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Effects of groundnut (*Arachis hypogaea*) powder on quality attributes and consumer acceptance of pound cakes

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Abstract
The effects of groundnut (*Arachis hypogaea*) powder on the physicochemical and sensory attributes of pound cakes were investigated. Based on the red skin surrounding the kernel, two types of powders were partially substituted to wheat flour at three different levels (0%, 15% and 30%, w/w) with other ingredients at their constant levels. The proximate analysis showed that the addition of groundnut powder had increased the crude protein, crude fiber, and total fat contents significantly ($p < 0.05$) ranging from 9.625% to 11.025%, 0.273% to 0.9375%, and 7.57% to 13.463% respectively. The peroxide value had decreased from 15.45 mEq/kg to 11.23 mEq/kg showing good antioxidant properties and the probability of higher shelf life. The approximate yielded energy varied significantly ($p < 0.05$) ranged from 281.40 Kcal to 314.57 Kcal. There were significant differences ($p < 0.05$) in the sensory attributes (color, flavor, taste, and overall acceptability) of the formulated cakes excluding texture. The Duncan Multiple Range Test concluded that the groundnut kernel powder without the red skins can be substituted up to 30% to wheat flour in the formulation of pound cakes to achieve the best consumer acceptance.

Keywords: cake, groundnut, kernel, physicochemical analysis, sensory analysis

1. Introduction
Groundnut (*Arachis hypogaea*) also known as the peanut belongs to the botanical family Leguminosae and classified as both legume and grain. Groundnut kernels are developed inside pods under the ground. This year-round globally important crop tastes like almonds and walnuts [1]. According to World Agriculture Outlook Board (2019), world annual production of groundnuts for 2018/19 is projected at about 41.77 million metric tons which have been reduced by 7.04% than the last year. China belongs to the top of the production chain with 17 million metric tons followed by India and Nigeria with a total production of 4.70 million and 3.20 million metric tons respectively [2].

Groundnuts are considered as the most nutrient-dense nut. More than 30 essential nutrients, antioxidants, and energy supplementing constituents help them to provide energy, reduce oxidative stress, recover injuries and develop muscles [3, 4, 5]. Phenolic acids in groundnut skins have higher antioxidant capacity than most of the herbs and fruits [6]. Studies suggest that consuming 1.5 ounces of groundnuts per day could fulfill half of the daily protein requirements for most children and adults as well as reduce the risk of various cardiovascular diseases [7]. National Academy of Sciences claims that consuming groundnuts with their skins can double its antioxidant capacity.

Food scientist George Washington Carver has shown the possibility to develop about 300 products of groundnuts for human consumption including groundnut butter, bread, cookies, cakes, doughnuts, pies, and desserts, etc. [8]. Studies found that groundnut powder could be incorporated in recipes up to 35 percent level without affecting the acceptability of the product [9]. Thus, this study was intended to explore the possible substitution of groundnut powder with wheat flour in the development of a functional cake which would be a good source of nutrition and also be accepted by the consumers.

2. Materials and methods
2.1 Sources of materials
Local variety groundnuts were harvested from Chilmari [25° 26' – 25° 40' North longitude and 89° 36' – 89° 50' East longitude], Bangladesh and used within three months of harvest. Cake ingredients were obtained from the local grocery and confectionery shop, Dinajpur, Bangladesh. All the chemicals used for this study including $NaHCO_3$ (baking soda) were analysis-grade and obtained from Merck, Darmstadt, Germany.

2.2 Preparation of groundnuts
The bulk of harvested groundnut pods were treated with a series of different processing techniques (de-husking, soaking, blanching, drying, and roasting) for different times. The pods were visually inspected and any foreign materials found were removed. Then they were carefully de-husked so that the red skin remained intact with the kernels. To increase the milling quality and sensory properties the kernels were soaked in water for 24 hours under room condition. Next, they were blanched in boiling water for 10 minutes in order to inhibit chemical and enzymatic reactions and eliminate heat labile anti-nutritional factors. A cabinet tray dryer (Electrical Cashew Kernel Dryer, Alidhra Cashew Industries Pvt. Ltd., India) was used to dry the kernels at a uniform temperature of 55±5 °C with continuous air flow for 48 hours. The kernels were roasted in a frying pan for 5 minutes to promote further dehumidification. Dried kernels with less than 10 percent moisture content were divided into two categories. In the first category, the kernels were kept intact but the red skins were peeled off for the second

category. Both were ground separately using a heavy-duty grinder machine (Jaipan Family Mate 850W, Jaipan Industries Ltd., India) and then screened through a mesh (300 µm). The powder was packed in a high-density polyethylene bag and stored at the ambient condition for further use.

