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Development of Low Fat Multigrain Murukku - A Traditional Savoury Product

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ABSTRACT

Murukku, a traditional savory product was identified as they are low in protein and mineral contents. It is also a deep fat fried product as a result of which its fat content is significantly high. So, Murukku was prepared using both the conventional deep fat frying and oven baking for control and variable products. Variable samples were prepared by incorporating Bengal gram, Black gram and Green gram flours. It was observed that the control and variable Murukku samples (deep fat fried and oven baked ones) fat content varied with baking and the oil uptake was reduced by 46.4% and 40.23% and protein content of Murukku was almost doubled with the addition of bengal gram, green gram and black gram flour at 8% each incorporation respectively. Control samples of deep fat fried and oven baked had low protein content 6.39% and 8.64% respectively when compared to variable samples of deep fat fried and oven baked are 9.83% and 14.54% respectively. Mineral content profile (%basis) was also observed to be more in variable samples. There was an increase in anti-oxidant activity in the variable samples.

Keywords: Murukku, Oil uptake, Oven baked, Protein content, Mineral content profile.

INTRODUCTION

People nowadays love to consume snack foods because of the light and quick meal that can be consumed anywhere and anytime compared to the main meal. Besides, by living in a very hectic lifestyle also lead many people to consume snack foods in a way to prevent them from hunger. (Albayrak et al., 2010) studied the traditional foods and assessed interaction between local and global foods in Turkey. Traditional foods play an important role in local identity, consumer behavior, the transfer of cultural heritage for future generations, and the interaction of this heritage with the rest of the world. In many countries, the promotion and protection of traditional food is directed through quality, agricultural and special policies. Traditional foods are protected by registering them in accordance with relevant laws. 'Murukku' is one of Indian traditional savory snack produced from rice flour with combination of chickpea flour or black gram flour, natural flavorings and spices. It is being prepared in spiral, coil or ribbon form. The combination of these ingredients gives a characteristic of odor that originates from the roasted chickpea flour and the spices. Since it is from Indian origin, so it has a strong spicy flavor. Other than India, it is also popular in Malaysia and Fiji. As because it is having a spicy taste and flavor, all people cannot accept it. So, the formulation has been modified several times with the incorporation of various chicken and fish extracts and flavors but not in large scale. And it was observed to be acceptable in certain class of people. The most widely consumed extruded snacks are made primarily with cereals or grains due to their good expansion

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characteristics; however, they tend to be low in protein and many other nutrients**.** Since fish and chicken has been claimed as the high protein sources, so, the addition of these ingredients will increase the protein content of murukku (Meng et al., 2010).

Foods fried in degraded oil are typically of low quality with off- flavor taste. Hence, the consumption of foods prepared with overused fats is a self-limiting process. Therefore, dietary hazards due to over consumption of fats are the major problems to be addressed in deep fat fried foods. Cardiovascular diseases, obesity and diabetes are all health complications associated with dietary fat intake. The National Heart, Lung and Blood Institute (NHLBI) recommend that caloric intake from all fat sources to be limited to 30% of total caloric intake (Perkins and Erikson, 1996). Hence the importance of understanding the fat uptake in deep fat fried products. In spite of all the health concerns associated with dietary fat, fried products remain popular till now. This is due to the distinctive textural and quality attributes that is imparted by deep fat frying. Hence, more emphasis is given on finding ways to reduce oil uptake during frying. Alternative cooking methods that will produce similar textural and sensory characteristics are being explored. Oven baking is often suggested as an alternative in finish-cooking of fried products.

Objectives of our study were to enhance the shelf life by modification of the traditional recipe by incorporating nutrient rich ingredients and by enhancing the micronutrients; to optimize the parameters during the development of snack product; to replace the traditional practice of deep fat frying with baking.

MATERIALS AND METHODS

All the raw materials including cereal flours, sugar, milk, refined oil were procured from local market. Rice (*Oryza sativa*) flour, Bengal gram (*Cicerari etinum*), Green gram (*Phaseolus mungo var. radiates*), Black gram (*Vigna mungo L.*), Soya flour *(Glycine max)*, Finger millet (*Eleucine coracana*) were mainly used for variable sample. All the chemicals used in the study were of analytical grade and mostly from S. D. Fine Chemicals Ltd., Mumbai.

