

Nutritional and Shelf-Life Estimation of Nutritive Muffins Incorporating *Dillenia indica* and *Terminalia Chebula* Flour

Jasmin Islam¹, Ph Vivekanandini Devi¹, Manash Pratim Sarma^{2*},
Madhumita Gogoi¹ and Rupam Medhi¹

¹Programme of Food Nutrition and Dietetics, Faculty of Science,
Assam down town University, Assam, India.

²Programme of Biotechnology, Faculty of Science,
Assam down town University, Assam, India.

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The present study was undertaken to develop nutritive muffins using *Dillenia indica* and *Terminalia chebula*, evaluate their sensory attributes, nutrient content and conduct shelf-life studies. Three variations of muffins were developed and under each formulation, three different level of incorporations were made and compared to a control muffin. The developed muffins were evaluated for their sensory acceptability and the most preferred F2 formulation was selected and evaluated for proximate composition and shelf life. Developed nutritive muffins had been highly accepted in all attributes, is nutrient-dense, innovative and healthier snack but low shelf-life due to non-addition of any artificial preservative.

Keywords: Elephant Apple; Haritaki; Minor; NE India; Shelf-Life.

Dillenia indica, common name-elephant apple and locally known as *outenga* in Assamese, belongs to the family Dilleniaceae. The various parts of the fruit are used traditionally for various therapeutic values, prevalently used in Indian traditional and ayurvedic medicine as it has many pharmaceutical and phytochemical activities^{1,2}. Elephant apple is one of the widely used fruits which are particularly used by various tribes of North-East India including Assam. The fruits are rich in nutritional composition and could be processed to commercial products. It is used in treating various ailments traditionally in the North-east India as the plant has various medicinal uses

pertaining to its high content of antioxidants and phenols. Almost every part of the plant is used traditionally in the cure of ailments and diseases^{3,4}. *Terminalia chebula*, a medicinal plant commonly known as Yellow myrobalan or Chebulic myrobalan or Haritaki and locally known as hilikha, is widely distributed throughout India, Burma and Srilanka. Due to its extraordinary power of healing, it is also considered as the “king of medicine” in Ayurveda⁵. In various traditional medicine systems, fruits of *Terminalia chebula* Retz. (Combretaceae) are widely used as crude drugs. It is well established to possess pharmacological activities such as antioxidant, hepatoprotective, neuroprotective,

*Corresponding author E-mail: dean.bas@adtu.in

cytotoxic, antidiabetic, anti-inflammatory activities and many more⁶. These minor fruit crops of Assam have a wide range of potentials in traditional medicine as well as in culinary purpose but remains underutilized due to lack of nutritional knowledge.

Over the years, the nutritional enhancement of food products has gained momentum and so, identification and incorporation of inexpensive, and nutrient-rich easily available food sources with antioxidants and medicinal benefits into different food products would serve as a big boon to the food industry⁷. The recent tendency for healthy food has influenced the development of new products with increased nutritional value, as well as benefits to consumers. Muffins are a favorite bakery product that is relished by many belonging to various age groups^{8,9}. Keeping in mind about health benefit, a healthy food product i.e. muffin is developed using underutilized fruits which contain a lot of medicinal and therapeutic properties.

The present study was aimed to develop nutritive muffins incorporating elephant apple and haritaki, keeping in view the various nutritive properties of these fruits. The objective of the study was to develop nutritive muffins using elephant apple and haritaki, to evaluate them for their sensory attributes, nutrient content and conduct shelf-life studies.

MATERIAL AND METHODS

For carrying out the present study, fresh samples of elephant apple and haritaki were procured from the local markets of Guwahati, Assam in the month of February to April, 2022. The raw ingredients, i.e., elephant apple and haritaki were first removed from their respective seeds to obtain the pericarp (Figure 1) and then finely cut into pieces for drying in hot air oven at 70°C for around 24-48 hours. The dried ingredient was grounded to obtain fine powder form with the help of a sieve of 75 microns. The dried powder was then utilized for preparation of nutritive muffins.

