Full Length Research Article

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Formulation of Nutri-Dense Energy Bar for Anaemic Adolescent Girls (18-22 Years)

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Abstract

Iron deficiency anemia is the most frequently acquired nutritional anemia and over 2 billion people i.e., nearly one third throughout the world have iron deficiency anemia. In India it is a major public health problem among preschoolers, adolescent girls, pregnant women and lactating mothers. The overall prevalence of anemia among adolescent girls is around 70 percent. One of the major causative factors for the prevalence of anemia is proved to be inadequate intake of all the essential nutrients especially iron. It is evident from varied research studies that one of the effective strategies in combating anemia could be through diet supplementation. *Spirulina (Arthrospira plantensis)* is a potent functional food for maintaining blood health. It can either be taken in the diet and allow the body to naturally absorb more iron than other food sources. Hence, the study was undertaken to find the effect of S*pirulina and* moringa incorporated energy bar in the improvement of the iron level in anemic adolescent girls (18- 22 years). This study focusses on the Formulation of Nutridense Energy Bar for Anemic Adolescent Girls (18-22 years). The study is undertaken with the following objectives – i) to assess the nutritional status of the adolescent girls ii) to formulate and standardize *Spirulina* incorporated moringa energy bar iii) to study the acceptability of *Spirulina* incorporated moringa energy bar.

***Key words*:** Adolescents, Nutritional anemia, *Arthrospira plantensis, Moringa oleifera,* Functional food

The term adolescence comes from the Latin word "adolescere", which means to grow maturity (Jaya and Rani, 2001). It is also means to emerge or achieve identity [1]. According to WHO (2003), an adolescence is any person between ages of 10 and 19 years. It is the development period during which a person is no longer a child, but not yet an adult. This is the phase of life when important changes occur in different dimensions of life such as physical, biological and emotional growth and maturity. Globally, iron deficiency anemia affects four to five billion people. In India it is a major public health problem among preschoolers, adolescent girls, pregnant women and lactating women. The overall prevalence of anemia among adolescent girls is around 70 percent [2].

Spirulina is the richest iron food, containing atleast 20 times more iron than any other food. *Spirulina's* iron is easily absorbed by the human body. The nutrients and phytonutrients make *Spirulina* a whole food alternative to isolated vitamin supplements [3]. In view of several merits of the *Spirulina* currently it has been called as "All-in-one" or "super nutrient" for humans [4]. *Spirulina* enhances the body's ability to generate new blood cells, macrophages, T-cells and natural killer cells [5]. *Spirulina* has reduced the ischemic brain damage and improved post stroke locomotor activity and also reduces degeneration of brain in the aged.

Moringa oleifera (*moringaceae*), also known as drumstick tree. Moringa can withstand both severe drought and mild frost conditions and hence widely cultivated across the world. With its high nutritive value, every part of the tree is suitable for either nutritional or commercial purposes [6]. *Moringa* is rich in phytosterols like stigmasterol, sitosterol and kampesterol which are precursors for hormones. These compounds increase the estrogen production, which in turn stimulates the proliferation of the mammary gland ducts to produce milk. It is used to treat malnutrition in children younger than 3 years [7].

MATERIALS AND METHOD

Procurement of raw materials

In the present study ingredients such as *Spirulina*, drumstick leaves, groundnuts, jaggery, almonds were selected to prepare the nutridense energy bar. The drumstick leaves were purchased from the local market of Madurai. Other ingredients such as groundnuts, jaggery, and almonds were purchased from nearby departmental store. *Spirulina* powder was bought from the Antenna Nutritech Foundation, Kondayampatti. The ingredients were cleaned and foreign particles were removed and stored in airtight containers.

Chemicals

The chemicals and reagents needed for the study were Analytical Grade reagent and Laboratory grade reagent for the biochemical analysis of the samples.

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Utensils

Stainless steel vessels, plates, spoons, bowl, trays, knives were used for preparing and serving the products was obtained from departmental laboratory.