Murukku Processing

Sample preparation: Rice flour (80 g) was taken for control sample and for variable sample rice flour, bengal gram flour, green gram flour, black gram flour were taken in the ratio of 57g: 8g: 8g: 8g respectively. Butter, salt, chili powder, and flavorings were added in the ratio of 10g: 2g: 5g: 2g respectively to the batter. The batter was then mixed with warm water till it formed a dough and then it was kneaded and was kept for 15 min for conditioning. Dough was then extruded to form a product with desirable shape as that of popular murukku.

For Deep Fat Frying (DFF), refined oil was pre-heated upto 180°C. Then the murukku was deep fat fried for 2 to 3 min depending on thickness of the samples. The products were removed from the pan with the help of a strainer, and were allowed to cool. Packing was done in a polyethylene or in an aluminum foil or in metalized polyester pouches. The package was then kept for storage studies at room temperature. In case of baking, the oven was pre-heated to 240°C. The extruded murukku were kept inside the oven for 20 to 25 min, depending on thickness of the product. After baking they were removed from the oven and cooled. Packaging was done in the polyethylene or in an aluminum foil or in metalized polyester pouches. The package was then kept for storage studies at room temperature. The standardised samples were prepared in bulk and kept for storage studies at monthly intervals. The process parameters are mentioned below in the table no. I

Table I. *Optimized process parameters*

Process Parameters	Values
Initial temperature of oil	180°C
Final temperature	160°C
Time taken for frying	2-3 min
Resting period of dough	15mins

Analysis of Samples

Preliminary studies were performed for the purpose of identifying the appropriate proportions of ingredients, sample thickness and baking temperature. Analysis was carried out for proximate composition, total sugars and mineral content (calcium, phosphorus and iron) of the samples. Antioxidant activity determination, ERH determination, texture analysis, color measurement, and sensory analysis were also performed.

Fat content estimation was carried out as per the method given by AOAC, 2000. Fat was extracted from an oven dried sample using a Soxhlet extraction apparatus. Protein content was estimated by the Kjeldahl method given by AOAC, 2000 which is based on the determination of the amount of reduce nitrogen present in the sample. Total sugar content was estimated by AOAC, 2000 and mineral content (calcium, phosphorus and iron) are the minerals estimated in dried products using standard methods (Ranganna, 1986). For antioxidant activity determination, ABTS assay method (Khantaphant and Benjakul, 2008) was adopted. Equilibrium relative humidity was performed using the Ranganna, 1986 method for storage studies. Texture measurement analysis was carried out by using Brookfield texture analyzer. Color measurement was performed by using Hunter LAB color measurement system. Samples were served to 7 trained panelists and requested for sensory evaluation using 9 point hedonic scale (Amerine et al. 1965). Sensory attributes such as color, texture, crispiness, taste and flavor were assessed and average values were taken for these prepared products.

RESULTS

In the present study, efforts were made to standardize the process for the preparation of Murukku. The pre-determined thickness had given good texture and sensory attributes and the product got uniformly cooked. The resting period of dough was maintained for 15 mins to smoothen the dough and for air incorporation into it. There were four sample types - a) deep fat fried control, b) baked, c) deep fat fried multigrain and d) baked multigrain. The results are shown in table no. II and III.

Table II. *Proximate analysis, Mineral content, Antioxidant activity and Color analysis of Control murukku samples*

