Development of Value-Added Cookies Incorporated with Spirulina *Platensis* for The Mitigation of Malnutrition in Children

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ABSTRACT

Child malnutrition is more prevalent in India, manifesting as stunting and underweight problems in children. India is home to roughly one-third of the world's malnourished children. Malnutrition remains a major public health issue in the developing world. As a result, malnutrition is the most important risk factor for disease burden in developing countries. Long-term malnutrition causes "anemia," which affects the general population of developing countries, as well as many other diseases such as goiter, hypokalemia, tooth decay, and vitamin deficiency, which has existed for many years. Thousands of well-executed intervention programs could not even improve the situation a single time. This study focused on incorporating Spirulina as a dietary supplement into cookies to fortify the food product with enriching protein, calcium, iron, vitamin B12, and phosphorus to improve a child's foundation years. Spirulina is a blue-green algae with high nutritional value. In the same area, Spirulina produces 20 times more protein than soya, and Spirulina typically contains about 60 percent protein. It is high in vitamin B12, copper, and iron. Spirulina protein contains few calories.

The researcher added Spirulina in specific quantity to food product recipes of cookies, pasta and noodles. These were then assessed for their nutritive value under normal condition. The results indicated significantly increased values of protein, calcium, phosphorus and iron will not much change in the taste of the food products.

Keywords: *Spirulina, Malnutrition, Anemia, Hemoglobin, Iron*

INTRODUCTION

In recent years, this microscopic organism has attracted individuals and scientists from all over the world. Spirulina is used in a variety of industries, including agriculture, food, pharmaceuticals, perfumery, medicine, and science. It's also utilized as a food supplement and comes in tablet, capsule, and powder form, as well as being incorporated into a variety of foods like cakes, biscuits, noodles, and health beverages (Hayashi *et al*., 1996).Under the microscope, the microorganism known as "Spirulina" is categorised as cyanobacterium and has a spiral filament. Spirulina, or Arthrospira as it is presently known, is a blue-green alga with a long history. The spiral or helical structure of its filaments gives it its name (Belay, 2002).

Spirulina is a photosynthetic prokaryotic or eukaryotic microbe that uses light to generate carbohydrates, proteins, and lipids. Microalgae are cultivated for its polyunsaturated fatty acids, pigments, antioxidants, and therapeutically useful chemicals. *Spirulina platensis* is a plant that is used to treat malnutrition, particularly in children, all over the world. This blue-green cyanobacteria algae is grown in temperate seas all over the world and is regarded a functional food because of its high content of proteins, vitamins, minerals, healthy fatty acids, and other healing phytonutrients like various active plant colours. Because of its high protein content and nutritional value, a blue green microalga has been utilized as a food supplement since ancient times (Burtin P., 2003).Arthrospira (Spirulina), the richest sources of proteins is about 60-70%. Attempting a study on using Spirulina as a protein supplement, it was observed that it can be substituted up to 40% of protein content in diets (Rabelo SF, 2013).

Today's consumers prefer low-calorie, low-fat, and low-cholesterol ready-to-eat goods, i.e. healthy foods, and are aware of the link between diet and illness development. Considering the efforts made to reduce the incidence of diseases such as malnutrition, cancer, cardiovascular, and coronary heart disease, and to enhance health status, the development of food-rich recipes will play a significant role in ensuring consumer health. Cookies are particularly popular among baked goods, as they are viewed as delightful products with unique organoleptic features (Henrikson R. 1989). Cookies are prominent confectionary items because of their organoleptic qualities, adaptability, convenience, texture, and look. The use of natural components with functional qualities that go beyond basic nutrients is an appealing option to create new goods. Microalgal biomass is an important source of fine molecules such as carotenoid pigments, vitamins, proteins, fatty acids, and other physiologically active substances, which may have health advantages (Hoseini SM, 2013) .

Medical scientists are more interested in Spirulina as a nutraceutical and potential pharmaceutical source. Spirulina is a fantastic super food. In its normal state, it contains 65 to 71 percent complete protein. This is greater than in almost any other unprocessed food. Spirulina is a nutrient-dense superfood for optimal health. Superfoods are foods that have health-promoting and disease-preventing characteristics in addition to their nutritional worth. It is nature's most nutrient-dense concentrated whole food source. (Simpore *et al*., 2005).

Iron is essential for the physical and cognitive development of children and teenagers. Anemia is the world's most common nutritional deficiency illness. One-third of the world's population (nearly 2 billion people) is anaemic. Anemia is more prevalent in all age groups in India than in other developing countries.

According to research, iron supplementation improves haemoglobin levels and growth. Since iron supplementation programmes have had little reported success in alleviating anaemia, attention is shifting to food-based approaches that have a larger potential for far-reaching and long-term impact long-term benefits for iron deficient management. (Belay, 2002).