2.3 Process of cake manufacturing
Through a series of trial and error, coupled with continued informal sensory evaluation by the trained panelists, a modified manufacturing process was formulated that includes incorporation of different levels of groundnut powders (Table. 1).

First of all, a clean bowl and an electric beater (Electric Hand Mixer, HM-1053, Miyako, Indonesia) were taken. To begin with the dough formation process, the whole eggs were beat until a foamy texture was formed. After that sugar was finely ground and added to the continuous beating. Next, milk powder was first mixed with hot water and then added to the mix. After that, the rest of the ingredients e.g. butter, wheat flour, groundnut powder, salt, flavor, preservative and finally baking powder was serially added to the mix. The beating was continued until the dough had a sticky texture. Finally, the dough was transferred to a cake pan and then baked at 180°C for 30 minutes in a pre-heated oven.

2.4 Chemical attributes
Crude Protein, crude fat, crude fiber, moisture, and ash were determined by standard methods adopted by AACC [10] respectively as follows 46-10.01, 30-10.01, 32-10.01, 44-15.02 and 08-01.01. Total carbohydrate was determined by subtraction method suggested by Pearson (1976) [11]. Peroxide value was determined according to Baiano and Nobile (2005) [12].

2.5 Physical attributes
The color attributes (l, a, and b) values of the crust and crumb were measured using a color measurement spectrophotometer (CM-2500d, Konica Minolta, Japan). Firmness was measured with a penetrometer (Gy-4, Tsingtao Toky Instruments Co. Ltd., China). Specific volume was determined by the standard method 55-50.01 adopted by AACC [10].

2.6 Sensory attributes
Consumer acceptance test for the formulated cakes was performed at the manufacturing date by hedonic rating test described by Jones *et al*. (1955) with 9 points scale where 1 represents the minimum and 9 represents the maximum score [13]. Twenty-five (25) trained panelists evaluated each cake's sensory attributes including color, texture, flavor, and taste. Overall acceptance was calculated statistically based on the sensory scores to predict consumer acceptance.

2.7 Statistical analysis
All experimental data of the study were compiled using Microsoft Excel 2007 (Microsoft Corporation, Washington, USA). Each experiment was done in triplicates. Data related to chemical, physical and sensory attributes were analyzed by IBM® SPSS® Statistics 25 (IBM Corporation, New York, USA). The results were expressed as the mean ± standard deviation. Significant differences ($p < 0.05$) between the means were determined by Duncan's Multiple Range Test (DMRT).

3. Results and discussion
3.1 Chemical attributes of groundnut powder
Groundnut kernels are higher in protein and carbohydrate percentages but lower in crude fiber, crude fat, moisture and ash percentages than the whole groundnut powder (Table. 2). Comparing with previous studies the ranges found in the study were satisfactory [14, 15].