Energy source

Electric current and Liquefied Petroleum Gas is used for heating purpose.

Equipment's

Equipment used for analysis is listed down in the (Table 1).

Table 1 Equipment's used for analysis and its purpose

Equipment	Purpose
Weighing balance	To weigh raw materials
Electrical balance	To weigh chemical reagents and samples for nutrient analysis
Mixer	For making moringa leaf into powder
Hot air oven	To estimate moisture content
Muffle furnace	To estimate Ash content and crude fibre content
Photoelectric colorimeter	To estimate Iron, Phosphorus, calcium
Kel plus apparatus	To estimate Protein content
SOCS Plus apparatus	To estimate fat content
Bomb calorimeter	To estimate energy content
Autoclave	To sterilize the apparatus
Laminar air flow chamber	To undergo microbial analysis

Method of preparation of peanut candy

The composition and preparation step of peanut candy is given below in the flow chart.

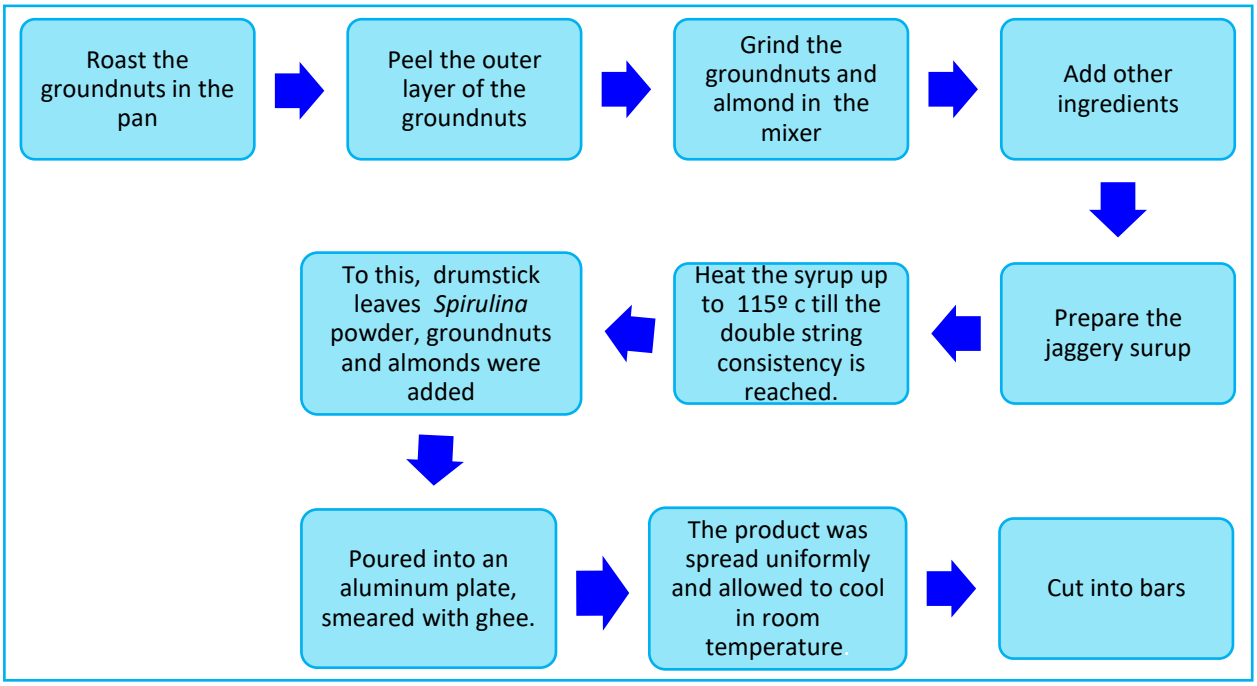

Fig 1 Formulation steps

Fig 2 Control

Fig 3 SMIPC

The proportion of ingredients used in the development of *spirulina* and moringa incorporated peanut candy is given in the (Table 2).

