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**Mayurakshi Kundu**  
M.Sc. Food & Nutrition Student,  
J.D. Birla Institute, 11 Lower  
Rawdon Street, Kolkata, India

**Dr. Adrija Sarkar**  
HOD & Assistant Professor,  
Dept. Of Science, J.D. Birla  
Institute, 11 Lower Rawdon  
Street, Kolkata, India

### Formulation of a low cost nutritious product to fulfil the macronutrient and micronutrient deficiencies of the economically challenged population

**Mayurakshi Kundu and Dr. Adrija Sarkar**

#### Abstract

Food habits of the economically challenged people were observed. They restrict themselves to cereal and pulses as they are cheaper options available for consumption. They have limited list of vegetables which they have in plenty. As fish, meat, milk and fruits are priced high, they often opt for egg. Thus, consumption of selective items and not a balanced diet made them highly prone to malnutrition and other deficiency disorders. Hence the aim was to plan a product for these people which would be cheap and at the same time nutritious. In order to execute the plan, a food product, "chikki" was made with nuts, puffed rice, rice flakes, jaggery, and roasted gram flour to make a product rich of micronutrients and also some macronutrients. The choice of the ingredients was based on its easy availability, price and nutrition. The product was quick to make and nourishing which served the purpose. The shelf life was studied and biochemical quantification was also examined.

**Keywords:** Malnutrition, chikki, macronutrient, deficiency

#### 1. Introduction

Chikki is a ready-to-eat Indian sweet generally made from groundnuts and jaggery. There are several different varieties of chikki in addition to the most common groundnut chikki. Each variety of chikki is named depending upon the ingredients used, which include puffed or roasted Bengal gram, sesame, puffed rice, beaten rice, or Khobara (desiccated coconut) [1]. Some chikkis are made using a combination of these ingredients. Special chikkis are made out of cashews, almonds, and pistachios. Though jaggery is the usual sweetener material, sugar is used as the base in certain types of chikkis. It is a very popular sweet item in both rural and urban South Asia (spanning India, Pakistan, Bangladesh, Nepal and Sri Lanka). Some also add glucose to the chikkis, which are usual there. It just started from a single flavor of jaggery and peanuts. But today there are many different exotic flavors available in the market [1]. The chikki in this project is made up of groundnut, jaggery, riceflakes, puffed rice, and roasted gram flour. These ingredients would reduce the cost of the product at the same time make this nutritionally beneficial as the aim is not to make the product energy rich only but also include other macronutrients and micronutrients. Mainly peanut chikkis are famous, where the main ingredients are sugar and peanut. Both these ingredients are very costly. Though the product is very energy rich but the sugar gives lots of empty calories. So low cost jaggery is used. As the main aim of developing the product is to provide enough of nutrients to cure deficiencies, groundnuts were chosen. They compose sufficient levels of mono-unsaturated fatty acids (MUFA), especially oleic acid. MUFA helps lower LDL or "bad cholesterol" and increases HDL or "good cholesterol" level in the blood [2, 3]. Riceflakes has PUFA (polyunsaturated fatty acid), MUFA (mono unsaturated fatty acid), transfat, carbohydrate and some amount of protein which is important for the labourers. Again puffed rice contains a few of the B vitamins, including thiamine, riboflavin, niacin and folate, but in small amounts. The cereal also contains small amounts of some minerals, including iron, magnesium, phosphorus and zinc. It is also high in potassium. Jaggery is rich in sodium, potassium even calcium and iron. Jaggery and roasted gram flour have good amount of calories too. It is used in little amount for binding [4]. All these nutrients make the product healthier. So chikki was made to fulfill the nutritional deficiencies in the diet of the labourers.

**Correspondence**  
**Mayurakshi Kundu**  
M.Sc. Food & Nutrition Student,  
J.D. Birla Institute, 11 Lower  
Rawdon Street, Kolkata, India

Thus the product was made and biochemical analysis was done of the basic product and several variations of this combination.

## 2. Materials and Methods

### 2.1 Selection of place

The college laboratory was selected to make the product and also for the sensory evaluation.

### 2.2 Selection of raw material

Raw material as nuts, riceflakes, puffed rice, jaggery, and roasted gram flour were bought from the local market. Only roasted gram flour was bought in packet form, the rest in open packets.

### 2.3 Method of making the chikki

For the chikki, nuts, riceflakes, puffed rice and roasted gram

flour was roasted separately. Measured amount of jaggery (50gms) was heated to 60-70 c. Then in the jaggery when it is melted and brown then put the roasted products and stir. Some roasted gram flour was used for binding. It was poured in a plate, and given shape of bar and cooled. When it was hard and cooled, sensory evaluation was done.

