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Fortification and Development of Nutritive Rich Cupcake using *Prunus dulcis*

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ABSTRACT

Background: Almond (*Prunus dulcis*) is the most consumed tree nut, next to walnut and cashew and India is number one importer of almonds. Ingredients such as Barnyard millet (*Echinochloa frumentacea*), Kodo millet (*Panicum sumatrense*) and Black rice (*Oryza sativa*) were popular in the past but neglected by people now a days due to changes in the life style and regular food intake. Taking this into consideration an attempt was made to utilize these ingredients to develop a low-cost cupcake (Almocake) with high calcium and magnesium content for people suffering from micronutrient deficiency. The current rate of cupcakes per kg is approximately 700 rs/kg but the "Almocake" is 495 rs per kg, which is much lesser than the commercially available one.

Methods: The ingredients were procured, dry roasted and ground. Three different proportions supplemented with 1:2:2:2, 1:2:1:2 and 2:1:1:1 ABVB (Almond, Barnyard millet, Kodo millet and Black rice) per serving were prepared and sensory analysis was carried out using a five-point hedonic scale that considered appearance, texture, taste and aroma.

Result: The proportion 2:1:1:1 was found to be comparatively better than the other proportions. Nutritional analysis tests show that calcium content of 39.4 mg and Magnesium content of 23.8 mg were present in the cupcake. The antioxidant activity by DPPH antioxidant test was found to be 60%. The shelf life analysis by spread plate technique of the product was observed to be 20 days.

Key words: Almond, Barnyard millet, Black rice, Kodo millet, Micronutrient deficiency.

INTRODUCTION

The term functional food, first used in Japan in 1980s, refers to the fortified foods with high nutritional value and increased health benefits. Japanese interest in the functional foods led to the awareness in order to create new food products**.** The perception of consumers towards food has changed in the recent past and people believe in food that attributes directly towards health rather than food just for hunger satisfaction (Mollet *et al*., 2002). There is a need for new products development for satisfying consumers' interest and to cope up with the changing needs (Asioli *et al*., 2017). Experts in Europe and the United States have realized that instead of the health care products, more attention is required for the development of healthier food products (Siro *et al*., 2008). Indian bakery industry produces roughly 1.3 million tons of baked goods (FnB news 2014). Food enrichment refers to improvement in the nutritional quality of food by adding nutrients that the food product is lacking. Poor dietary product quality is often characterized by micronutrient deficiencies (Tanvi *et al*., 2022). Bakery is one of the largest segments of food processing industry in India and maida, also known as refined flour, has been used as the most common base ingredient in bakery products. During the production of maida from wheat, endosperm of the wheat is removed from germ and bran, leading to loss of vitamins. NDTV (2018) reported the health defects of consumption of maida, also termed as "glue of gut", that has no fiber content and ultimately leads to obesity, stress and constipation. Micronutrient and protein deficits affect how well children grow and develop mentally and physically. Protein-infused cakes that boost public health and are more suitable for modern lifestyles were developed to address these challenges (Chhavi *et al*., 2021). Baked goods are frequently used as a way to provide fresh sources of useful ingredients, like dietary fiber and bioactive substances (Prashant *et al*., 2018). About 80% of worldwide almond production comes from California, of which 33% is consumed by US and remaining the 77% is exported to other countries and India stands as No.1 importer of almonds (Economic Times). This research work is based on an innovative approach of using healthy nutrient rich components with almond as base ingredient that completely replaces maida (white flour) in the cupcake.

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MATERIALS AND METHODS

Raw materials

Almond (*Prumus dulcis*), Barnyard millet (*Echinochloa frumentacea*), Black rice (*Oryza sativa*), Kodo millet

(*Panicum sumatrense*), honey, egg and fig (*Ficus carica*) were used as the main raw materials. The ingredients were collected from local market of Chennai, Tamil Nadu, India. They were washed properly before use, dried and stored in airtight container for further processing. This research work was carried out in the Department of Biotechnology, Rajalakshmi Engineering College, Thandalam, Chennai, India from June 2022 till January 2023.