Table 2 Proportion of ingredients used in the development of *spirulina* and moringa incorporated peanut candy

Ingredients	Amount (g)
Ground nut	35
Almond	15
Jaggery	70
Spirulina powder	3
Moringa powder	3

RESULTS AND DISCUSSION

The data collected from the present investigation entitled Formulation of nutri dense energy bar for anemic adolescent girls has been presented below under the following heads.

- Acceptability of Energy bar
- Nutrient analysis of Energy bar

Acceptability of energy bar

The results of the acceptability trial are discussed below:

Acceptability energy bar

Peanut candy was prepared by incorporating *spirulina* and moringa in same proportion and the acceptability for each sensory attribute is discussed in (Table 3).

Table 3 Mean scores obtained for the overall acceptability of the formulated product

Sensory parameters	Control	Energy bar
Appearance	8	8
Colour	7.9	7.8
Flavour	7.8	7.8
Texture	7.7	7.7
Taste	7.8	7.7
Overall acceptability	8	8
Overall mean score	7.9	7.8

Among the energy bar, the overall acceptability scores for energy bar and control were 8 and 8 respectively. The overall mean score for energy bar and control were 7.8 and 7.9 respectively. The overall mean score obtained for energy bar and control is shown in (Fig 4).

The study entitled Formulation and supplementation of *Spirulina* incorporated chikki among the selected HIV infected children (Priya 2010) have developed chikki this is done by mixing Ground nut, jaggery. They have incorporated spirulina in different ratio and organoleptic evaluation was done to identify the preferred variation. The variation with equal proportion was mostly preferred while simulating the present study, *spirulina* and moringa with the proportion of 3g is more acceptable. Here, we have used moringa and spirulina. The proportion of 3g is more acceptable similar to that of control sample.

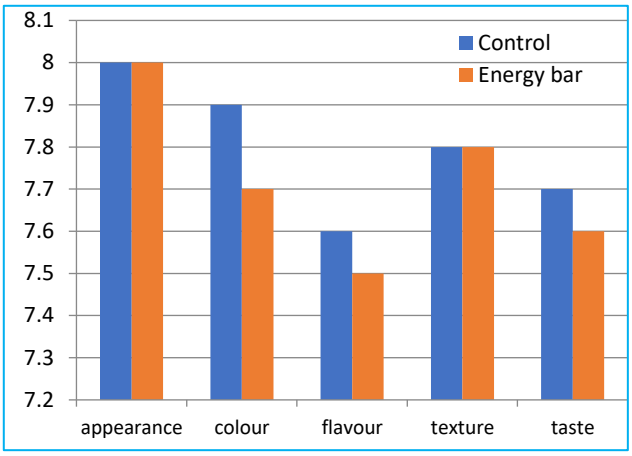

Fig 4 Overall mean score for energy bar and control

Nutrient content of energy bar

Data in (Table 4) depicts the energy, carbohydrate, protein, total fat, dietary fibre, calcium, iron and phosphorous content of energy bar.

Table 4 Nutrient content of energy bar

Nutrients	Control	Energy bar
Energy (kcal)	440	450
Carbohydrate (g)	56.43	57.9
Protein (g)	12.57	15.8
Total fat (g)	16.97	17.6
Dietary fibre (g)	1.35	4.5
Ash (g)	2.9	2.3
Iron (mg)	3.7	7
Calcium (mg)	84.4	90.4
Phosphorous (mg)	70	77.2

Energy content of energy bar incorporated peanut candy

The energy content of energy bar and the control products depicted in (Fig 5). (Fig 5) clearly shows that the Energy content of energy bar is 450 Kcal and that of control is 440Kcal. The energy content is slightly increase in energy bar.

