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Development and Evaluation of Spirulina Incorporated Little Millet Cookies

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Spirulina (*Spirulina platensis*), the blue green algae is rich in protein content and has several therapeutic properties. The present study focused on incorporating spirulina powder with little millet (*Panicum miliare*) flour in the preparation of cookies. Physico-chemical properties, textural profiles and sensory qualities of spirulina incorporated little millet cookies were analysed. Cookies were standardized by incorporating spirulina powder (5-10 %). The results of organoleptic evaluation showed that 8% spirulina powder with 75 % little millet flour was highly acceptable, with score for overall acceptability being 8.6. Carbohydrate, protein, fat, fibre, calcium and iron content of the standardized cookies were found to be 65.00, 12.31, 20.18 and 5.41g/100g, 27.50 and 6.92 mg/100g, respectively. The shelf life of the product was better in plastic containers (600 gauge) than polypropylene bags (200 gauge) for a storage period of up to 30 days.

Key words: Spirulina powder, Little millet cookies, Nutrient analysis, Sensory qualities, Physico-chemical properties

Spirulina *(Spirulina platensis*) is a cyanobacterium, commonly referred as blue-green alg+ae. Spirulina powder is a low-fat, low-calorie, cholesterol-free source of easily digestible vegetable protein containing all the essential amino acids, vitamins, minerals and fatty acids (Srilakshmi, 2001; Khan, 2005). Algae's are usually harvested from lakes (Becker, 1986). It is also rich in potassium and sodium moderate in magnesium, phosphorus, iron, and calcium along with traces of zinc, copper, manganese and selenium (Khader, 2001).

It also has many therapeutic properties such as hypocholestrolemic, immunological, antiviral and antiglutagenic effects. Commercial preparations of spirulina are potentially used in the treatment of several metabolic disorders, heart ailments, obesity and diabetics (Mark, 2007). Spirulina can be consumed in the form of eitherdry powder, tablets, or flakes.

Little millet is one of the oldest food grain known to mankind and possibly the first cereal grain used for domestic purpose. Millets possess immense health benefits, natural antioxidants and gain prime importance as good sources of protein, dietary fibre, energy and minerals which are involved in several metabolic functions of human body (Moure *et al.,* 2001). Hence, the current investigation on the development and evaluation of spirulina incorporated little millet cookies has been formulated to address the nutritional imbalance in children and elderly people.

Materials and Methods

Spirulina powder, wheat flour, icing sugar, baking powder, fat, corn flour and vanillin powder having standard quality have been procured from local market at Coimbatore. The little millet flour and spirulina powder used were cleaned by sieving through a 60 mesh sieve and mixed at various proportions (5-10 %).

The supporting ingredients added to the mixture were wheat flour, fat, icing sugar, baking powder, corn flour and vanillin powder as shown in Table1. The complete ingredients were made in the form of dough which was further rolled into uniform sheet of desired size before baking. Round shaped dough with 6 cm thickness and 4 cm diameter were cut using cookies cutter and baked in an oven at 180°C for 15 min. The baked cookies were cooled for 2-3 h and packed in thermally sealed polypropylene bags (P_1-200 gauge) or in plastic container (P_2 - 600 gauge). The cookies were stored for one month at room temperature 28°C and relative humidity of 65-85 %.

The cookies were analyzed for the nutritional quality, texture profiles and organoleptic parameters at 10 days internal over a period of 30 days.

The textural parameter of cookies *viz.,* force, distance and time have been determined using the texture analyzer (TA-XT2, Stable Micro Systems. Model: Texture Export Version 1.22, Survey, UK). Physical properties including diameter, thickness, spread ratio were calculated as per the methods described by AACC (1969). The Spirulina incorporated cookies were evaluated for their sensory attributes by a panel of 25 trained members using 9 point hedonic scale (Watts *et al*, 1989). The mean of sensory scores for attributes *viz*., colour and appearance, flavour, texture, taste and overall acceptability were recorded. Similarly, the nutritional values of basic ratio materials

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viz., Spirulina powder and little millet powder were also estimated using the methods suggested by AOAC (2005). Experiments were conducted with different formulations of little millet flour and spirulina powder was presented in the Table 1.

Results and Discussion

The physico-chemical properties, sensory characteristics and storage quality of the developed products were evaluated and discussed.

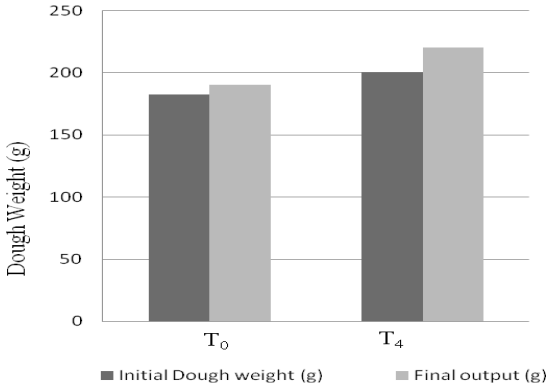

Fig.1. Dough weight and final output of the cookies produced

Physical properties of cookies

The physical properties of spirulina powder incorporated cookies were compared with that of little millet flour cookies and the results are presented in Table 2 and Fig.1 and 2. It was observed that before baking the weight of the cookies were noted as 200 g (T_4) and increased marginally over control (T_0-182 g). The height of the little millet based cookies before and after baking was 0.5, 0.6 and 0.6, 0.7 cm, respectively. The final weight of the cookies was 190 and 220 g for T_0 and T_4, respectively. It was further observed that the number of cookies was 19 in T_1 and 22 in T_4. The effect of incorporation of spirulina with little millet flour for making cookies increased the hardness of the final product, whereas stickiness was found to be decreased.

