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Sensory and Nutritional Evaluation of Cupcakes Prepared from a Flour Blend of Sprouted Wheat, Legumes and Unripe Banana

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ABSTRACT

The aim of the present study was to develop nutritious cupcakes by using easily available and nutrient-dense sprouts and unripe banana flour which are rich sources of macro and micronutrients as well as dietary fibers to boost the digestive health and immunity of the host. Cupcakes were prepared using sprouted wheat flour, raw banana flour and peanut butter common in three different formulations of test samples T_1 (Sprouted bengal gram), T_2 (Sprouted green gram) and T_3 (Sprouted field beans). The control sample (T_0) was prepared with refined wheat flour. Sensory evaluation was carried out using a 9-point hedonic scale and results showed that the overall acceptability score was higher for T_2 (8.29) with sprouted green gram flour. The nutritional composition of the test sample (T_2) and control sample (T_0) were determined. Protein, total dietary fiber, ash and total polyphenol (10.25 g, 3.18 g, 1.76 g and 133.27 GAE/100 g, respectively) were higher. Carbohydrates, fat and total calories (46.18 g, 7.60 g, 294.16 kcal/ 100 g, respectively) were significantly lower than control (T_0) sample. The use of sprouted wheat, legumes and raw banana flour enhanced the nutritional and antioxidant properties of cupcakes.

Key words: Cupcakes, sprouts, nutritional composition, green gram, unripe banana flour

INTRODUCTION

Current clinical evidence suggests that the intake of calorie-dense foods rich in carbohydrates and fat, but deficit in protein, favours increased rates of metabolic syndrome like inflammation, hyperglycemia and hyperlipidemia. Various plant-based functional foods have been suggested by many health organizations all over the world, which demand changes in dietary patterns, to improve health conditions and prevent chronic diseases (Hou *et al.*, 2018; Kumar *et al.*, 2018). Bakery products are extensively consumed and becoming a prime component of the international food market. Cakes are markedly cherished bakery products ingested by individuals of all ages worldwide. Cupcakes are novel products and are always consumed in celebrations and festivals and can be appraised of excellent potential, which can be commercialized in individual portions. Cupcakes can be easily supplemented with protein-rich flour to provide suitable products. The cupcake was developed in the United States in the 19th century, and it was futuristic because that saved time in the kitchen. They are transportable, easy to make, open garnishing strategies, tasty and inexpensive to make. The fortification of cupcakes and other cereal-based confections with legume flour mainly in regions where protein consumption is insufficient has long been recognized (Rebecca Jeyanthi *et al.*, 2016).

Sprouting increases nutrition content and also requires low processing, additives-free, simple, quick production cycle, lesser space and high yield (Kyriacous *et al.*, 2016). Germination activates and produces hydrolytic enzymes, and consumption is recommended for human health (Lemmens *et al.*, 2019) in cereals and legumes increases the activities of essential amino acids, and vitamin B complex and decreases its anti-nutrient. And the digestibility of stored protein and starch is improved due to their partial hydrolysis after sprouting. Legumes are an important human food crop after cereals. It constitutes a crucial part of the human diet as rich in protein (essential amino acids and sulfur-containing amino acids), bioactive compounds, vitamins and minerals, compared to cereals, and is

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known as 'the poor man's meat' (Hall *et al.*, 2017). Cereals are commonly a rich source of carbohydrates, dietary fiber, protein, vitamin E and B complex and minerals like iron, zinc, magnesium and phosphorus. Sprouted wheat flour was found to have remarkably higher crude protein, crude fat, thiamine and riboflavin to increase the activities of hydrolytic enzymes, and B-group vitamin and reduce dry matter and anti-nutrient total polyphenols (free and bound) and their antioxidant activity remarkably enhanced with no change in fatty acids, dietary fiber and alpha-tocopherol. Sprouting in Bengal gram increases its total polyphenols and shows DPPH activity and antioxidants. It also increases inhibitory potential against alpha-glucosidase and alpha-amylase. It is desirable for the management of diabetes and also increases its protein, essential amino acids, fiber, calcium, iron and ascorbic acid content with minor changes in fats and carbohydrates (Durovic *et al.*, 2021).