3.2 Chemical attributes of formulated cakes
With the addition of groundnut powder during the formulation of cakes the crude protein, crude fat, crude fiber, ash, and energy value were significantly increased where the carbohydrate, moisture, peroxide value, and pH decreased (Table. 3). Based on the food chart established by Briggs and Wahlqvist (1984), the crude protein and crude fat content were in the range but the crude fat, crude fiber, and carbohydrate content were lower than ideal [16]. Amino acids in groundnut kernels had increased the crude protein content but the skins hydrolyzed the peptide bonds using protease enzyme and slightly lowered the protein molecules. The skins showed a higher saturated fat content than kernels [3]. Groundnuts had consequently increased the insoluble dietary fibers of the cake samples including cellulose, hemicelluloses, and lignin [17]. Method for calculating the carbohydrate content was indirect and therefore the results contain significant differences ($p < 0.05$) [11]. Groundnut has a high amount of water absorption capacity (WAP) which was found to be about 3 liters/kg of groundnut protein [18]. Though the moisture content was consequently decreased, the cakes were found to be well moistened [16]. Lipid oxidation in cakes could be inhibited by the use of antioxidant activity [19]. Antioxidants in groundnuts, especially in the skins, lowered the peroxide value [3, 6]. Whole groundnut powder had higher acid content than the kernel powder. Addition of sodium bicarbonate as a leavening agent has carried the formulated cakes to acceptable pH ranges of 6.6 to 7.6 [20]. Approximate energy was calculated using the "Atwater Factor" [21]. Addition of groundnut powder has consequently increased the energy of the cake samples. Cake sample containing 30% whole groundnut powder shown to have the highest energy (314.573 Kcal). The data showed that the developed cakes have a better nutritional value and can be used to combat hunger energy malnutrition.

3.3 Physical attributes of the formulated cakes
The physical attributes including crust color, crumb color, firmness, and specific volume were instrumentally measured (Table. 4). The l, a, and b corresponds to lightness, redness, and yellowness respectively. The addition of groundnut powder had changed the crust color from lighter to darker and vice-versa for the crumb [22]. The color difference of more than 2 units in ΔE confirmed the visible changes in both crust and crumb color. Whole groundnut powder increased the firmness more than the kernel powder, while excessive powder caused reverse result [23]. On the contrary, no significant difference ($p < 0.05$) was observed on the volume of the formulated cakes.

3.4 Sensory attributes of the formulated cakes
The sensory attributes including color, texture, flavor, and taste were evaluated by twenty-five (25) trained panelists

(Table. 5). The non-enzymatic Maillard reaction between reducing sugar and protein have changed the color to a darker level which had led to lower acceptance [24]. There were no significant differences ($p < 0.05$) in the texture. Pattee *et al*. (2000) showed a positive correlation of sweet flavor with groundnuts but the skins have added a smoky flavor [25]. Mostin (2001) reported a bitter, metallic, unpleasant taste caused by groundnuts and its skins [26]. The overall acceptability concluded that the cake formulated with 30% groundnut kernel powder was superior among the formulated cakes that satisfy the finding Jain *et al*. (2014) [9].

Tables

Table 1: Composition of cake formulation

Ingredients*	Formulations				
	T_1	T_{2a}	T_{2b}	T_{3a}	T_{3b}
Wheat flour (g)	150	127.5	127.5	105	105
GKP (g)	0	22.5	0	45	0
WGP (g)	0	0	22.5	0	45
Whole eggs (Pieces)	2	2	2	2	2
Castor sugar (g)	120	120	120	120	120
Unsalted butter (g)	40	40	40	40	40
Milk powder (g)	25	25	25	25	25
Baking powder (TS)	4	4	4	4	4
Baking soda (g)	2	2	2	2	2
Salt (TS)	¼	¼	¼	¼	¼
Flavor (Drops)	10	10	10	10	10
Hot water (ml)	100	100	100	100	100

*GK: Groundnut kernel powder, WG: Whole groundnut powder, TS: Tablespoon.

Table 2: Chemical characteristics of groundnut powder

Parameters	GKP[1]	WGP[2]
Crude Protein (%)	24.47	23.50
Crude Fat (%)	44.38	46.88
Crude Fiber (%)	8.45	10.60
Carbohydrate (%)	23.42	20.58
Moisture (%)	5.12	5.43
Ash (%)	2.61	2.67

[1, 2] see legend to Table. 1 for details.