Items → **Properties**	**Deep fat fried Control murukku**				**Baked murukku**			
Days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
% Fat	28.92 ± 0.03	28.85 ± 0.02	28.81 ± 0.03	28.74 ± 0.01	15.51 ± 0.02	15.47 ± 0.03	15.42 ± 0.04	15.38 ± 0.01
% Protein	6.39 ± 0.03	6.38 ± 0.01	6.34 ± 0.03	6.29 ± 0.04	8.64 ± 0.01	8.6 ± 0.01	8.57 ± 0.03	8.52 ± 0.01
% Crude fibre	2.47 ± 0.02	2.41 ± 0.02	2.39 ± 0.01	2.35 ± 0.02	3.62 ± 0.01	3.55 ± 0.02	3.5 ± 0.02	3.46 ± 0.02
%Carbohydrates (by difference)	59.41 ± 0.02	59.62 ± 0.01	59.82 ± 0.02	60.08 ± 0.01	68.77 ± 0.04	68.99 ± 0.02	69.2 ± 0.01	69.44 ± 0.02
Calcium (mg/ 100g)	285.01 ± 0.01	278.02 ± 0.01	271. 01 ± 0.02	268.01 ± 0.01	298.01 ± 0.02	293.01 ± 0.03	289.03 ± 0.01	281.1 ± 0.01
Phosphorus (mg/ 100g)	56.03 ± 0.02	51.1 ± 0.01	47.01 ± 0.01	41.07 ± 0.01	71.05 ± 0.02	67.02 ± 0.01	62.01 ± 0.01	55.04 ± 0.01

Iron (mg/ 100g)	1.45 ± 0.02	1.41 ± 0.01	1.36 ± 0.01	1.31 ± 0.01	1.57 ± 0.01	1.53 ± 0.02	1.47 ± 0.01	1.42 ± 0.01
Antioxidant activity by ABTS (%)	31.71 ± 0.12	31.34 ± 0.09	30.78 ± 0.1	28.92 ± 0.07	36.85 ± 0.07	36.13 ± 0.4	35.79 ± 0.02	34.96 ± 0.03
L*	63.73 ± 0.01	66.61 ± 0.01	63.9 ± 0.02	63.87 ± 0.01	62.33 ± 0.01	62.78 ± 0.01	61.86 ± 0.01	60.19 ± 0.03
a*	5.3 ± 0.02	4.94 ± 0.01	4.51 ± 0.01	4.51 ± 0.02	9.23 ± 0.01	8.9 ± 0.01	8.9 ± 0.01	9.3 ± 0.02
b*	21.48 ± 0.01	21.29 ± 0.02	20.13 ± 0.02	20.57 ± 0.02	22.29 ± 0.03	22.42 ± 0.05	22.13 ± 0.01	21.49 ± 0.03

**The values mentioned above are Mean ± Standard Deviation*

Table III. *Proximate analysis, Mineral content, Antioxidant activity and Color analysis of Multigrain murukku samples*

Items → **Properties**	**Deep fat fried multigrain murukku**				**Baked multigrain murukku**			
Days	0 days	30 days	60 days	90 days	0 days	30 days	60 days	90 days
% Fat	28.81 ± 0.01	28.78 ± 0.02	28.71 ± 0.02	28.68 ± 0.03	17.22 ± 0.01	17.2 ± 0.01	17.17 ± 0.03	17.13 ± 0.01
% Protein	9.83 ± 0.03	9.81 ± 0.01	9.78 ± 0.01	9.74 ± 0.01	14.54 ± 0.02	14.5 ± 0.02	14.36 ± 0.03	14.33 ± 0.01
% Crude fibre	4.25 ± 0.02	4.18 ± 0.01	4.11 ± 0.03	4.09 ± 0.02	5.21 ± 0.01	5.16 ± 0.01	5.07 ± 0.02	5.01 ± 0.01
%Carbohydrates (by difference)	52.84 ± 0.02	53.04 ± 0.02	53.29 ± 0.01	53.49 ± 0.01	57.51 ± 0.01	57.73 ± 0.01	58.09 ± 0.01	58.3 ± 0.01
Calcium (mg/ 100g)	342.02 ± 0.01	336.04 ± 0.01	330.02 ± 0.01	322.02 ± 0.01	371.04 ± 0.01	367.02 ± 0.02	360.06 ± 0.01	352.01 ± 0.01
Phosphorus (mg/ 100g)	1.93 ± 0.01	1.86 ± 0.04	1.79 ± 0.01	1.73 ± 0.01	2.1 ± 0.01	1.97 ± 0.01	1.89 ± 0.01	1.85 ± 0.01
Iron (mg/ 100g)	158.01 ± 0.04	153.02 ± 0.04	148.01 ± 0.02	145.03 ± 0.04	164.01 ± 0.01	160.01 ± 0.03	156.02 ± 0.03	151.01 ± 0.03
Antioxidant activity by ABTS (%)	42.57 ± 0.08	41.87 ± 0.05	40.05 ± 0.03	38.57 ± 0.03	43.82 ± 0.07	43.26 ± 0.05	41.64 ± 0.04	40.17 ± 0.04
L*	67.48 ± 0.02	67.7 ± 0.02	66.69 ± 0.04	66.57 ± 0.02	63.63 ± 0.03	65.28 ± 0.05	61.99 ± 0.03	62.15 ± 0.02
a*	6.54 ± 0.01	6.29 ± 0.02	6.03 ± 0.02	5.99 ± 0.02	9.62 ± 0.02	9.34 ± 0.03	9.96 ± 0.02	9.73 ± 0.03
b*	23.55 ± 0.01	23.38 ± 0.01	22.56 ± 0.04	22.71 ± 0.02	21.71 ± 0.03	22.8 ± 0.03	20.94 ± 0.01	21.31 ± 0.04