### 2.4 Selection of evaluators

The college students were made to do the sensory evaluation. They were all of same age group. (21-23). The subjects did not receive any professional training.

### 2.5 Data collection method

20 subjects were selected. Sensory evaluation was done by hedonic scale for the product. The basic product was rated and along with that the best variation was chosen.

**Table 1:** Amounts of ingredients used for basic and variation

Nutrient	Amount For basic (gm)	Variation 1 (gm)	Variation 2 (gm)	Variation 3 (gm)
Nuts	10	15	20	20
Riceflakes	7.5	11	15	19
Puffed Rice	7.5	11	15	19
Roasted gram flour	2.5	5	7.5	10
Jaggery	50	50	50	50

### 2.6 Cost calculation

The cost of the ingredients was calculated along with the finished products, the basic and the best variation.

**Table 2:** Price of the basic product

Ingredient	Amount (gm)	Price (Rs.)
Badam	10	1.5
Riceflakes	7.5	0.6
Puffed rice	7.5	1.1
Roasted gram flour	2.5	0.3
Jaggery	50	3
	Total	6.5

**Table 3:** Cost calculation of chikki

Type of cost	Percentage	Amount (Rs.)
Miscellaneous cost	10% of food cost	0.65
Cost of processing	15% of food cost	0.97
Cost of labour	20% of food cost	1.3
Overhead cost	15% of food cost	0.97
Profit	20% of food cost	1.3
	Total	11.69

Cost of 60gms of chikki is Rs. 11.69

**Table 4:** Price of variation 2

Ingredient	Amount (gm)	Price (Rs.)
Badam	20	3
Riceflakes	15	1.2
Puffed rice	15	2.2
Roasted gram flour	7.5	0.6
Jaggery	50	3
	Total	10

**Table 5:** Cost calculation of chikki

Type of cost	Percentage	Amount (Rs.)
Miscellaneous cost	10% of food cost	1
Cost of processing	15% of food cost	1.5
Cost of labour	20% of food cost	2
Overhead cost	15% of food cost	1.5
Profit	20% of food cost	2
	Total	18

Cost of 60gms of chikki is Rs. 18

### 2.7 Nutrient Quantification

Estimation of the micronutrient and macronutrients of the basic and best variation was done taking several amounts and aliquots.

Estimation of Protein- Protein estimation was carried out by Biuret Method. The optical density was recorded using spectrophotometer at 550nm<sup>[5]</sup>.

Estimation of Fat-was estimated using soxhlet method<sup>[5]</sup>.

Determination of carbohydrate was done by Anthrone Method. The absorbance was checked in spectrophotometer at 630nm<sup>[6]</sup>.

Determination of calcium was done by end point OCPC Method. The ortho cresolphthalein complexone combines with calcium at alkaline pH to form a purple colour complex, the absorbance of which is measured at 578nm<sup>[5]</sup>.

Determination of Iron was done by Ferrozine method. The Fe (II) ions react with Ferrozine to form a violet coloured complex. Intensity of the complex formed is directly proportional to the amount of Iron present in the sample<sup>[5]</sup>.

Sodium and Potassium both determined by flame photometry. When a solution containing cations of sodium and potassium is sprayed into flame, the solvent evaporates and ions are converted into atomic state. In the heat of the flame (temperature about 1800°C), small fraction of the atoms is excited. Relaxation of the excited atoms to the lower energy level is accompanied by emission of light (photons) with characteristic wavelength (Na: 589 nm, K: 766 nm). Intensity of the emitted light depends on the concentration of particular atoms in flame<sup>[5, 7]</sup>.

### 2.8 Shelf life study

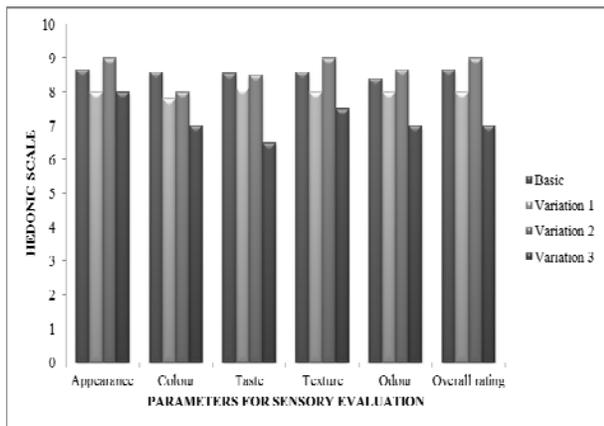
The samples were kept outside at room temperature for more than two months and the texture, colour, appearance, taste, odour did not change. This is because the moisture content of the product was extremely low. Ingredients which had high shelf life were chosen to make this product because the economically challenged people do not have refrigerators.

