhibition zone (DIZ.) (Deepan et al., 2012, Rubavathi and Ramya, 2016).

Preparation of flattened millet rice

Collection of unpolished Millet rice was polished by traditional man-made technology. The Millets was washed to remove surface bound dust. 100gm of millet was soaked in 200ml of water mixed with 0.1gm of extracted *Cardiospermum halicacabum* and *Ocimum tenuiflorum* for 5 hours. Extract solution observed millet was flattened by using homemade compressing technique and roasted. Flattened Millet rice samples were stored in airtight container for 15 days to evaluate its shelf life.

Formulation of millet barfi

Ingredients

The powdered *Cardiospermum halicacabum* and *Ocimum tenuiflorum* were taken for formulation of Millet Barfi. Then the main ingredient, designed flatten millet rice was taken. Other ingredients such as Jaggery powder, Nuts, water, ghee were obtained from Tiruchengode market, Namakkal, Tamil Nadu, India.

Formulation of *C. halicacabum* and *O. tenuiflorum* induced Millet Barfi

Powdered jaggery, designed millets, and plant extracts ingredients were measured in appropriate quantity and mixed. This millet mixture was the main ingredient of formulation of Millet Barfi. Sugar and water were equally added and boiled. After the Sugar Syrup was ready, little amount of punched cardamom was added before addition of Millet mixture. Then the mixture was slowly added and stirred properly. After that take a metal plate and coat it with a little amount of oil or ghee. Then gently pour the syrup on the plate. After some time when the syrup gets cooled take out the plate and start extracting it with a spoon or anything. The millet barfi was allowed to air cool for 20 minutes to room temperature and were packed in airtight plastic container (Balasubramanian et al., 2020).

Organoleptic evaluation

To get the overall acceptability from the consumers, the organoleptic evaluation was performed. It has been evaluated by using the organs as eye for colour, tongue for taste and flavour. Based on the sense, marks were awarded for the respective parameters. The marks were awarded based on 9-hedonic scale values ranges from 1 to 9 where 1 = extremely dislike and 9 = extremely like. This organoleptic evaluation was performed for the Millet Barfi based on the 9-hedonic scale values by 10 different experts. It was based on the parameters as colour, flavour, texture, taste, and overall acceptability. The set of same people were involved in every variety of Millet Barfi and after every trial,

the average of the mark was taken as a et Barfi incorporated with *C. halicacabum* and *O. tenuiflorum* extracts at different concentration were assessed at intervals of 0, 5 and 10 days of storage period with ten panellists.

Evaluation of physiochemical properties

Cardiospermum halicacabum and *Ocimum tenuiflorum* incorporated Millet Barfi was analysed for moisture content, protein estimation, Carbohydrate estimation and fat estimation. The pH of Millet Barfi was measured with a pH meter that was calibrated with standardized pH buffer solutions 4.0 and 7.0 prior to the analysis. The moisture content of the samples was determined according to the Association of Official Agricultural Chemists. 3 g of each Millet Barfi sample was placed in oven at 105 °C for 3 h. The moisture content was then expressed as (%) of the dry weight of the sample.

Moisture content (%) = Final weight – Initial weight

Protein estimation was done according to (Lowry's *et al.*, 1951). Solution A, solution B, solution C and Folin's phenol (1:1) was prepared. Bovine serum albumin was used as the standard for this test and stock solution as well as working standard was prepared to set as a reference. Varying concentration of working standard and the corresponding solution C were added and kept for 10 min incubation, Folin's phenol was added and incubated for 30 min at dark. The same procedure was done using the formulated sample and the values were analysed based on the standard used by

plotting the graph. The blue colour was obtained, and it was measured by optical density at 660 nm.

Shelf-life evaluation

The shelf life of the millet barfi was evaluated by the standard plate count method using nutrient agar media. The number of colonies on the plates was recorded. The sensory evaluation was carried out to get consumer response for shelf-life analysis. The evaluation was performed at weekly intervals to assess the changes in sensory parameters for the duration of three weeks.