**The values mentioned above are Mean ± Standard Deviation*

Fat Content

The baked multigrain murukku (17.22%) and baked murukku (15.51%) were having low fat content when compared with deep fat fried control samples (28.92%) and deep fat fried multigrain samples (28.81%). There was almost 53% reduction of oil content in the baked samples and 59% reduction in baked multigrain samples as compared to the deep fat fried samples. As per health point of view, fat should not be more than 15% of the total diet. Hence, the baked products can be recommended for all the age groups. Baked multigrain murukku are advised for normal population as well as people suffering from cardiovascular diseases.

Protein Content

Control samples were having low protein content (6.39% for deep fat fried samples and 8.64% for baked samples) when compared to baked multigrain murukku (14.54%) and deep fat fried multigrain

murukku (9.83%). Protein content was almost doubled with change in the main formulation (with the addition of Bengal gram, green gram, black gram flour at 8%, 8%, 8% each incorporation). An adult requires on an average 100 g protein and growing children require slightly higher quantities. Products with 12% protein are considered to be optimal for human consumption. As multigrain murukku samples had high protein content (10%-14.5%) as compared to the traditional murukku sample (6%-9%), multigrain samples were preferred over control samples. Among the two multigrain murukku products, baked products have high protein content of 14.54% over the deep fat fried products. The deep fat fried product has 28.92% fat, which is not ideal for human consumption as per the latest ICMR guidelines.

Crude Fibre Content

Crude fibre content for baked multigrain murukku was higher by 5.21% as compared to the rest of samples. Deep fat fried control product had 2.47%, baked sample had 4.25% and deep fat fried multigrain product had 2.67% as shown in table no. II and III. The variation in the crude fibre content was due to the variation in oil uptake in the case of deep fat fried products as well as due to the incorporation of variety of flour. Crude fibre is known to prevent a number of diseases such as diabetes, cancer etc. Baked multigrain murukku was recommended as it contained around 5% crude fibre.

Mineral Content

The nutritional characteristics of the murukku presented in the Table no. II and III give the comparison of properties of these murukku in two major products multigrain deep fat fried and baked samples. From the tables, it is clearly seen that multigrain murukku products are having higher mineral content as compared to control samples. This is mainly due to the incorporation of Bengal gram, black gram and green gram flours, which make them nutritionally enriched with protein, crude fibre and some micronutrients. Calcium, Iron and Phosphorous are of nutritional importance in the diets of population. Calcium content in deep fat fried control samples was 285.01 mg%, baked samples 298.01 mg% whereas deep fat fried multigrain samples had 342.02 mg% and baked multigrain samples had 371.04 mg%. This marginal increase is due to the incorporation of Bengal gram, green gram and black gram flours in the multigrain product samples. Iron content in deep fat fried multigrain sample was 1.93 mg% and baked multigrain product was 2.1 mg% whereas deep fat fried control samples had 1.45 mg% and baked samples had 1.57 mg%. In case of iron, multigrain products were having high iron content over the control products. Phosphorus content in deep fat fried multigrain samples was 158.01 mg% and baked multigrain product was 164.01 mg% whereas deep fat fried control had 56.03 mg% and baked had 71.05 mg%. Marginal increase in phosphorous content is due to the incorporation of variety of flours. These three minerals play an important role in the metabolism of humans and their requirement changes at different age groups.