Table 3: Chemical characteristics of developed cakes

Parameters	Formulations				
	T_1	T_{2a}	T_{2b}	T_{3a}	T_{3b}
Crude Protein (%)	9.63	11.02	10.85	11.03	10.88
Crude Fat (%)	7.57	7.60	8.03	11.29	13.46
Crude Fiber (%)	0.28	0.43	0.82	0.51	0.94
Carbohydrate (%)	43.69	44.05	45.19	40.09	37.48
Moisture (%)	36.60	34.60	32.60	34.40	34.50
Ash (%)	2.24	2.297	2.511	2.686	2.748
Peroxide Value	15.45	13.99	13.51	11.82	11.23
pH	7.19	7.18	7.15	7.13	7.05
Energy (Kcal)	281.40	288.69	296.42	306.09	314.57

T_1, T_{2a}, T_{2b}, T_{3a} and T_{3b}: see legend to Table. 1 for details.

Table 4: Physical characteristics of developed cakes

Parameters		Formulations				
		T_1	T_{2a}	T_{2b}	T_{3a}	T_{3b}
Crust Color	l	39.13±.99	41.91±4.13	36.06±2.35	33.39±3.26	39.12±2.83
	a	14.94±1.13	13.71±1.12	13.25±0.63	13.64±0.84	14.73±0.59
	b	27.36±0.19	22.90±1.19	22.45±0.90	21.17±1.40	24.36±1.37
	ΔE	69.66±7.18	63.46±3.50	66.62±1.92	71.10±1.77	66.71±1.96
Crumb Color	l	61.81±1.83	56.05±3.92	50.02±4.39	56.58±1.18	55.39±1.16
	a	6.13±1.92	4.44±0.37	8.04±1.40	4.54±0.67	6.71±0.57
	b	37.32±4.88	28.82±1.24	27.93±1.44	27.85±1.42	25.36±0.24
	ΔE	53.30±4.08	45.83±2.28	47.03±1.12	47.88±3.44	44.38±0.92
Firmness (lb/min)		1.12±0.05	1.82±0.05	2.19±0.30	1.39±0.15	1.39±0.10
Sp. Volume (cm^3)		0.90	0.92	0.92	0.85	0.88

T_1, T_{2a}, T_{2b}, T_{3a} and T_{3b}: see legend to Table. 1 for details; Sp. Volume: Specific volume.

Table 5: Sensory score of formulated cakes

Parameters	Formulations				
	T_1	T_{2a}	T_{2b}	T_{3a}	T_{3b}
Color	7.64±0.50^{a}	7.40±0.40^{ab}	7.60±0.54^{c}	7.24±0.49^{b}	6.44±0.64^{c}
Texture	7.56±0.48^{a}	7.52±0.44^{a}	7.44±0.50^{a}	7.48±0.53^{a}	7.40±0.35^{a}
Flavor	6.64±0.50^{b}	7.44±0.51^{a}	6.64±0.49^{b}	7.36±0.51^{a}	6.32±0.48^{c}
Taste	6.56±0.44^{c}	7.20±0.47^{b}	6.32±0.48^{b}	7.52±0.65^{a}	6.36±0.49^{c}
Overall acceptability	7.10±0.70^{b}	7.39±0.53^{a}	6.75±0.64^{c}	7.40±0.49^{a}	6.36±0.66^{c}

T_1, T_{2a}, T_{2b}, T_{3a} and T_{3b}: see legend to Table 1 for details.

4. Conclusions

The present study concluded that substitution of groundnut powder into wheat flour up to 30% significantly improve the nutritional quality of the developed cakes. The sensory evaluation test recommended not to incorporate the red skin in cake development although it contains higher fat content and antioxidant properties. This simple preparation technique is suitable for both home and commercial enterprises and posses the ability to compete with other functional cakes available in the market.