CFU/ml= (No. of colonies × Dilution factor) / Volume of culture plate

RESULTS AND DISCUSSION

Processing of the millets

Vishra Agro Sales Dehuller and Grader is used for the processing of the millets. It is highly used for its safe, compact, low weight and portable, less power requirement, better grain flow control and its improved hulling chamber design

Capacity : 200-250 kg per hour
 Hulling Percentage : 100%
 Motor capacity : 2 HP
 Materials : MS and Grain touch SS
 Double stage : Bye pass option
 Shaker : Multi option – Two in one machine

The phytochemical compounds present in the Methanolic extracts of *Cardiospermum halicacabum* and *Ocimum tenuiflorum* were shown in the Table 1.

Table 1: Phytochemical screening of leaf extracts

Phytochemical tests	<i>Cardiospermum halicacabum</i>	<i>Ocimum tenuiflorum</i>
Carbohydrates	+	+
Alkaloids	-	+
Flavonoids	+	+
Tannins	+	-
Saponins	+	+
Glycosides	-	-
Terpenoids	-	+
Proteins	+	+

The results interpret that carbohydrates, flavonoids, saponins, proteins were present

in both *C. halicacabum* and *O. tenuiflorum*. Glycosides was absent in both the extract.

Sermakkani and Thangapandian, 2010. The results obtained from the phytochemical test were compared with the previous research (Viji *et al.*, 2009 and Patel., 2021).

Antioxidant activity of the palnt extracts

The results of the FRAP and DPPH assay was shown in a graph fig 1 and Fig 2. The result interprets that *C. halicacabum* has

slightly higher antioxidant property compared with standard. *O. tenuiflorum* has shown same level of activity as standard. (Patel & Tyagi *et al.*, 2013) showed the results of FRAP assay of herbal extracts. Results were in accordance with the (Balasubramani *et al.*, 2016) and Rubavathi *et al.*, 2020

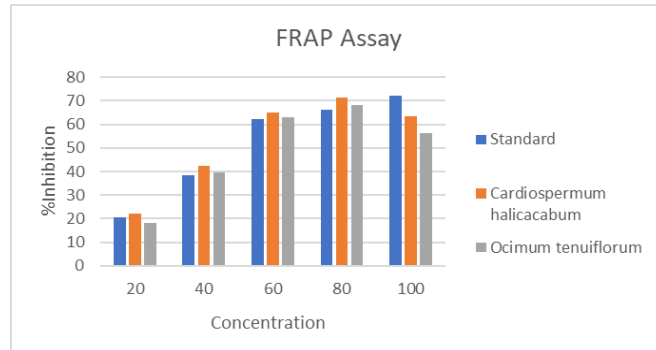


Fig 1: FRAP assay of the plant extracts

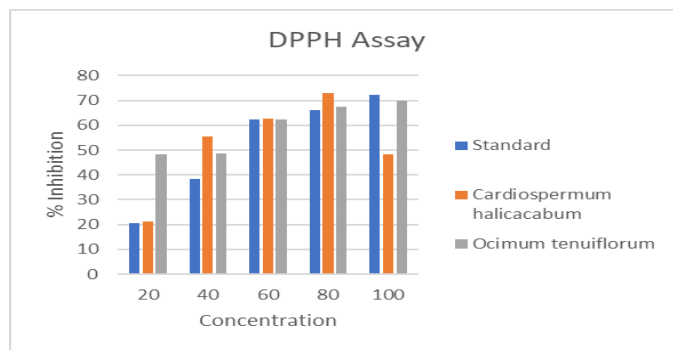


Fig 2: DPPH assay of the plant extracts

The antibacterial activity of the plant extracts were done against the common microorganisms such as *E.coli*, *Pseudomonas*, *B.Subtilis* and *S.aureus*. The zone of inhibition was shown in fig 3 and the

numerical value of the inhibition was given in table 2 which shows the highest inhibition at 60 (µg/ml) concentration of plant extracts (Deepan *et al.*, 2012, Veerappan *et al.*, 2012)