For the preparation of muffins, elephant apple powder was recombined with refined wheat flour and three variations of muffins were developed and standardized which included elephant apple muffins, haritaki muffins, elephant apple and haritaki mixed muffins. The muffins were formulated and standardized taking one

control composition. Three different level of incorporations were done under each formulation, which were coded as follows: F1 (5%), F2 (10%), F3 (15%) of elephant apple incorporation; H1 (2%), H2 (4%), H3 (6%) of Haritaki incorporation and FH1 (5% Elephant apple and 5% Haritaki incorporation), FH2 (5% Haritaki and 10% Elephant apple incorporation), FH3 (10% Haritaki and 5% Elephant apple incorporation). The developed products were then compared to the control muffin formulation with 100% refined flour composition (coded as C). The muffins were evaluated for their acceptability taking into account their sensory attributes by 30 semi-trained panelists using the 9-point hedonic rating scale. The muffins with the highest score of sensory acceptability was further examined for its proximate composition and shelf life using standard methods.

Moisture, ash, fat and dietary fibre content of the muffins was determined following the Association of Official Analytical Chemists (AOAC, 2005) method¹⁰. Protein content was determined following the Kjeldahl method (1883)¹¹, total carbohydrate and total sugar content was determined by method stated by Sadasivam and Manickam (2008)¹². The energy value was determined by multiplying the percentage of crude protein, crude fat and carbohydrate by the calorific value of these three i.e., by the factor 4, 9, 4 respectively and the estimation was recorded as kcal per 100 g following method by Gopalan *et al.* (2000)¹³.

Shelf life of the muffins were examined in Polypropylene packaging for a period of 1 month. The muffin samples were checked after 30 days, using microbial count to see whether the packaging material best preserved the samples. Total Plate Count (TPC) was determined by pour plate technique on Plate Count Agar (PCA) medium (incubated at 30°C/48 h) after one month of storage. This method for estimating microorganism was modified from Tate, R.L. (2000)¹⁴. Microbial analysis was measured using the following formula:

$$\text{No. of CFU/ml or gm} = \frac{\text{No. of colonies} \times \text{Dilution factor}}{\text{Amount plated}}$$

Dilution factor = Reciprocal of the dilution (e.g., 10⁻⁷=10⁷)

All the data of the sensory evaluation were further statistically analyzed in replicates of three. The means were evaluated and represented as mean \pm SD according to descriptive statistics.

RESULTS AND DISCUSSION

The degree of likeness or dislikeness of the muffins was evaluated by means of sensory evaluation. Descriptive sensory evaluation can be defined as “collection of techniques that seek to differentiate between ranges of products based on all of their sensory characteristics and determine quantitative description of all the identifiable sensory attributes, not only the defects”¹⁵. In the assessment of acceptability of all the different variations of muffins, F2 formulation (Figure 2) containing 10% Elephant apple powder was the most preferred one in all sensory attributes (color, appearance, taste, texture, flavor and overall

acceptability) based on the ratings of hedonic scale given by 30 semi-trained panelist members. In terms of overall acceptability, F3, H1 and FH1 respectively were preferred next to F2 by the panelist members. The mean hedonic test scores results are reported in this study (Table 1).

Terminalia chebula fruit extract exhibits antioxidant, analgesic and cyto-toxic activities which favours its use in folk medicine⁵ and it can be also incorporated into food products. The present study reports the utilization of haritaki powder in bakery products (muffins) for the first time. Elephant apple powder can be used as alternative or supplement to wheat flour in the manufacture of nutritious bakery products. With respect to nutritional and sensory scores, addition of 10% EAP (elephant apple powder) biscuits was acceptable that may help to fulfill the daily nutrient requirements¹⁶. In a study¹⁷, it was reported that the muffins were softer in days 0-4 but after 16