Composition of the ingredients

Almond, barnyard millet, kodo millet and black rice were taken in different proportions in the ratio of 1:2:2:2, 1:2:1:2 and 2:1:1:1 among which 2:1:1:1 proportion was selected as the standard due to better textural pattern and rate of acceptance. Further processing was continued with this standard proportion.

Product formulation

For 100 grams of "Almocake" the following quantities of ingredients were used (Table 1).

Methodology

Barnyard millet, Kodo millet and black rice were dry roasted separately in low flame. After roasting the material was allowed to cool. The roasted components and almonds were ground into fine flour. The flour was sieved and baking powder was added to the flour and kept aside. In a separate bowl, refined sugar and egg were added and whipped until a smooth mixture was obtained. A small quantity of oil along with the flour was added to the mixture and stirred. The whole batter was then mixed lightly, chopped figs were added and kept aside. The batter was transferred to cupcake moulds in which butter paper was already placed inside in order to prevent the stickiness. It was pressure cooked for 15 minutes at high flame and 30 minutes at low flame (Fig 1).

Antioxidant assay

Antioxidant activity was estimated by DPPH (1, 1-Diphenyl -2-picrylhydrazyl) radical scavenging method. DPPH solution was prepared by dissolving 4.3 mg of DPPH (1, 1-Diphenyl -2-picrylhydrazyl) in 3.3µl methanol and the test tubes were covered with sheets of tin foil to shield them from the sun. As a control, 3 ml of methanol was dissolved in 150 µl of DPPH solution. The sample (cupcake) was prepared at several concentrations ranging from 100 mg/ml of water to 500 mg/ml of water. 3 µl of methanol and 150 µl of DPPH

Table 1: Ingredient for "Almocake".

Ingredients	Weight (In grams)
Almond (*Prumus dulcis*)	20
Barnyard millet (*Echinochloa frumentacea*)	10
Kodo millet (*Panicum sumatrense*)	10
Black rice (*Oryza sativa*)	10
Egg	10
Honey	10
Refined sugar	27
Baking powder	3
Oil	5
Fig (*Ficus carica)*	10

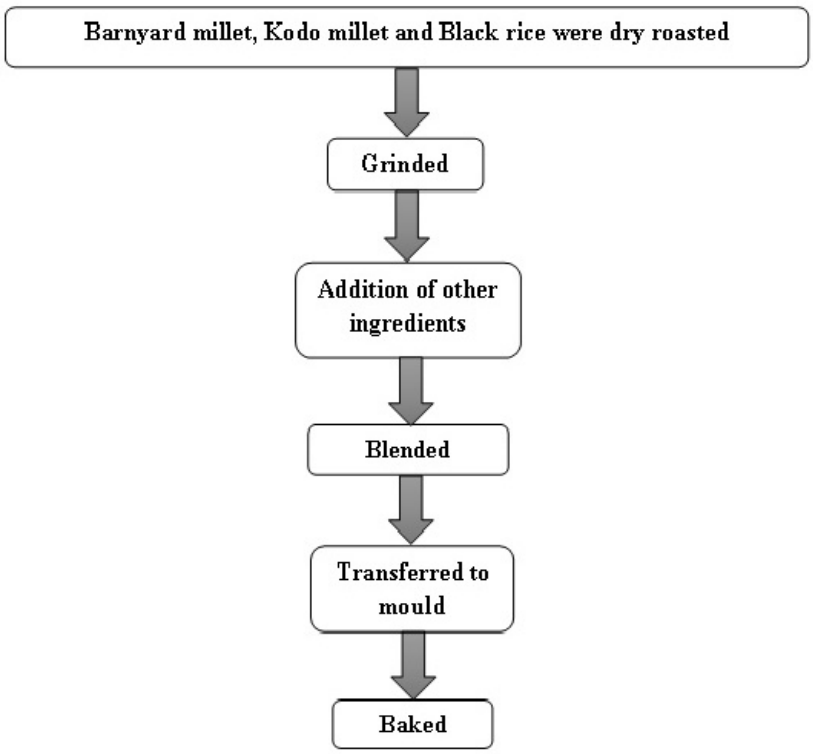


Fig 1: Process flowchart.