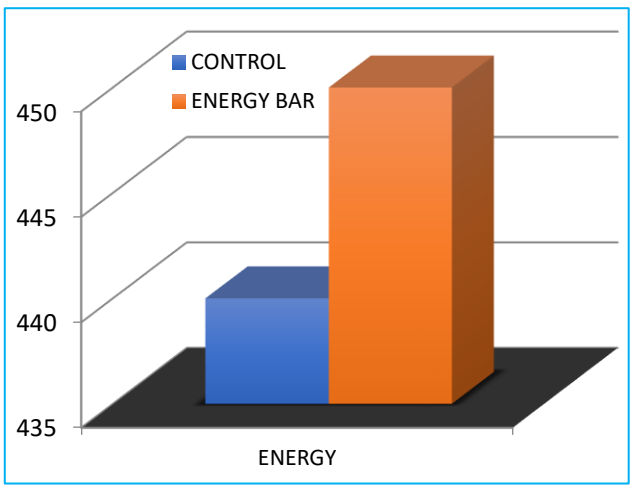

Fig 5 Energy content of energy bar and its control

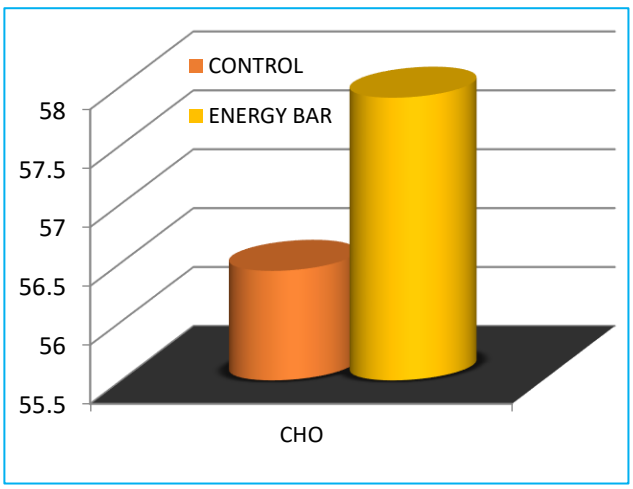

Fig 6 Carbohydrate content of energy bar and its control

Carbohydrate content of energy bar

The carbohydrate content of energy bar and the control products depicted in (Fig 6). (Fig 6) shows that the carbohydrate content of energy bar incorporated is 57.9g and that of control is 56.43g.

Protein content of energy bar

The Protein content of energy bar and the control products depicted in (Fig 7). (Fig 7) clearly shows that the Protein content of energy bar is 15.8g is higher than that of control which is12.57g. Therefore, protein content of energy bar is high than that of control.

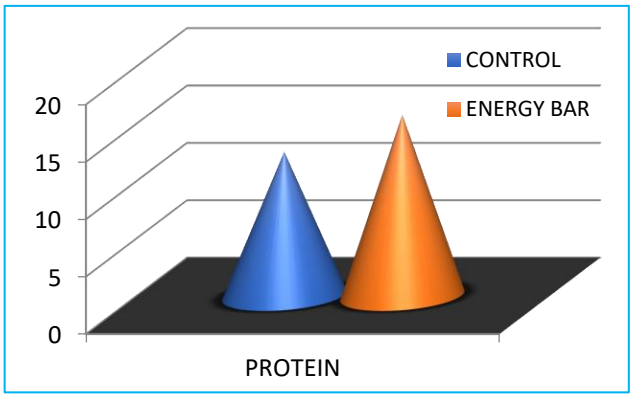

Fig 7 Protein content of energy bar and its control

Total fat content of energy bar

The Total fat content of energy bar and the control products depicted in (Fig 8). (Fig 8) clearly shows that the Total fat content of energy bar is 17.6g and that of control is 16.97g. Fat content of energy bar is more or less similar to that control.