### 3. Results and Discussions

**Table 6:** Price comparison with the local market

Product	Market	Amount	Price (Rs.)
Basic- Peanut and sugar chikki	Loose in local market	60gms	15
Variation 1- Peanut and sugar chikki	Branded	60gms	20
Variation 2- Chikki with nuts, roasted gram flour, rice flakes, puffed rice, jaggery	Product made	60gms	11.69 (Homescale-Rs.6.5)
Variation 3- Chikki with double amount of nuts, roasted gram flour, rice flakes, puffed rice and keeping amount of jaggery same	Product made	60gms	18 (Homescale-Rs.10)

#### 3.1 Sensory evaluation



**Fig 1:** Sensory evaluation for the product

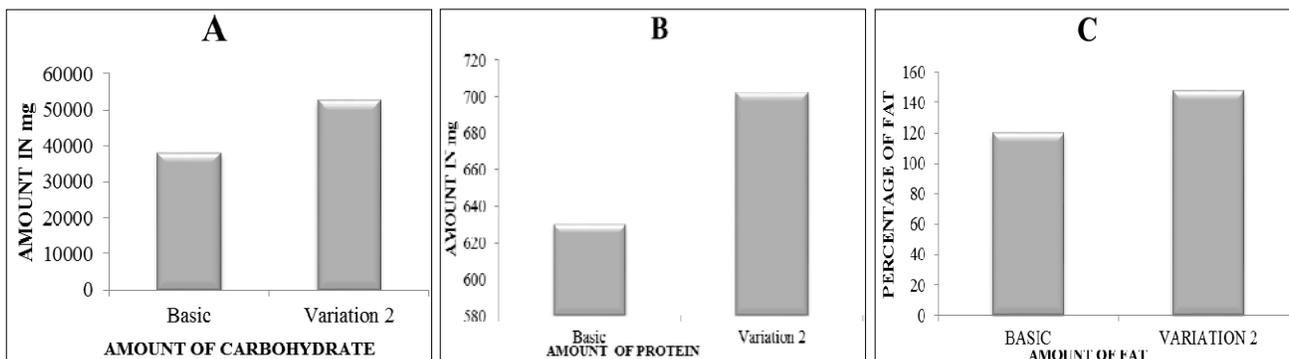
By doing the average of the results, it was seen the product’s overall rating was 8.65 and the best variation was chosen to be Variation 2 and its overall rating was 9 which means that the products were highly acceptable.

#### 3.2 Analysis of nutrients

1 serving was 60gms. So all the calculations were for the 60gm of the product.

Variation 2 was selected as the most liked product. In every case it was seen the variation 2 was a better product than basic. The carbohydrate content for basic was 38gms whereas for variation 2 it was 52gms. Similarly, the protein content for basic was 630mg whereas in variation 2 it was 702mg (as shown in the figure below) It was a major issue to increase the fat content of the labourers diet. So it was seen the basic recipe has 120mg of fat and variation 2 has 148mg of fat.