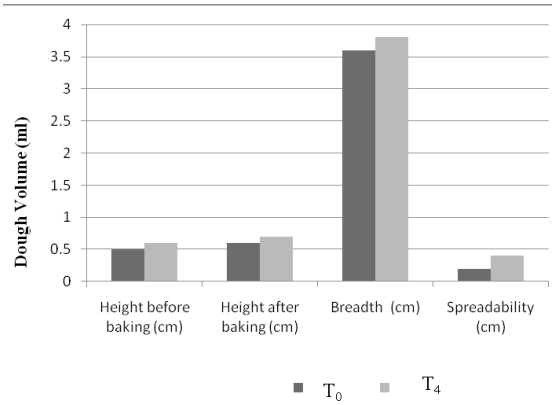

Fig. 2. Physical properties of the cookies

Nutrient composition of the cookies

The 100 g sample of dried spirulina powder contained protein 57.47 g, fat 7.53 g, carbohydrate 23.90 g, fibre 3.60 g, vitamin 10.10 g, minerals 2.80 g, energy 290 Kcal, calcium 117 mg and iron 25.50 mg and the nutrient content of little millet flour contain protein 7.70 g, fat 4.70 g, carbohydrate 67.0 g, fibre12.20 g, energy 34.10 Kcal, calcium 17.0 mg, and iron 9.30 mg, respectively.

Table 1. Formulation of spirulina incorporated little millet cookies

Ingredients	Control	Incorporation levels					
	(T_o)	5 % (T_1)	6 % (T_2)	7 % (T_3)	8% (T_4)	9% (T_5)	10% (T_6)
Little millet flour	75	75	75	75	75	75	75
Spirulina powder	-	5	6	7	8	9	10
Wheat flour	25	20	19	18	17	16	15
Icing sugar	30	30	30	30	30	30	30
Baking powder	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Fat	50	52	54	56	58	60	62
Corn flour	1	1	1	1	1	1	1
Vanillin powder	0.5	0.5	0.5	0.5	0.5	0.5	0.5

The results of the nutrient analysis of spirulina incorporated little millet cookies are presented in Table 3. The moisture content was found to be increased from 8.45 to 8.49 g for T_4 in P_2 during the storage period of 30d. Carbohydrate, Protein, Fat and fibre content of the standardized cookies were found to be 65.00g; 12.31g; 20.18g; 5.41g/100g respectively. The observations further indicated a marginal increase in calcium 27.50 mg and iron content 6.92 mg/100 g than the control cookies.

Table 2. Physical properties of cookies

Characteristics	Little millet flour (alone) (T_0)	Spirulina powder incorporated (T_4)
Dough weight (g)	182	200
Height before baking (cm)	0.5	0.6
Height after baking (cm)	0.6	0.7
Breadth (cm)	3.6	3.8
Spreadability (cm)	0.2	0.4
Final output (g)	190	220
No. of cookies	19	22
Hardness / Compression (Kg f)	0.95 ± 0.03	0.98 ±0.04
Stickiness (g)	25.47 ± 0.87	24.01 ±0.87

Sensory evaluation

The sensory evaluation scores of control and spirulina incorporated little millet cookies were evaluated on 0th and 30th day of storage and the mean scores of sensory attributes for the cookies were

found to be high with an average acceptability rate of 8:75 %. The mean score for colour and appearance, taste, flavour and texture was 8.7, 8.6, 8.7 and 8.6 in Plastic container (P_2) for T_4 sample were found to be highly acceptable at the end of the storage period. The crispiness of the cookies decreased, while the taste and lightness gradually increased during the storage period (Table 4). The overall acceptability of the formulated cookies were found to be 8.6.

Table 3. Nutrient changes in little millet based cookies

Nutrients (g/100g)	Little millet flour				Little millet flour + Spirulina powder			
	Polypropylene packs		Plastic container		Polypropylene packs		Plastic container	
	0th day	30th day	0th day	30th day	0th day	30th day	0th day	30th day
Moisture	8.24	8.36	8.24	8.31	8.45	8.55	8.45	8.49
Carbohydrate	66.85	66.82	66.85	66.84	65.74	64.35	65.74	65.00
Protein	6.25	6.22	6.25	6.24	12.36	12.23	12.36	12..31
Fat	21.87	21.83	21.87	21.86	20.24	20.15	20.24	20.18
Crude fibre	2.65	2.61	2.65	2.64	5.62	5.37	5.62	5.41
Ash	0.90	0.87	0.90	0.89	0.89	0.84	0.89	0.85
* Calcium	15.73	15.69	15.73	15.72	27.56	27.41	27.56	27.50
* Iron	4.03	4.00	4.03	4.02	6.98	6.71	6.98	6.92

* (mg / 100g)

Table 4. Sensory evaluation of the cookies

Parameter	Little millet flour				Little millet flour + Spirulina powder			
	Polypropylene		Plastic container		Polypropylene		Plastic container	
	0th day	30th day	0th day	30th day	0th day	30th day	0th day	30th day
Colour and appearance	8.5	8.3	8.5	8.4	8.8	8.5	8.8	8.7
Taste	8.6	8.4	8.6	8.5	8.7	8.5	8.7	8.6
Flavour	8.6	8.3	8.6	8.5	8.8	8.4	8.8	8.7
Texture	8.6	8.2	8.6	8.4	8.7	8.5	8.7	8.6
Overall acceptability	8.4	8.1	8.4	8.2	8.6	8.4	8.6	8.6

Conclusion

The results of the study indicated that mixing 8g of spirulina powder with 75g of little millet flour for the preparation of cookies could be superior both in nutritional value and physico-chemical properties with highly acceptable sensory qualities.

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