Sprouted green gram prevents degenerative disease because bioactive food components contain polyphenols that have antioxidants, anti-bacterial (Krishnappa *et al.*, 2017.), antidiabetic, antihyperlipidemic, antihypertensive, antiinflammatory, anticancer, antitumor, and antimutagenic properties (Kumar and Baojun, 2017) and affects biochemical composition like increase in protein, essential amino acids, fiber, calcium, iron and ascorbic acid content with minor changes in fats and carbohydrates. Health benefits of green banana flour are GI symptoms, insulin sensitivity, weight control, renal and hepatic problems associated with diabetes (Falcomer *et al.*, 2019) and also prevents glutathione depletion and inhibits myeloperoxidase activity and lipid peroxidation, inhibiting alkaline phosphatase activity showing intestinal anti-inflammatory activity. The present study was aimed at developing nutritious cupcakes and studying their nutritional content with sensory properties.

MATERIALS AND METHODS

All the raw ingredients for research purposes were purchased from the local market of Rajokari, New Delhi, India. All the dry ingredients were cleaned manually (by hand) to remove damaged seeds, stones, dust, light materials, glumes, stalks and other extraneous materials. After cleaning, all the raw ingredients were packed in an airtight container for further use.

Wheat, green gram, bengal gram and field beans were initially soaked for 24 h at room temperature, then soaked grains were spread on cloth and maintained moist by cyclic sprinkling of water for 48 h. After that sprouted grains were sun-dried for four days and then sun-dried grains were ground to fine flour in a blender. After that flours were used for incorporation in cupcakes.

Cupcakes were developed using dried sprouted grain flour. For the preparation of cupcakes, different sprouted flour was used for different samples. The sample of cupcakes was divided into four types (formula) and the different ratios of ingredients were taken as detailed in Table 1. The various operations involved in the preparation of cupcakes are detailed in Fig. 1. Different types of cupcakes are shown in Fig. 2.

Table 1. Formulation of cupcakes of different sample combinations (in g)

Ingredients	T_0	T_1	T_2	T_3
Refined flour	30	-	-	-
Wheat flour	-	12	12	12
Banana flour	-	8	8	8
Bengal gram flour	-	10	-	-
Green gram flour	-	-	10	-
Field beans flour	-	-	-	10
Milk	28	28	28	28
Curd	6	6	6	6
Sugar	20	20	20	20
Peanut butter	15	15	15	15
Baking powder	0.65	0.65	0.65	0.65
Baking soda	0.20	0.20	0.20	0.20
Salt	0.15	0.15	0.15	0.15

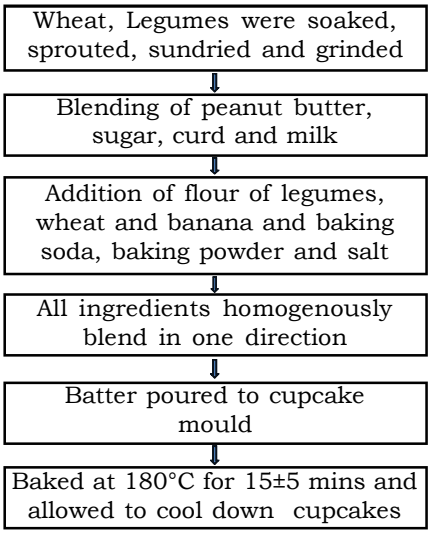

Fig. 1. Schematic representation of the process in development of cupcakes.

Fig. 2. Different types of samples of cupcakes.