Food-based approaches aim to improve nutrition by increasing the availability and consumption of a nutritionally appropriate and micronutrient-rich diet composed of a variety of readily available foods. Food-based treatments are acknowledged as a vital component of a more comprehensive strategy to combat iron and other micronutrient deficiencies, which is desperately needed. Spirulina has a type of protein that may be beneficial for anaemia and other deficient illnesses (Desai and Sivakami, 2004).

METHODOLOGY

The study was carried out in four phase

1) Procurement of Spirulina: Pure Spirulina powder was procured purchased from a Food Company.

2) Development of value added food products: Most acceptable value added addition level of Spirulina powder i.e. 5% percent was incorporated in cookies

(A) To effectively develop the controlled sample of cookies,

(B) To effectively develop the Spirulina incorporated cookies

3) Organoleptic Evaluation: The develop value added cookies, wasstandardized using composite scoring evaluation with the help of experts. The develop value added product along with their control samples served to the experts for organoleptic evaluation.

4) Nutritional Evaluation: Prepared products were analyzed for moisture, protein, fat, fibre, ash, phosphorus, calcium, iron, alcoholic acidity, pH, peroxide content

Sample preparation- Four samples are taken for experimental in this study, for fortification of cookies.

Table 1: Sample Preparation

Treatment	Sample Ingredients	Ratio Ingredients
A	Flour with Spirulina powder	95 %+5%
B	Flour with Spirulina powder	90%+10%
C	Flour with Spirulina powder	85%+15%
D	Flour without Spirulina powder	100

Table 2: Cookies Preparation

Traditional Indian cookies (as control) were prepared using the following formulation:

Ingredients	Quantity (gm/kg)
Wheat Refined Flour	50 gm
Sugar	12.5gm
Shortening oil	13.75 gm
Baking Powder	1 gm
Baking soda	1 gm

The cookies were baked in an oven at 180°C for 15 min. After cooling, cookies were kept inside sealed cellophane packages (with low permeability to air, oils, greases, bacteria and water) at room temperature for 3 months.

Image2: Controlled Cookies

Image 3: Spirulina Cookies

ORGANOLEPTIC EVALUATION

Organoleptic evaluation of cookies was done by 5 trained panelists, after baking. In individual booths at room temperature, panelists used clean white plastic dishes to serve 40 gram of labeled samples at random on their palates. Cookies were rated in terms of flavour, odour, colour, texture uniformity, non-mouth texture, and mouth texture using a 9-point hedonic test* (9; like extremely and 1; dislike extremely). Finally, total acceptability was determined using the equation.

NUTRITIONAL PARAMETERS-

- ❖ Determination of moisture.
- ❖ Determination of fat.
- ❖ Determination of protein.
- ❖ Determination of total mineral.
- ❖ Determination of carbohydrate
- ❖ Determination of energy.

STATISTICAL ANALYSIS

The data from the 9-point hedonic scale were examined using average score and standard deviation, with the product with the highest average score and lowest standard deviation demonstrating the best acceptability. The chi-square test was used to assess the data. The test was carried out to demonstrate the considerable difference in the values of various nutritional content manufactured products.

Table 3: Results of the Fortified Products

S. No.	Test Parameter	Unit	Control biscuits	5% Spirulina fortified biscuits
1.	Moisture	%	2.76	2.52
2.	Proteins	%	4.50	20.33
3.	Fat	%	17.49	6.24
4	Carbohydrate	%	2.31	23.06
5	Energy	Kcal	554	670
4.	Fibre	%	0.68	1.17
5.	Ash	%	3.08	4.07
6.	Calcium	Mg/100 gm	214.25	288.97
7.	Phosphorus	Mg/100 gm	54.34	115.91
8.	Iron	Mg/100 gm	1.86	3.93
9.	Alcoholic acidity	%	0.23	0.31
10.	Ph	-	7.025	6.025
11.	Peroxide value	Meq/Kg	0.967	0.745

The above table shows the higher value of energy, protein, carbohydrate, fat, moisture and total mineral in experimental sample compare to control.