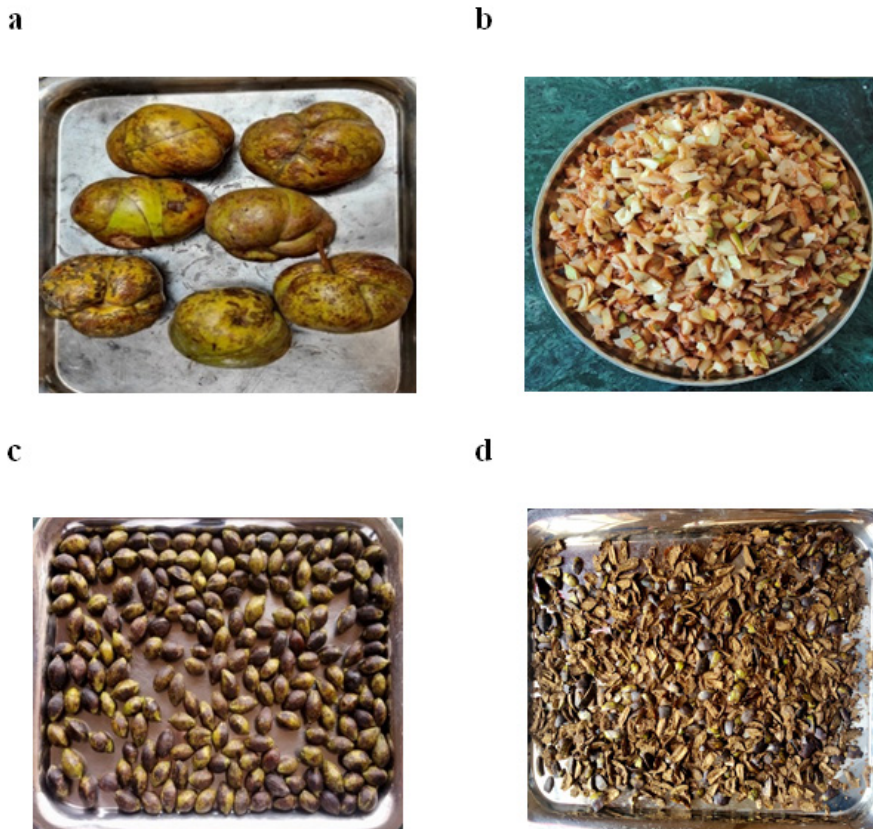


Fig. 1. a) Raw fruit of Elephant apple, b) Pericarp of Elephant apple after removal of seeds for oven drying, c) Raw fruit of Haritaki, d) Pericarp of Haritaki after removal of seed for oven drying

days, it had greater firmness which indicated that the overall acceptability of muffins was better in 0-4 days. In another study¹⁸, it was reported that 2.5%, 5.0%, 7.5%, and 10.0% incorporation of fermented rice bran muffins had lower firmness while 20% and 25% incorporation of fermented rice bran muffins were more accepted.

The elephant apple muffins (F2) had highest acceptability score, hence were selected

and further evaluated for its proximate composition and shelf life stability. The proximate composition results (Table 2) for nutritive muffins were 8.56 g/100 g moisture, 29.99 g/100 g fat, 4.62 g/100 g protein, 1.23 g/100 g ash, 40.28 g/100 g carbohydrate, total sugars 5.03 g/100 g, 0.71 g/100 g soluble dietary fibre (SDF), 4.19 g/100 g insoluble dietary fibre (IDF) and 4.90 g/100 g total dietary fibre (TDF). Elephant apple has a great potential

Table 1. Mean hedonic test scores of Elephant apple muffins, Haritaki muffins, Elephant apple and Haritaki mixed muffins

Formulation	Product	Quality attributes					
		Colour (Mean±SD)	Appearance (Mean±SD)	Taste (Mean±SD)	Texture (Mean±SD)	Flavour (Mean±SD)	Overall acceptability (Mean±SD)
Refined flour	Control	7.26 ±0.90	7.51±1.16	7.23±0.81	7.06±0.73	7.4±0.85	7.33±0.75
Elephant apple muffins	F1	7.96±0.66	7.8±0.96	7.83±1.01	7.6±1.03	7.76±1.00	7.83±0.98
	F2	8.36±0.76	8.16±0.83	8.33±0.88	8.2±0.84	8.1±0.80	8.3±0.79
	F3	8.13±0.93	8±0.78	8.13±0.73	8.2±0.76	7.9±0.90	8.3±0.66
Haritaki muffins	H1	7.52±1.23	7.28±1	7.76±1.06	7.16±1.08	7.52±0.89	7.76±1.03
	H2	7.12±1.07	6.88±0.90	7.24±0.99	6.8±1.05	6.92±1.23	7.36±0.93
	H3	6.32±1.56	6.6±1.2	6.28±1.4	6.52±0.85	6.28±0.96	6.48±1.13
Elephant apple+ Haritaki muffins	FH1	7±1.12	6.47±0.85	7.28±1.16	6.95±1.32	7.28±1.45	7.28±0.98
	FH2	7.1±0.84	6.57±1.09	6.52±1.09	6.57±0.95	6.42±1.39	6.71±1.16
	FH3	7.14±0.88	6.71±6.98	6.47±1.21	6.47±1.36	6.38±1.32	6.71±1.20