Antioxidant Activity by ABTS Method

The antioxidant activity in the deep fat fried multigrain samples and baked multigrain samples were 43.82% and 42.57% respectively, compared to the deep fat fried control samples (31.71%) and baked murukku samples (36.85%), which were having low antioxidant activity as shown in Table no. II and III. This increase in anti-oxidant activity present in the multigrain samples may be attributed to the incorporated Bengal gram, black gram and green gram flours.

Color Analysis

The prepared murukku samples were analyzed for Color analysis L*, a*, b* values using Hunter color measurement system and the values are presented in Table no. II and III. The samples were kept for

storage studies and were assessed. Color values did not change significantly even for the storage period of 3 months.

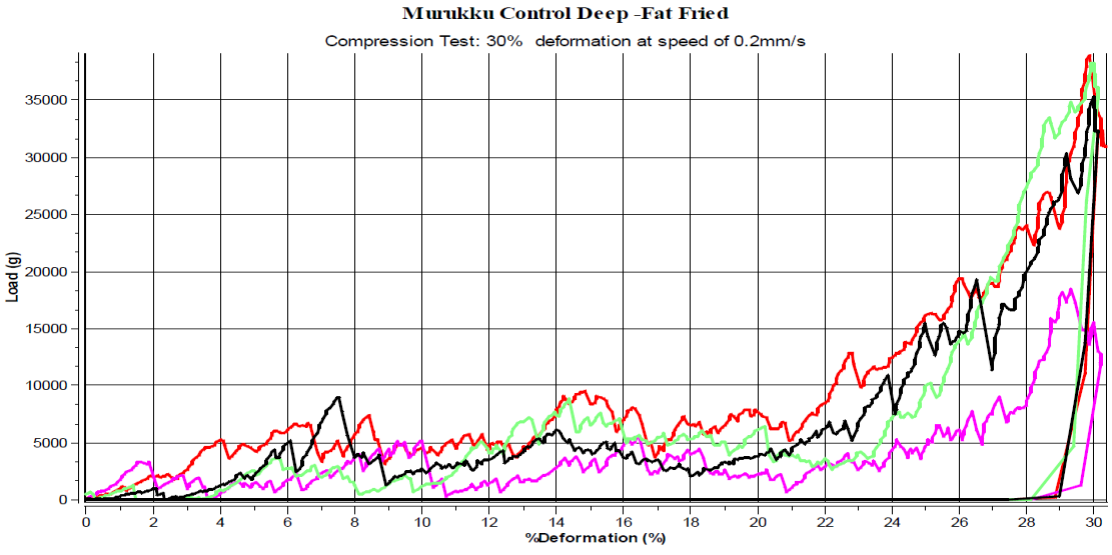
Texture Analysis: Comparison of the compression of control samples, variable deep fat fried samples and baked samples

The texture analysis of control samples and multigrain samples in deep fat fried and baked conditions were observed. The average peak load was found to be 27.270 Kg at 30% deformation in deep fat fried multigrain samples compared to the rest of the samples whose peak load was very high. Deep-fried snack and baked products are used in the experiments to determine 'crispy' and 'crunchy' attributes. For a product to be 'crispy' and 'crunchy' the texture should be, firm and brittle in physical term. The product has to fracture and disintegrate completely while biting and chewing. It is also clear that the sound emission during biting and mastication has a large effect on the sensory perception. The comparison of the compression of control samples, deep fat fried multigrain samples and baked multigrain samples are presented in the Table no. IV.

TableIV. *Texture Analysis: comparison of compression*

Parameters Items → ↓	**Hardness Cycle 1 (g)**	**Apparent Modulus 10^6xN/m²**	**Peak Stress N/m²**	**Strain at Peak Load**	**Fracturability (g) / Average Peak Load (kg)**
deep fat fried Murukku control	328.01 ± 0.01	6.72 ± 0.03	8931203.01 ± 0.01	0.3 ± 0.04	32.8 ± 0.01
baked Murukku	452.02 ± 0.01	4.81 ± 0.02	1774219 ± 0.01	0.25 ± 0.02	30.96 ± 0.03
deep fat fried multigrain Murukku	466.001 ± 0.02	7.56 ± 0.02	1270142 ± 0.01	0.3 ± 0.02	27.27 ± 0.01
baked multigrain Murukku	384.02 ± 0.01	1.19 ± 0.01	1045497 ± 0.02	0.3 ± 0.01	38.38 ± 0.01