All the samples of developed cupcakes prepared with flour banana, sprouted grain and legumes were evaluated for their sensory attributes by a panel of 18 judges from the Department of Nutrition and Dietetics and Department of Microbiology, Faculty of Allied Health Sciences, SGT University, Gurugram. The judges were served the cupcakes with control and different test samples. Control (T_0) was prepared from ingredients used in the standardized recipe and test samples were prepared by using flour of sprouted legumes and wheat with a mixture of unripe banana flour. The samples were coded to avoid any bias. The panelists were requested to score the cupcakes for eight sensory attributes: colour, appearance, taste, texture, flavour, chewiness and overall acceptability by using a scorecard based on the nine-point Hedonic scale (Srilakshmi, 2020). The final scores for each attribute for each product were obtained by averaging the scores of all 18 panelists.

In the present study, the determination of various proximate nutrients (moisture, fiber, protein, fat, ash and carbohydrates) of cupcakes was carried out using standard techniques in the Nutrition and Dietetics laboratory, SGT University, Gurugram.

Moisture content was determined by the oven-drying method. The estimation of protein content of cupcakes was done by Micro Kjeldahl method. Crude fat content was computed as:

Crude fat (%) = (100) x [(Weight of ether soluble material)/(weight of sample)]

Fiber content was determined by acid alkali method by FibroTRON, FRB-4, manufactured by Tulin equipment.

Ash content was determined by the dry ashing method. Difference method determined carbohydrate content. The energy value of the product was calculated based on given formula :

Energy value (Kcal/100 g) = (4 X Protein %) + (9 X Fat %) + (4 X Carbohydrate %)

Total polyphenol content was determined by Folin-Ciocalteu method.

The data were collected and presented in results as mean and standard deviation. The average nutritional and sensory score values of the developed cupcakes were statistically analyzed by using two-way ANOVA (analysis of variance).

RESULTS AND DISCUSSION

Cupcakes were evaluated for colour, appearance, taste, texture, flavour, chewiness and overall acceptability (Table 2). Among all formulated cupcakes, sample T_2, which contained sprouted green gram flour 8.29, was highly acceptable by panelists among test samples.

A significant difference was obtained in colour among the different treatments of developed sprouted flour cupcakes. The maximum was obtained by T_0 (8.85±0.69) which had refined

Table 2. Organoleptic properties of cupcake

S. No.	Attributes	T_0	T_1	T_2	T_3
1.	Colour	8.85±0.69	7.59±0.70	8.13±0.63	7.98±0.55
2.	Appearance	9.14±0.49	7.78±0.56	8.16±0.62	7.87±0.46
3.	Taste	9.05±0.46	7.27±0.48	8.52±0.75	7.89±0.57
4.	Texture	9.15±0.51	7.66±0.30	8.31±0.44	7.66±0.36
5.	Flavour	9.13±0.38	7.31±0.49	8.37±0.74	7.90±0.65
6.	Chewiness	8.96±0.54	6.87±0.59	8.18±0.64	7.42±0.56
7.	Overall acceptability	9.22±0.44	7.27±0.74	8.29±0.70	7.66±0.59

*Values are presented as mean ± SD from the samples of cupcakes.

wheat flour, followed by T_2 (8.13±0.63) which had sprouted green gram flour, T_3 (7.98±0.55) which had sprouted field beans and minimum scored by T_1 (7.59±0.70) which had sprouted Bengal gram flour.

A significant difference was obtained in appearance among different treatments of developed sprouted flour cupcakes. The maximum was obtained by T_0 (9.14±0.49) which had refined wheat flour, followed by T_2 (8.16±0.62) which had sprouted green gram flour, T_3 (7.87±0.46) which had sprouted field beans and minimum scored by T_1 (7.78±0.56) which had sprouted Bengal gram flour.

A significant difference was obtained in taste among different treatments of developed sprouted flour cupcakes. The maximum was obtained by T_0 (9.05±0.46) which had refined wheat flour, followed by T_2 (8.52±0.75) which had sprouted green gram flour, T_3 (7.89±0.57) which had sprouted field beans and minimum scored by T_1 (7.27±0.48) which had sprouted Bengal gram flour.

A significant difference was obtained in texture among different treatments of developed sprouted flour cupcakes. The maximum was obtained by T_0 (9.15±0.51) which had refined wheat flour, followed by T_2 (8.31±0.44) which had sprouted green gram flour, T_3 (7.66±0.36) which had sprouted field beans and minimum scored by T_1 (7.66±0.30) which had sprouted Bengal gram flour.