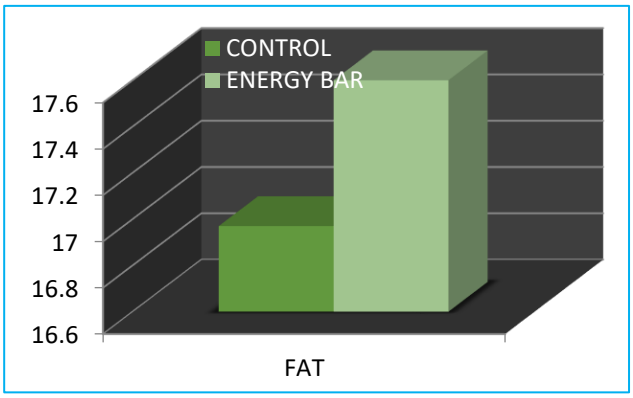

Fig 8 Total fat content of energy bar and its control

Crude fibre of Energy bar

Crude fibre of energy bar and the control products depicted in (Fig 9). (Fig 9) clearly shows that the crude fibre of energy bar is 4.5g and that of control is 1.5g. Crude fibre content is high in energy bar than that of control.

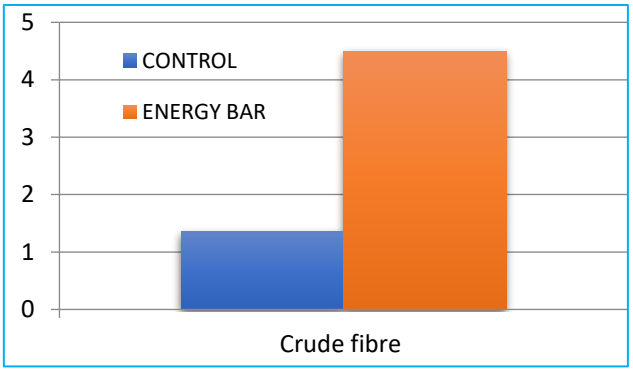

Fig 9 Crude fibre of energy bar and its control

Ash content of energy bar

Ash content of energy bar and the control products depicted in (Fig 10). Figure 10 clearly shows that the Ash content of energy bar is 2.9%.and that of control is 2.3%. Ash content energy bar is low than that of control.

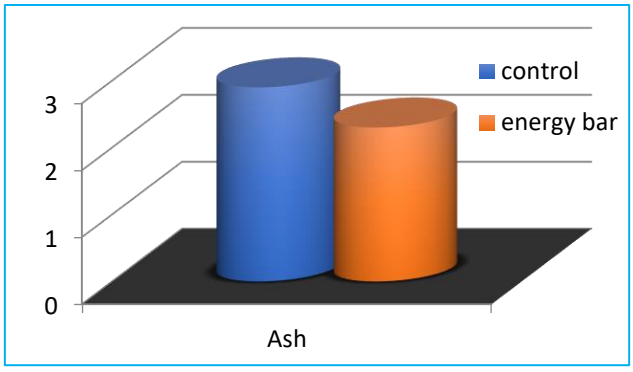

Fig 10 Ash content of energy bar and its control

Calcium content of energy bar

Calcium content of energy bar and the control products depicted in (Fig 11). Figure 11 clearly shows that the calcium content of energy bar is 90.4mg and that of control is 84.4mg. Calcium content of energy bar is high than that of control.

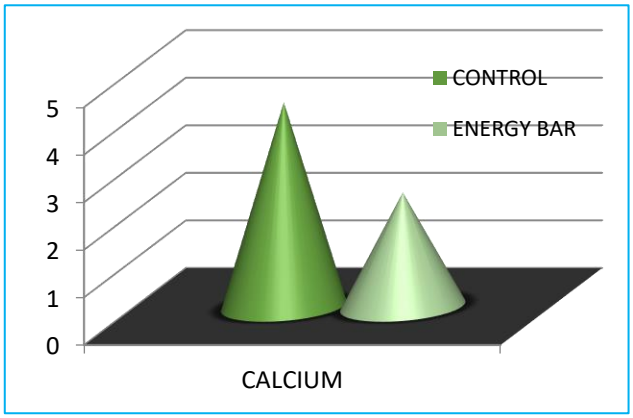

Fig 11 Calcium content of energy bar and its control

Phosphorous content of Energy bar Incorporated peanut candy

Phosphorous content of energy bar and the control products depicted in (Fig 12). The phosphorous content of energy bar is 77.2mg and that of control is 70mg. Phosphorous content of energy bar is high than that of control.