**The values mentioned above are Mean ± Standard Deviation*



File *Data*

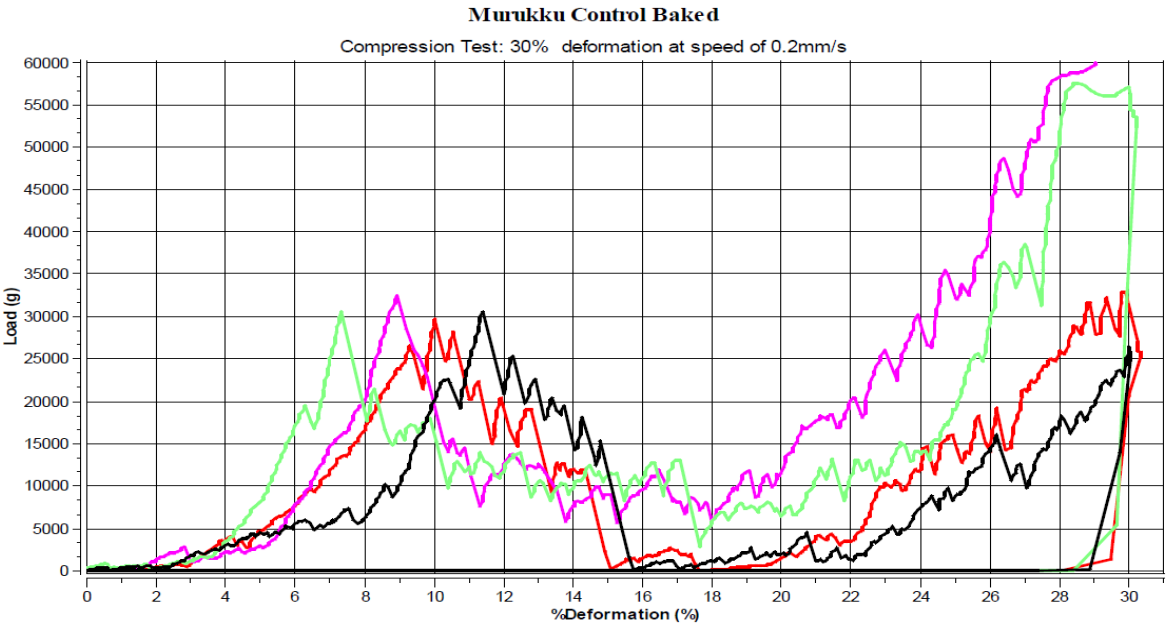
Data set #1:Murukku / control DFF / 1 Load (g)

Data set #2: Murukku / control DFF /2 Load (g)

Data set #3: Murukku / control DFF /3 Load (g)

Data set #4: Murukku / control DFF /4 Load (g)