were added to each sample. A UV-visible spectrometer was used to measure the absorbance at 517 nm after 15 minutes of incubation. The antioxidant activity was calculated using the following formulae, (Nilima and Hande 2011).

$$\% \text{ Scavenging} = \frac{\text{Absorbance of control} - \text{Absorbance of test sample}}{\text{Absorbance of control}} \times 100$$

Sensory analysis

Sensory analysis using Standard Hedonic Scale is the most frequently used method in food industries to assess the organoleptic quality of food (Civille and Oftedal, 2012). Sensory analysis of the cupcake on a scale of 5 was done for different age groups of human subjects starting from: 5 years to 50 years. The important sensory parameters analyzed includes, appearance and color, size and shape, texture, aroma, dryness, softness, taste and after taste.

Shelf- life analysis

The shelf life of the product was determined by spread plate technique using nutrient agar with 1 gm of freshly prepared cupcake. The agar plates were kept at 37°C for 24 hours while the bacterial count was measured (Gimenez *et al*., 2012).This procedure was repeated two days once till 25th day and the observations were recorded.

Product packaging

Packaging preserves the product and maintains its texture, taste and color by blocking the products' contact with moisture present in the atmosphere. Biobags are one such packaging material that is nontoxic, biodegradable and compostable, has good anti-static property and are great oxygen barriers which do not allow the entry of air inside the package and increases the shelf life of the product. Hence Biobags were used as a packaging material for this product (Fig 2). It has no Polyolefins which makes them harmless and they are made from natural extracts.

RESULTS AND DISCUSSION

Proximate analysis of nutrients

The proximate composition of nutrients, *i.e*., moisture, protein, fibre, ash and iron in the formulated product were analyzed per 100 g of the cupcake and it is represented in Table 2.

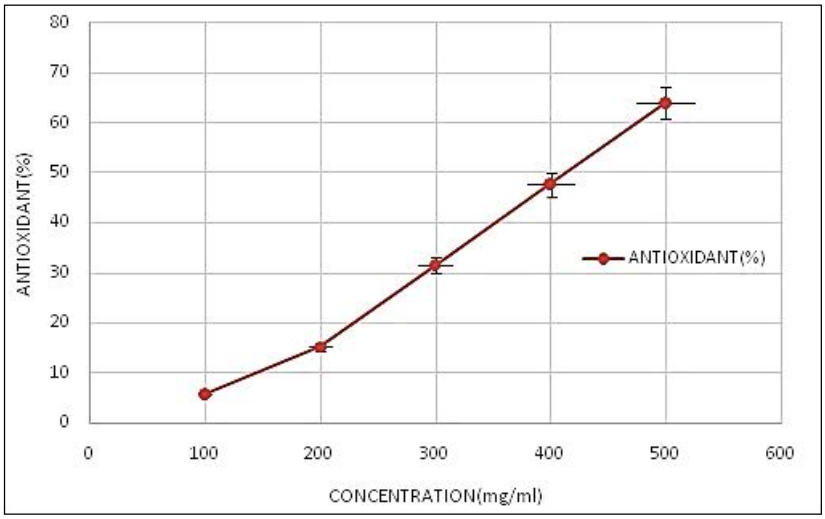


Fig 2: Antioxidant activity of almocake.

Table 2: Proximate and nutritional analysis of almocake.