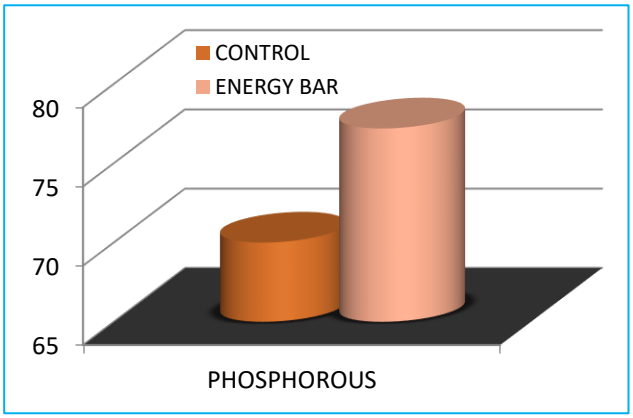

Fig 12 Phosphorous content of energy bar and its control

Iron content of energy bar

Iron content of energy bar incorporated peanut candy and the control products depicted in (Fig 13). Illustrations in (Fig 13) clearly shows that the Iron content of energy bar is 7mg and that of control is 3.7mg. so the iron level is high in energy bar than that of control. Iron content of energy bar high than that of control.

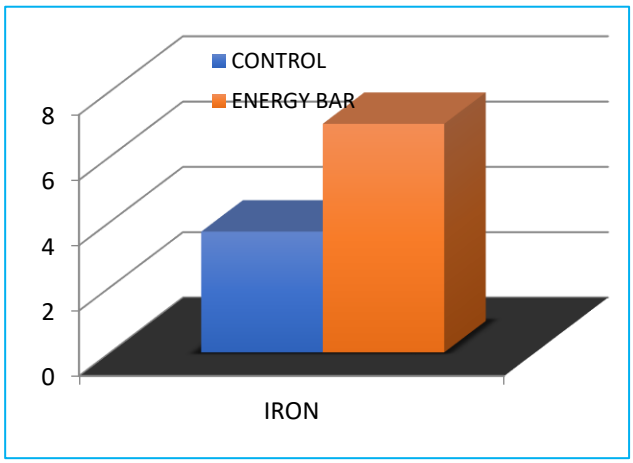

Fig 13 Iron content of energy bar and its control

Mani and colleagues evaluated formulated the *spirulina* syrup with 5 g of *Spirulina* powder (as syrup or parathas) for young anaemic girls, 18–22 years. They have conducted organoleptic evaluation and nutrient analysis. the iron content of *spirulina* syrup is 8mg.M. Uliyar et al., (2000). Here the current study focuses on the formulation of energy bar and conducted the organoleptic evaluation and nutrient analysis. The iron content of energy bar is 7mg.

The mineral make-up of *Spirulina* is attractive too. *Spirulina* being chiefly rich in calcium and iron is good for blood rejuvenation and healthy working of teeth and bones. The nutritional worth of *Spirulina* has been well documented by complete studies carried out by UNIDO; Central Food Technological Research Institute, they formulated the *spirulina* chikki and thus calcium level is 120.2mg. Mysore and several international agencies (Grosshagauer, Kraemer, and Somoza,2020). Therefore, the current study on formulated the Nutri Bar which is rich in calcium of about 90.4mgis similar to the study done at CFTRI.

Spirulina which is rich in protein *Spirulina* contains eight necessary and eight non- necessary amino acids that build the protein molecule. Therefore, it can be used as a main source for protein malnutrition (Benelhadj, Gharsallaoui, Degraeve, Attia, &Ghorbel, 2016).