A significant difference was obtained in flavour among different treatments of developed sprouted flour cupcakes. The maximum was obtained by T_0 (9.13±0.38) which had refined wheat flour, followed by T_2 (8.37±0.75) which had sprouted green gram flour, T_3 (7.90±0.65) which had sprouted field beans and minimum scored by T_1 (7.31±0.49) which had sprouted bengal gram flour.

A significant difference was obtained in chewiness among different treatments of developed sprouted flour cupcakes. The maximum was obtained by T_0 (8.96±0.54) which had refined wheat flour, followed by T_2 (8.18±0.64) which had sprouted green gram flour, T_3 (7.42±0.56) which had sprouted field beans and minimum scored by T_1 (6.87±0.59) which had sprouted Bengal gram flour.

A significant difference was obtained in overall acceptability among different treatments of developed sprouted flour cupcakes. The maximum was obtained by T_0 (9.22±0.44) which had refined wheat flour, followed by T_2 (8.29±0.70) which had sprouted green gram flour, T_3 (7.66±0.59) which had sprouted field beans and minimum scored by T_1 (7.27±0.74) which had sprouted Bengal gram flour.

The nutritional composition was determined between T_0 (refined wheat flour) and T_2 (sprouted green gram flour), which were highly acceptable formulated samples (Table 3).

Table 3. Nutrition composition of cupcakes

Nutrients	T_0	T_2
Protein/100 g	8.21±0.08	10.25±0.18
Carbohydrates/100 g	48.61±0.46	46.18±0.18
Fat/100 g	8.83±0.16	7.6±0.10
Moisture/100 g	19.44±0.69	18.75±0.10
Ash/100 g	0.7±0.002	1.76±0.05

The average protein content in T_2 (10.25±0.18 g/100 g) was higher than T_0 (8.21±0.08 g/100 g). As sprouting increased the protein content in wheat (Islam *et al.*, 2019) especially amino acids like isoleucine, leucine and phenylalanine. In green gram also improved *in vitro* protein digestibility.

The average carbohydrate content in T_0 (48.61±0.46 g/100 g) was higher than T_2 (46.18±0.18 g/100 g). Soaking and sprouting decreased carbohydrate content in wheat (Zhu *et al.*, 2017) and in green gram as an increase in amylase and invertase enzyme activity.

The average fat content in T_0 (8.83±0.16 g/100 g) was higher than in T_2 (7.60±0.10 g/100 g). Sprouting decreased fat content in green gram but increased fatty acids content of which linoleic and linolenic fatty acids were found maximum, whereas sprouting had less effect on total fat content in wheat.

The average moisture in T_0 (19.44±0.69 g/100 g) was higher than T_2 (18.75±0.10 g/100 g) as sprouting caused a decrease in water holding capacity of wheat (Cardone *et al*,, 2020).

The average ash content in T_2 (1.76±0.05 g/100 g) was higher than T_0 (0.702 g/100 g) as sprouting increased total ash content due to an increase in minerals content in wheat and green gram.

The average total dietary fiber in T_2 (3.18±0.32 g/100 g) was higher than in T_0 (2.18±0.10 g/100 g). An increase in total dietary fiber due to the incorporation of raw banana flour and sprouting caused an increase in soluble dietary fiber in wheat (Cardone *et al.*, 2020) and green gram (Fig. 3).

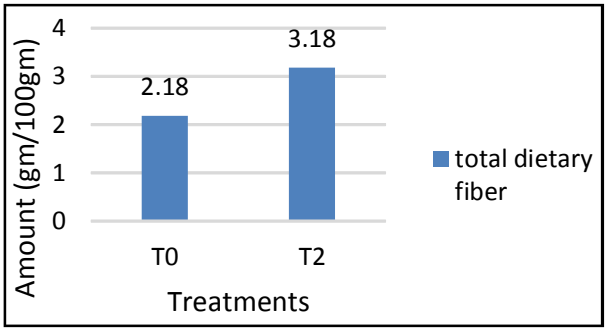

Fig. 3. Total dietary fiber content of cupcakes.