Parameters	Methods	Units	Results
Energy (By calculation)	Fao method	Kcal/100 g	437
Carbohydrates (By difference)	CTL/SOP/FOOD/262-2014	g/100 g	46.2
Total protein	AOAC 20th Edn.2016, 920.152	g/100 g	8.30
Total fat	AOAC 20th Edn.2016, 954.20	g/100 g	24.3
Fiber	AOAC 20th Edn.2016, 991.43	g/100 g	6.15
Total sugars	Fssai manual	g/100 g	29.3
Magnesium as Mg	IS 5494: 1990 (RA.2003)	mg/100 g	23.8
Calcium as Ca	IS 5949:1990 (RA.2003)	mg/100 g	39.4
Iron as Fe	IS 3025 (Part 40) – 1991 (R 2009)	mg/100 g	3.50
Moisture	IS 1155 : 1968 (RA.2013)	g/100 g	20
Total ash	IS 12711:1989 (RA. 1994)	g/100 g	1.20

Antioxidant assay

The antioxidant activity in the control was nil and the sample with concentration of 500mg/ml showed maximum antioxidant activity of 60%. This may be due to the ingredients such as Almond (*Prumus dulcis*), Barnyard millet (*Echinochloa frumentacea*), Black rice (*Oryza sativa*) and Fig (*Ficus carica*) which have excellent antioxidant properties. The results are represented in the Table 3 and Fig 2.

Sensory analysis

The hedonic scale (Fig 3) representation proves that all the sensory parameters present in the cupcake are acceptable by the prospective consumers of all age groups. It was, especially, the case with respect to appearance, taste and softness. These three parameters on an average lie in the scale range of 4-5. The organoleptic property of almond is considered to be the main reason behind the taste and softness in the cupcake.

Shelf life of the product

The standard CFU/gm of aerobic organisms in baked items like cupcakes is found to be $<10^5$(satisfactory), 10^5-$<10^6$(Acceptable), $>10^7$ (Unsatisfactory), as per the norms followed in Gilbert et al. 2000. The data obtained for the cupcakes was in accordance to the norms and it is considered to be safe for consumption without changes in the organoleptic properties upto the 20th day from the date of production. The bacterial count was observed to be less than the unacceptable levels till 20th day (Fig 4) and hence the shelf life of the product was fixed as 15- 20 days (approx.). The CFU/gm of the cupcakes is represented in Table 4. Frosted and unfrosted cupcakes can be stored in normal room temperature in a dry condition but the best way of storing the cupcake is without any frosting on the top. Wrappings can be made in order to prevent the dryness of the cakes also. Storing in an airtight container blocks the growth of the harmful bacteria and extends the shelf life.

Comparison of the attributes of almocake with a control cupcake

A comparative study on the nutritional attributes of this cupcake with a popular cupcake commercially available in

Table 3: Antioxidant Activity of "Almocake".

Concentrtion (Mg/Ml)	Absorbance @ 517 nm	Antioxidant (%)
Control	0.958	-
100	0.902	5.84
200	0.812	15.24
300	0.656	31.52
400	0.501	47.70
500	0.349	63.9

Table 4: Detection of bacterial colony formation.

Day	Cfu per gram
1	NG
3	NG
5	2.8×10^2
7	2.2×10^3
9	1.2×10^4
11	6.4×10^4
13	2.9×10^5
15	1.4×10^6
17	6.8×10^6
19	4.6×10^7
21	9.4×10^7
23	3.2×10^8
25	7.8×10^8

*NG- No growth, CFU- Colony forming units.