Setyaningsih et al., 2019, evaluated the shelf life of the *Spirulina* biscuit and compared the chemical composition of *Spirulina* biscuit with the commercial biscuit. According to the sensory test, the *Spirulina* biscuit with coconut cream contains higher protein than a commercial biscuit, while it has lower lipid than that of the commercial biscuit. (Setyaningsih, Mahmudah, Trilaksani, Tarman, & Santoso, 2020). Accordingly in the present study, the formulated energy bar, lowers the LDL level and increase the HDL level, because of its lipid lowering capacity.

Here it can be concluded that *Spirulina* not only increases of iron level but also helps to prevent malnutrition in children because it has more protein and it also help increase of HDL level. Hence, it is considered as the super food.

The result confirm that the intake of energy bar increases of haemoglobin level in the body.

The carbohydrate, protein, energy, fibre, fat, iron, calcium and phosphorus content of formulated energy bar was 57.9g, 15.8g, 450kcal, 4.5g, 17.6, 7g, 90.4mg and 77.2mg and the control peanut candy was 56.43g, 12.57g, 440kcal, 1.35g, 16.97g, 3.7mg, 3.2mg, 84.4mg and 70mg. The statistical analysis of data in Table 5 revealed that there was a significant difference ($p \geq 0.05$) between the energy bar incorporated with *Spirulina* and moringa peanut candy and the control peanut candy without incorporation.

Table 5 Paired t – test (Nutrient content of candy)

Product	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error mean	95% confidence interval of the difference				
				Lower	Upper			
Control and product	-4.37250	3.1362	1.10755	-6.99144	-1.75356	3.948	7	.006

*5% significant level

CONCLUSION

The data regarding the sensory attributes and nutrient analysis of energy bar have been summarized and concluded. The acceptability of energy bar products viz., peanut candy incorporated with *spirulina* and moringa were evaluated for colour, flavour, consistency, taste and overall acceptability. The result stated that SMPC is acceptable and the overall mean scores of the SMIPC were more or less equal with the overall mean scores of the control sample. The sensory attributes like colour, flavour, texture, taste and overall acceptability of *Spirulina* and moringa incorporated peanut candy (SMIPC) was found to be good. The overall mean scores for *spirulina* and moringa incorporated peanut candy were more or less equal to the control samples. Nutrients like energy, carbohydrate, protein, fat, crude fibre, iron, phosphorus and calcium were higher in SMIPC. Iron is increased in the *Spirulina* and moringa incorporated peanut candy.

LITERATURE CITED

1. Alimo K. 1994. dietary intake of *Spirulina* vitamins, minerals and fiber of persons ages two months and over in the united status: third national health and nutrition examination survey, phase i.1988-91.
2. Annapurna V. 1991. Bioavailability of *Spirulina* carotenes in preschool children national Institute of nutrition, Hyderabad, India. *Jr. Clin. Biochem. Nutrition* 10: 145-157.
3. Atrukorala TMS, Silvia DR. 2008. Iron Status of Adolescent females in three schools in an urban area of Sri Lanka. *Journal of Tropical Pediatrics* 36: 316.
4. Blank FC. 2001. Hand Book of Food and Nutrition, Agrobios. pp 86-87.

5. Chatterjee Gitanjali. 1999. Handbook of Food and Nutrition, Rajat Publications, New Delhi. pp 12-13.
6. Davis DC. 2000. Study shows *spirulina* Boost immune system.
7. Finely NJ. 1989. Power foods. *spirulina*. Better Nutrition.
8. Jain LG. 2003. Research Methodology. Methods, Tools and Techniques. Mangal Dheep Publications. P-195.
9. Kauser F, Parveen S. 2001. Effect of *spirulina* as a nutritional supplement on malnourished children. *Indian Jr. Nutr. Diet.* 38(8): 269.
10. Seshadri, C.V. 1993. "Large scale nutritional supplementation with spirulina alga". All India coordinated project on *spirulina* shri AMM Murugappacheetiar Research centre (MCKC/ Madras, India.
11. Yasodhara P, Pathak. 2001. Consumption of *spirulina* and its nutrient intake. *Mary Land Medical Research Institute* 82(3): 153.