The average calorie value T_2 (294.16±1.90 Kcal/100 g) was lower than T_0 (306.84±2.01 Kcal/100 g; Fig. 4). Similar trends were presented by Jahan *et al.* (2021) using sprouted wheat and green gram based weaning food for infants.

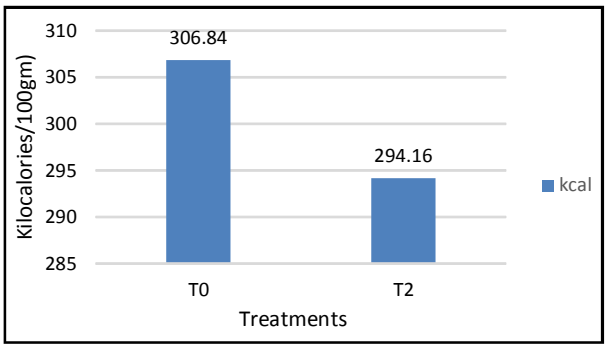

Fig. 4. Energy values of cupcakes.

The average total polyphenols content T_2 (133.27±2.75 GAE mg/100 g) was higher than T_0 (20.18±0.38 GAE mg/100 g; Fig. 5). It was due to sprouting in wheat and green gram. Baking had a negligible effect on the total polyphenol content of the cupcake (Alfeo *et al.*, 2020).

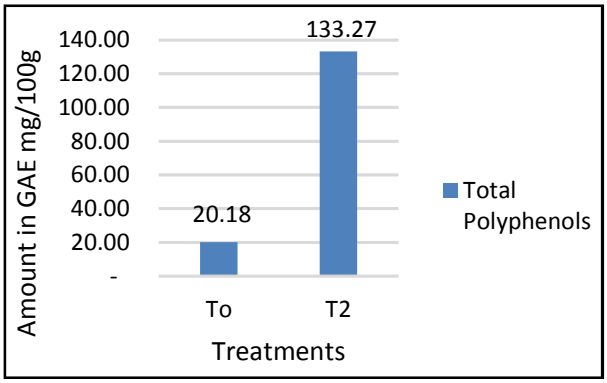

Fig. 5. Total polyphenol content of cupcakes.

The perusal of data (Fig. 6) showed that the cost for the developed cupcakes ranged from 10.37-10.55 in the experimental samples, and there was a slight difference in cost between T_1 (10.38), T_2 (10.55) and T_3 (10.37), whereas control T_0 (6.58) cost was the minimum. The cost per 100 g of each treatment of developed cupcakes ranged due to the nutrients it provided.

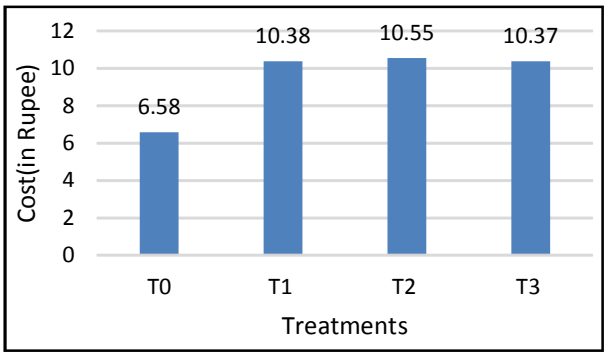

Fig. 6. Cost of cupcakes.

CONCLUSION

The developed nutritious cupcakes had acceptable sensory evaluation as well as containing higher levels of protein, total dietary fiber, ash and total polyphenol, whereas the content of carbohydrates, fat and energy decreased significantly due to sprouting. The test sample of cupcakes was an innovative nutritious product beneficial for malnourished people, all vulnerable age groups as well as our food industry. Thus, it can be concluded that cupcakes made with sprouted wheat, legume and unripe banana flour replacer have good potential to be used as an alternative to refined flour with benefit to society.

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