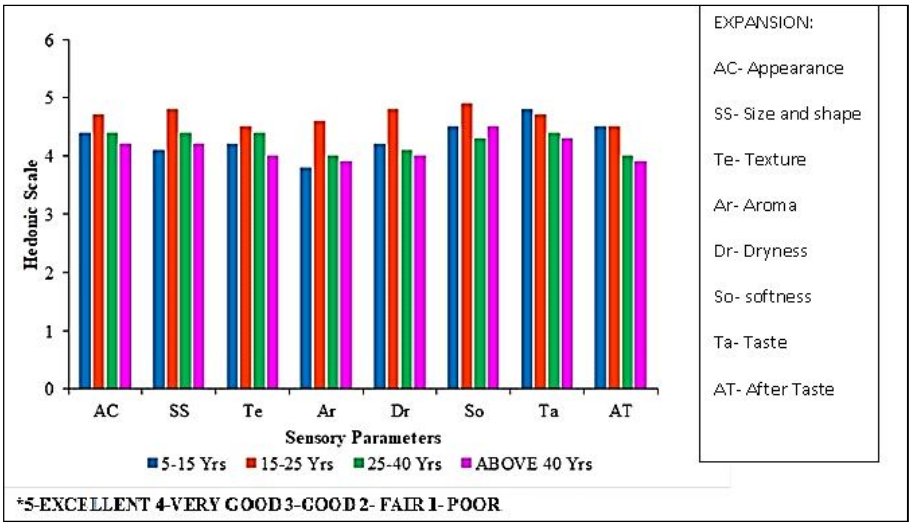
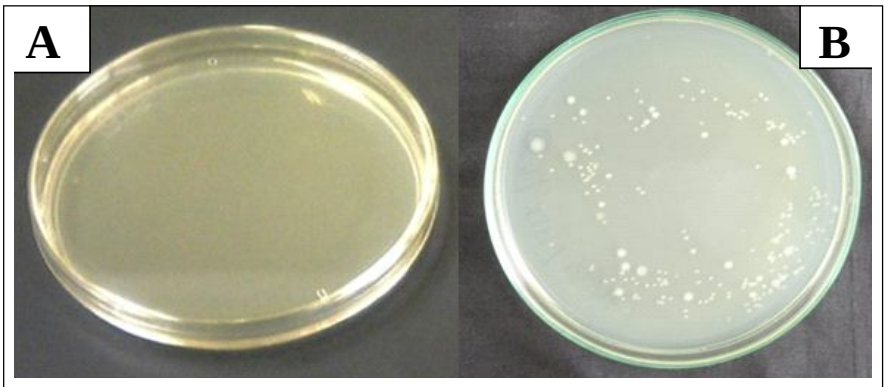


Fig 3: Sensory analysis with the hedonic scale of 5.



A) Agar plate with no growth on the first day.
B) Agar plate shows acceptable number of colonies after 20 days of cake preparation.
*CFU- Colony Forming Unit**;** *NG- No Growth detected.

Fig 4: Shelf life analysis of Almocake on agar plates.

Table 5: Comparison of the attributes of Almocake with a control cupcake.

Parameters	Units	Almocake	Commercially available cupcake
Energy (By calculation)	Kcal/100 g	437	343.53
Carbohydrates (By difference)	g/100 g	46.2	61.0
Total protein	g/100 g	8.30	5
Total fat	g/100 g	24.3	28
Fiber	g/100 g	6.15	1
Total sugars	g/100 g	29.3	40
Magnesium as Mg	mg/100 g	23.8	0
Calcium as Ca	mg/100 g	39.4	4.76
Iron as Fe	mg/100 g	3.50	0.68

the market is given in Table 5. Sugar and fat contents are high in the commercially available cupcake compared to this cupcake. Also there is no trace of magnesium and a merge amount of calcium and iron is available in the commercially cupcake. On the other hand Almocake is rich in proteins, fibres, magnesium, calcium and iron.

CONCLUSION

A cupcake has been developed using only almonds, millets and black rice and completely replacing refined flour. This is also enriched with proteins, fibre, iron and micronutrients like calcium and magnesium due to the fortification with millets, black rice and fig. This paves the way for the cupcake to be a potentially healthier and a delicious confectionary product in the market.

Conflict of interest: None.

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