Table 2. Nutritional composition of nutritive muffins (F2)

Parameters	Amount (g/100 g)
Moisture	8.56
Protein	4.62
Fat	29.99
Fibre	0.79
Ash	1.23
Carbohydrate	40.28
Total sugars	5.03
SDF	0.71
IDF	4.19
TDF	4.90



Fig. 2. F2 formulation of muffins

Table 3. Microbial load of formulated muffins (F2) after 30 days of storage

Different packaging material bags	No. of Colonies	Total dilution factor	Volume of culture plated in mL	CFU/mL
Polypropylene Ziploc bag	245	10 ⁶	1	2.45x 10 ⁸

to be used in food and pharmaceutical industry. Elephant apple can be a functional ingredient for food processing industries due to its high fibre content and very less fat content¹. Another study reported that the chemical composition of muffins with 20% pumpkin powder had better nutritive values as compared to the control muffins as the bakery products prepared from refined flour are low in vitamins, minerals and dietary fibre content¹⁹. For the development of fibre rich bakery products, fruit and vegetable pomace can be used as a novel ingredient²⁰. Elephant apple is widely found in various regions of Assam and exhibits significant clinical & pharmacological activity⁴. For people suffering from lifestyle disorders, inclusion of healthy ingredients in the development of muffins can be beneficial⁹.

The shelf life of elephant apple muffins (F2) was examined in polypropylene packaging for one month at room temperature and microbial load was assessed using standard methods. Shelf life of food can be defined as a period of time after production and packaging, during which the food product maintains level of quality acceptable for consumption under well-defined storage conditions²¹. The microbial analysis was carried out after 1 month storage. There was no visible microbial growth detected but presence of colony formation of fungi was recorded. The values of the microbial count of the formulated muffins obtained by serial dilution are reported in this study (Table 3).

The CFU/ml of Polypropylene Ziploc bag was recorded as 2.45×10^8 (Table 3) which revealed that muffins cannot be stored for a longer duration. Similar results were reported in another study¹⁷ where the overall acceptability of muffins was better in 0-4 days but deteriorated after few days. Another study revealed that over storage for 7 days, the sensory scores of muffins for color and appearance, odor, flavor, texture and overall acceptability decreased and for day 6, the CFU/ml value for both control and moringa muffin was 8.9×10^{10} and 7.45×10^{10} respectively⁷. Another study²² reported muffins with jaggery had better acceptance even after 21 days and sugar could be replaced with jaggery in muffins without affecting its properties. A cfu/ml value e^{106} for bakery and confectionary products is considered

unsatisfactory as per Centre of Food Safety, Food and Environmental Hygiene Department²³. Thus, muffins can be safely consumed for a longer period with proper packaging and natural preservatives.

CONCLUSION

The present study investigated the incorporation of Elephant apple and Haritaki powder in muffins at different levels of incorporation in order to select the most desirable muffin, to evaluate them for their sensory attributes, nutrient content and subjected to shelf-life studies. Nutritive muffins developed by the addition of extracted powder obtained from Elephant apple received high acceptance in all sensory attributes according to Hedonic test results, proximate results recorded the nutrient content which recommend it can be a healthier alternative snack for different sections of the society compared with the control muffin. Microbial load results revealed that muffins cannot be stored for a longer duration as no artificial preservative was used. The study concludes that the value addition of incorporation of elephant apple powder can improve the sensory attributes of muffins thereby enhancing the nutritive value with reasonable cost. Hence the approach demonstrated in the present study shows that it could also serve as a stepping stone to the production of other bakery products from such underutilized fruits and use of this innovative ingredient formulation concept can be fruitful in creating successful commercial bakery products.

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Conflict of Interest

The authors report no conflicts of interest. The authors are responsible for the content and writing of the paper.

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