Figure1. *Texture analysis of deep fat fried control murukku*



File *Data*

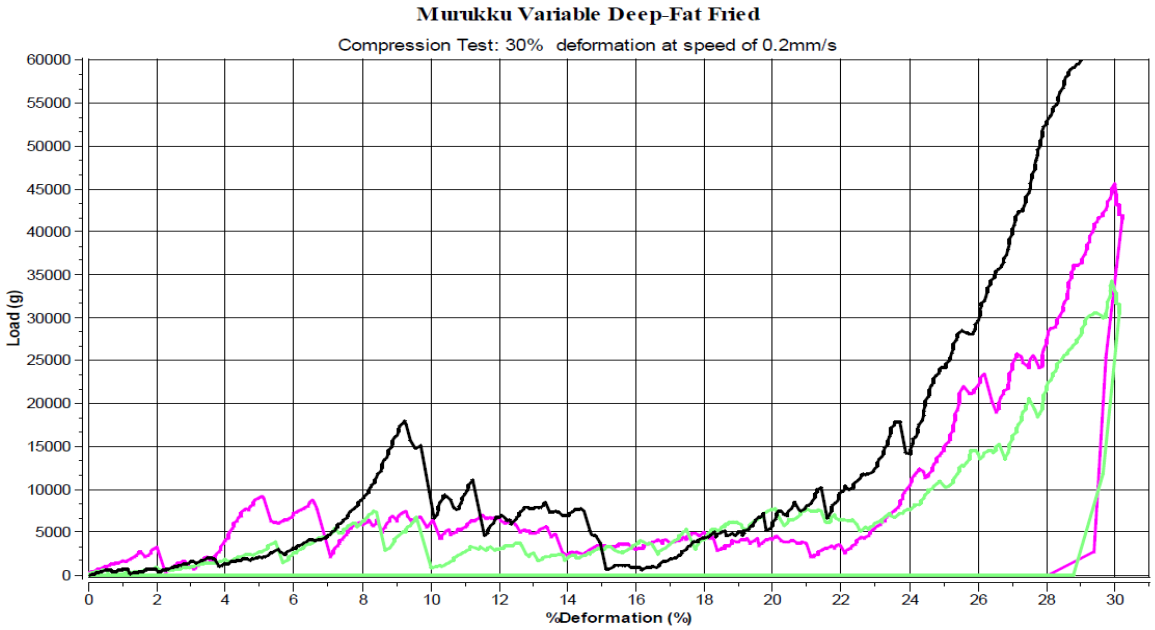
Data set #1:Murukku / control baked / 1 Load (g)

Data set #2: Murukku / control baked /2 Load (g)

Data set #3: Murukku / control baked /3 Load (g)

Data set #4: Murukku / control baked /4 Load (g)

Figure2. *Texture analysis of baked murukku*



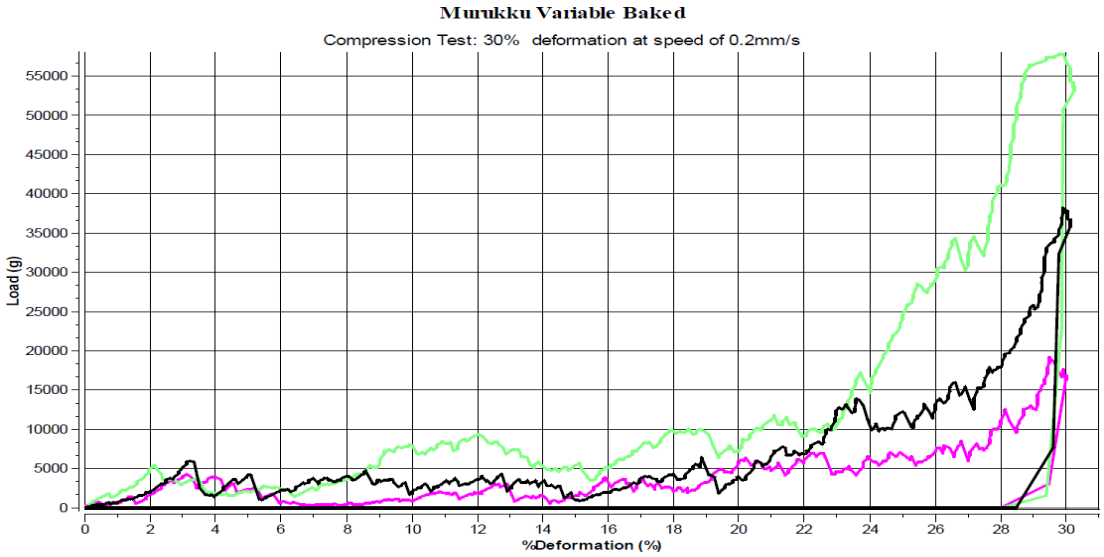
File *Data*

Data set #1:Murukku / variable DFF / 1 Load (g)

Data set #2: Murukku / variable DFF /2 Load (g)

Data set #3: Murukku / variable DFF /3 Load (g)

Figure3. *Texture analysis of deep fat fried multigrain (variable) murukku*



File *Data*

Data set #1:Murukku / variable baked / 1 Load (g)

Data set #2: Murukku / variable baked /2 Load (g)

Data set #3: Murukku / variable baked /3 Load (g)

Figure4. *Texture analysis of baked multigrain (variable) murukku*

Sensory Analysis

The sensory ratings were given as per the nine point hedonic ratings. The overall acceptability of the product was found very well even after 3 months storage period and all the parameter such as appearance, color, flavor, crispiness, taste, and texture were determined.