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6. References

1. Bilello S. 21st Century Homestead: Nitrogen-Fixing Crops. LULU Press, North Carolina, USA, 2016.
2. World Agriculture Outlook Board. World Agricultural Supply and Demand Estimates (WAP 4-19). United States Department of Agriculture, Foreign Agriculture Service, USA, 2019.
3. King JC, Blumberg J, Ingwersen L, Jenab M, Tucker KL. Tree nuts and peanuts as components of a healthy diet. The Journal of Nutrition. 2008; 138(9):1736S-1740S.
4. Chen S, Kim W, Henning SM, Carpenter CL, Li Z. Arginine and antioxidant supplement on performance in elderly male cyclists: a randomized controlled trial. Journal of the International Society of Sports Nutrition. 2010; 7(13):1-7.
5. Settaluri VS, Kandala CVK, Puppala N, Sundaram J. Peanuts and their nutritional aspects. Food and Nutrition Sciences. 2012; 3:1644-1650.
6. Gonzalez CA, Salas-Salvado J. The potential of nuts in the prevention of cancer. British Journal of Nutrition. 2006; 96(Suppl. 2):S87-94.
7. Ahuja JKC, Haytowitz D, Pehrsson PR, Roseland JM, Exler J, Khan M, *et al*. USDA national nutrient database for standard reference. Release 28. United Nation Department of Agriculture, USA, 2015.
8. Dhanesh TB, Kochhar A. peanut processing and it's potential food applications. international journal of science and research. 2015; 4(6):2701-2706.
9. Jain S, Bhati D, Saxena N. Incorporation of groundnut meal in selected products after removal of aflatoxin. Journal of Human Ecology. 2014; 48(2):341-346.
10. AACC. Approved Methods of Analysis, 11th Ed. American Association of Cereal Chemists. Minnesota, USA, 1999.
11. Pearson D. The chemical analysis of foods, 7th Ed. Longman Group Ltd., Essex, USA, 1976.
12. Baiano A, Nobile MAD. Shelf life extension of almond paste pastries. Journal of Food Engineering. 2005; 66(4):487-495.
13. Jones LV, Peryam DR, Thurstone LL. Development of a scale for measuring soldier's food preferences. Food Research. 1955; 20:512-520.
14. Ingale S, Shrivastava SK. Nutritional study of new variety of groundnut (*Arachis hypogaea* L.) JL-24 seeds. African Journal of Food Science. 2011; 5(8):490-498.
15. Fagbohun ED, Faleye OS. The nutritional mycoflora changes during storage of groundnut (*Arachis hypogea*). International Journal of Agronomy and Agricultural Research. 2012; 2(6):15-22.
16. Briggs ML, Wahlqvist DR. Food Facts. 2nd Ed. Penguin Books, Victoria, USA, 1984.
17. Bhat MA, Bhat A. Study on physico-chemical characteristics of pumpkin blended cake. Journal of Food Processing and Technology. 2013; 4(9):262-265.
18. Yu J, Ipek G. Peanut protein concentrates: production and functional properties as affected by processing. Food Chemistry. 2007; 103(1):121-129.
19. Juskiewicz J, Zdunczyk Z, Jurgonski A, Brzuzan L, Godycka-Klos I, Zary-Sikorska E. Extract of green tea leaves partially attenuates streptozotocin induced changes in antioxidant status and gastrointestinal functioning in rats. Nutrition Research. 2008; 28(5):343-349.
20. FDA. Foodborne pathogenic microorganisms and natural toxins handbook: the "bad Bug Book". Food and Drug Administration, Centre for Food Safety and Applied Nutrition, USA, 2001.
21. Merrill AL, Watt BK. Energy value of foods: basis and derivation. Agriculture Handbook 74. US Department of Agriculture, Agricultural Research Service, Washington, DC, USA, 1973.
22. Hafez AA. Physico-chemical and sensory properties of cakes supplemented with different concentration of marjoram. Australian Journal of Basic and Applied Sciences. 2012; 6(13):463-470.
23. Wotton JC, Howard NB, Martin JB, McOsker DE, Holme J. The role of emulsifiers in the incorporation of air into layer cake batter systems. Cereal Chemistry. 1967; 44:333-343.
24. Dhingra S, Jood S. Organoleptic and nutrition evaluation of wheat breads supplemented with soybean and barley flour. Journal of Food Chemistry. 2002; 77(4):479-488.
25. Pattee HE, Isleib TG, Giesbrecht FG, McFeeters RF. Relationships of sweet, bitter, and roasted peanut

sensory attributes with carbohydrate components in peanuts. Journal of Agricultural and Food Chemistry. 2000; 48(3):757-763.
26. Mostin M. Taste disturbances after pine nut ingestion. European Journal of Emergency Medicine. 2001; 8(1):76.