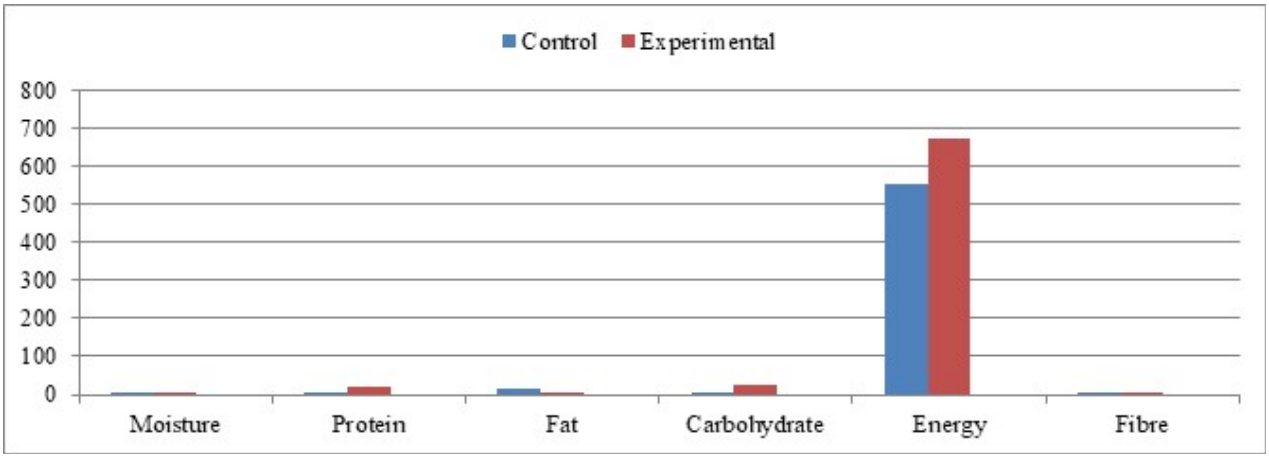
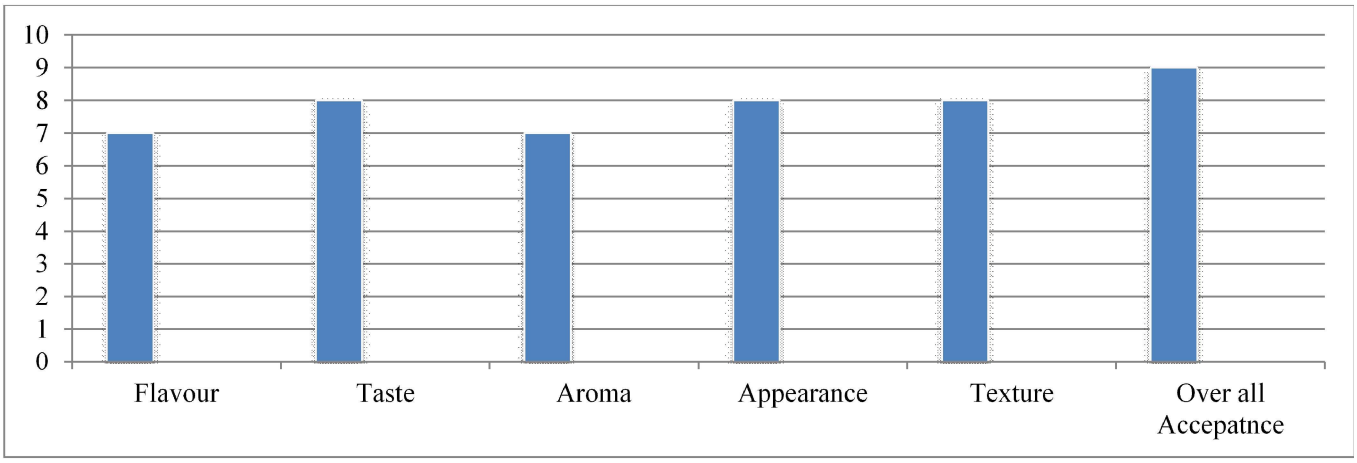


Fig 1: Fat, Protein Carbohydrate, Moisture Energy and Total minerals in control and Experimental product

GRAPH SHOWING SENSORY EVALUATION OF SPIRULINA ENRICHED BISCUITS THROUGH COMPOSITE SCORING:



RESULT AND DISCUSSION

Organoleptic Evaluation: Table 4 reveals that all the food samples were subjected to organoleptic evaluation by the experts and the results were noted. Spirulina fortified food products were falling into the liked, disliked or neither like nor dislike. Study reveals that the study of food products from a total of 50 human experts, who has judge the biscuits. The results are 65% liked

Table 4: Acceptability of Fortified Food Product

Study of Spirulina fortified food products	Fortified Biscuits	
	N%	
Liked	30	65%
Disliked	15	23%
Neither like nor dislike	5	12s%

Nutritional Analysis : Nutritional analysis was carefully evaluated by the researcher under normal conditions. Table 1 show that the nutritional content of fortified food items was significantly higher than that of control samples.

Shelf life study : The researcher assessed the shelf life of all products in the current study based on their organoleptic evaluation over a one-month storage period under normal conditions.

CONCLUSION

The current study found that Spirulina fortified food products prepared from Spirulina at 5% levels were accepted on organoleptic parameters, with the most acceptable products remaining within a satisfactory range during storage. The results show that developed food products are nutritious and have a much higher nutritional value than control samples. As a result, this valuable product has a high extrusion potential and a high acceptability on organoleptic parameters, and better-quality Spirulina fortified food products provide significant benefits to consumers.

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