TableV. *Sensory Analysis*

Items	Texture	Crispiness	Taste	Flavor	Color	Overall acceptability
deep fat fried control murukku	8.01 ± 0.01	8.02 ± 0.03	8.01 ± 0.01	7.00 ± 0.01	8.01 ± 0.02	7.8 ± 0.01
baked murukku	6.01 ± 0.01	7.01 ± 0.01	8.00 ± 0.01	7.00 ± 0.01	8.01 ± 0.01	7.2 ± 0.02
deep fat fried multigrain murukku	8.01 ± 0.01	9.00 ± 0.01	8.00 ± 0.02	8.01 ± 0.01	9.00 ± 0.02	8.4 ± 0.01
baked multigrain murukku	7.01 ± 0.02	8.00 ± 0.02	7.01 ± 0.01	8.00 ± 0.01	8.01 ± 0.01	7.6 ± 0.01

**The values mentioned above are Mean ± Standard Deviation*

Experimental Sorption Isotherm of Control and Multigrain murukku

In all the murukku samples, the moisture gained rapidly above 70% relative humidity and hence murukku product was termed as non-hygroscopic. Lumps formation and fungal growth was observed at 90% relative humidity. Critical moisture content at 70% relative humidity was noted as 16.37% and danger point was absent even at 70% relative humidity. The results suggested that the products can be stored even in polyethylene pouches though metalized polyester and aluminium laminated pouches as they protect against light and oxygen and prevent moisture gain.

Storage Studies

All the four prepared murukku samples were prepared in bulk with optimized recipe and stored in 3 packaging materials namely polythylene pouches/ metalized polyester poches/ aluminum foil

laminates. All the parameters were studied at monthly intervals and there were no significant changes in all the four stored products. The values were presented in Tables II and III. Hence, the products can be recommended even after a storage period of three months.

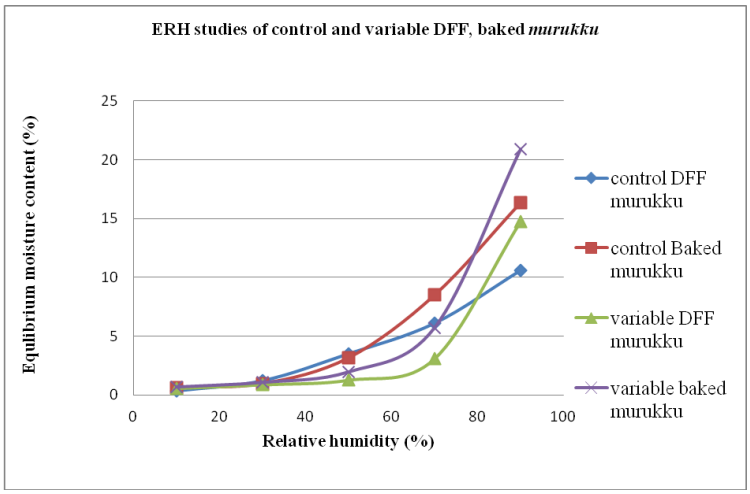


Figure5. *Experimental Sorption Isotherm Curves of Control and Multigrain (variable) Murukku*

DISCUSSION

From all the results, it was observed that modification of simple traditional recipes can be made by replacing or substituting simple raw materials, nutrients in the traditional products. Simple food processing operations such as deep fat frying can be replaced by baking, thus lowering fat content in the food products. From our study, the objectives of protein and mineral enrichment and reducing fat content was achieved. The extruded murukku snack is originally rice based savory product. Multigrain product samples were prepared by incorporating Bengal gram, black gram and green gram and these were nutritious as compared to control samples that were prepared. Baked multigrain product was having high nutritive values with high protein and mineral contents compared with deep fat fried control products. All murukku samples were non-hygroscopic and can be stored for 3 months without any quality deterioration.

(a) (b)

Figure6. *a) Deep fat fried control murukku b) Baked murukku*

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