#### 3.3 Micronutrients



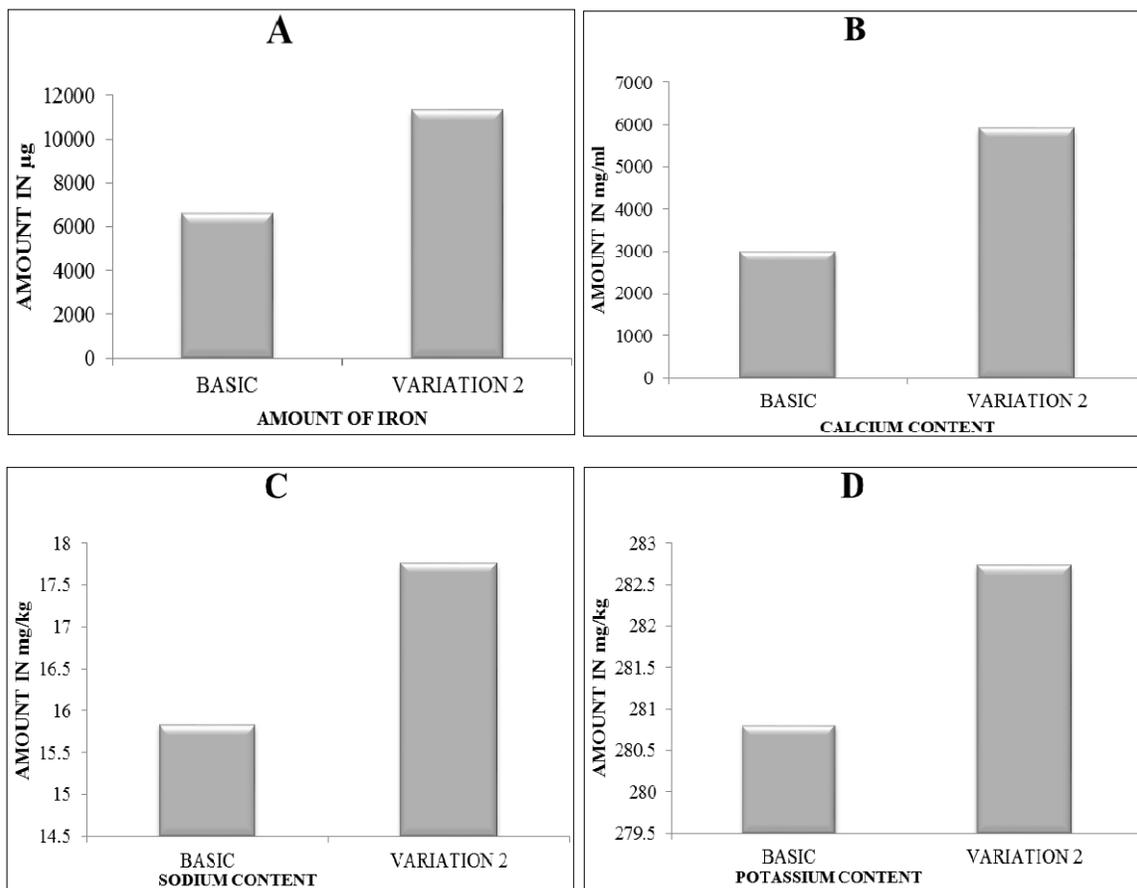
**Fig 2:** Amount of macronutrients. A. Amount of carbohydrate B. Amount of protein. C. Amount of fat

#### 3.4 Micronutrients

It was seen that the chikki has enough amount of iron. The basic recipe contains 6625.6µg of iron whereas in variation 2 it increased to 11340µg of iron. It was proved this product along with variation is extremely helpful for anaemia. The diet of the labourers lacked enough calcium as they could not afford much of milk and milk products. The basic recipe provided 3000mg/ml of calcium whereas the variation 2 provided 5920.8mg/ml of calcium.

As the labourers lost sodium in sweat while working, the product was made sodium rich. The basic recipe gave 15.84mg/kg sodium whereas the variation 2 gave 17.76mg/kg of sodium.

A lot of potassium was lost while sweating and the diet of the labourers also lacked potassium. So this product was made potassium rich. The basic has 280.8 mg/kg potassium whereas variation 2 has 282.72mg/kg potassium (as shown in the figure below)



**Fig 3:** Amount of micronutrients in product A. A. Iron content B. Calcium content C. Sodium content D. Potassium content

#### 4. Conclusion

It is seen from various surveys that food habit and quality of life lead to severe deficiency diseases like anaemia, scurvy etc. It is also seen that these people from low socio-economic background, lacked knowledge about importance of various foods and the ingredients present in them. With poverty their food quality is decreasing. They are concentrating more on energy and carbohydrate rich food as they are cheaper and give satiety. Majority of the population is consuming less protein, fat and almost all are deficient in vitamins and minerals. Because of this, many deficiency disorders are also taking place which is affecting the next generation as well. To reduce these problems, an initiative was taken to prepare a low cost nutritious food product, chikki, so that the diet can be rich in energy, fat, sodium, potassium, iron and also has vitamins as B complex vitamins which are beneficial for health. The product was extremely acceptable among the subjects and at the same time it was cheap than other varieties of chikkis available in the market. The temperature was checked at intervals during cooking to prevent high temperature nutritional losses. For confirming whether major nutrients were lost while cooking or not, biochemical analysis of the product were performed. Both the basic recipe and best variation proved to be a good source of macro and micronutrients. Thus the low cost product chikki was considered to be healthy yet affordable.

#### 5. Acknowledgement

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