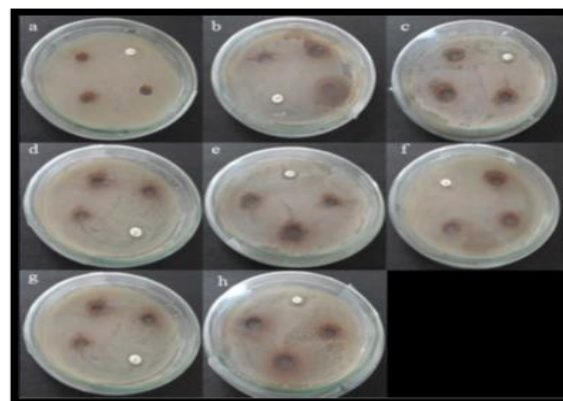


Fig 3: Antibacterial activity of the plant extracts

Table 2: Antibacterial activity of the plant extracts

Organism	Concentration (µg/ml)	Inhibition of the extracts (mm)	
		<i>Cardiospermum halicacabum</i> Methanol	<i>Ocimum tenuiflorum</i> Methanol
<i>E.Coli</i>	20	4	3.5
	40	9	7
	60	11	10
<i>Pseudomonas</i>	20	5	3
	40	8.5	7
	60	10	9.5
<i>B.subtillus</i>	20	4	2
	40	7.5	7
	60	12	11
<i>Streptococcus aureus</i>	20	5	3
	40	7	5
	60	11.5	9.5

The polished millets were induced with the extracts and soaked were 5 hours for 5 hours and dried to make the flattened form which is represented in Fig 4.



Fig 4: a) Finger millet & flattened millet rice and b) barnyard millets & flattened millet rice

The formulation of barfi was done with the millets that are induced with the plant extracts which has the high medicinal values. The formulated barfi was shown in fig 5. The sensory evaluation was done for the development of consumer efficiency.

The various concentrations of the plant extracts were induced into the barfi and the organoleptic test was done. The overall acceptability of the barfi was highest up to the 0.5g concentration.



Fig 5: Millet barfi induced with plant extracts

Table 3: Sensory evaluation of millet barfi samples

Trials (Concentrations at which the plants extracts were incorporated)	Sensory evaluation parameters				
	Flavour	Texture	Taste	Colour	Overall acceptability
0.3g	8	8	7	8	8
0.4g	8	8	7	8	8
0.5g	7	8	7	8	8
0.6g	7	7	6	6	5
0.7g	7	6	6	7	7

Physiochemical evaluation of extracts incorporated millet barfi

The moisture content of Millets Barfi was determined by moisture analyser at 120 °C for 10 mins. The % Moisture of formulated Millet Barfi was found to be 4.98%.

% Moisture = (Weight of the sample - Weight of the sample after drying/weight of the sample before drying) *100

The quantitative analysis of carbohydrate was performed by Anthrone's method. The reading was observed at 620 nm. The amount of carbohydrates in the millet barfi was found to be 42.69%

Protein estimation was done by Lowry's et al (1957) method for *Cardiospermum halicacabum* and *Ocimum tenuiflorum* extract incorporated Millet barfi samples. The reading was observed at 660nm. The amount of protein in the millets barfi was found to be 18.96%

The fat content of millets barfi was estimated by ether extraction method at 35°C for 1 hr. The amount of fat present in millets barfi was found to be 8.64%

The fiber content was determined by using a muffle furnace. The amount of fiber in the millets barfi was found to be (Detection Limit 0.9%).

Shelf-life analysis was done by standard plate count method to find out the shelf life of developed Millet Barfi and to ensure the safety of the product. At week 1 no contamination was observed. Microbial growth was calculated by

CFU /ml= (Number of colonies) *Dilution factor

By using this formula, the microbial growth was evaluated as 0.003 CFU/ml which proved that the millet barfi has longer shelf life.

CONCLUSION

In this study, we have reported that *Cardiospermum halicacabum* and *Ocimum tenuiflorum* extract incorporated millet Barfi contains the higher nutritional value. It is a rich source of nutrients, calcium, antioxidant, amino acids, vitamins, and minerals which do not cause any stomach irritation or burning sensation. The Millet Barfi produced has additional medicinal values because of the plant materials added. *Cardiospermum halicacabum*, *Ocimum tenuiflorum* contains many phytochemicals that protect against ulcer. Antibacterial and phytochemical are carried out for the plant extracts. Organoleptic, Microbial, and Physiochemical analyses are carried out for the Millet Barfi samples. The addition of plant extract at different concentrations in Millet Barfi showed significant changes in pH, and sensory evaluation. Among all the different compositions of millet Barfi samples, 0.5g of *Cardiospermum halicacabum* and *Ocimum tenuiflorum* extract incorporated millet barfi was accepted by 10 panellists who evaluated the millet barfi samples on different days and also shown a significant increase in protein content.

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