



## RESEARCH ARTICLE

### OPTIMIZATION OF FUNCTIONAL SPIRULINA COOKIES ON THEIR SENSORY ATTRIBUTES

**\*Sonam Kushwaha**

Baba Saheb Bhem Rao Ambedkar University Lucknow

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#### ABSTRACT

Spirulina is a microscopic and filamentous cyanobacteria that has a long history in human nutrition. Potential health properties of Spirulina due to its nutritional and therapeutic ingredients are the fields of interests for future research. Early interest in spirulina focused mainly on its rich content of protein, vitamins, minerals, essential amino acids, fatty acid spirulina comprises 60-70% protein by dry weight. The spirulina used in the production of cookies by some addition percentages zero,5,10 and 15%.Data of sensory evaluation results showed that the adding spirulina by ratio zero had lower score for most properties compared to other taste. In the overall sensory scores fist sample were higher among the other ingredient compositions. The intension was to incorporate 5 % possible quantity of spirulina mixture in the making of cookies to get good taste. It was observed that sensory scores given by the panel judges aged 30-40 yrs. people for all sensory attributes i.e. it changes from for color and it was obtained by incorporation of spirulina in it

## 1. INTRODUCTION

Spirulina which is one of the blue-green algae rich in protein 61.57% and contains a high proportion of essential amino acids (38.81% of the protein) and a source of naturally rich in vitamins especially vitamin B complex such as vitamin B12 (193 µg / 10 g) and folic acid (9.66 mg / 100 g), which helps the growth and nutrition of the child brain, also rich in calcium and iron it containing (1043.62 and 338.76 mg / 100 g, respectively) to protect against osteoporosis and blood diseases as well as a high percentage of natural fibers. So, the spirulina is useful and necessary for the growth of infants and very suitable for children, especially in the growth phase, the elderly and the visually appetite. It also, helps a lot in cases of general weakness, anemia and chronic constipation. Spirulina contain an selenium element (0.0488 mg/100 g) and many of the phytopigments such as chlorophyll and phycocyanin (1.472% and 14.18%), and those seen as a powerful antioxidant. It ensures the whole food and alkaline balance of the body. Health promotions targeting knowledge enhancement about material and child nutrition and direct nutrient supplementation are often utilised as nutrition intervention programmes in developing countries. In 2008 The Laced published a series of papers on maternal and child under nutrition in which the need to focus on the crucial period from

conception to a child's second birthday was identified. Cookies are widely consumed confectionary products, appreciated for their organoleptic properties, versatility, convenience, texture, and appearance. Application of natural ingredients with functional properties beyond traditional nutrients is an attractive way to design new products. Microalgal biomass is a valuable source of fine chemicals such as carotenoid pigments, vitamins, proteins, fatty acids and other biologically active compounds, presenting potential health benefits. Spirulina platensis is a microscopic and filamentous cyanobacterium that has a long history in human nutrition.

Potential health properties of *S. platensis* due to its nutritional and therapeutic ingredients are the fields of interests for future research. Early interest in *S. platensis* focused mainly on its rich content of protein, vitamins, minerals, essential amino acids fatty acids. *S. platensis* comprises 60-70% protein by dry weight. Also, this microalgae is a rich source of vitamin B12, provitamin A (β-carotene), iron and γ-linolenic acid (GLA). In 1997, the FDA based on several studies conducted on rodents and human historical usage of *S. platensis* microalgae, confirmed its safety and announced that its maximum daily intake is 1.35 gr. Therefore, there is not any limitation to use dried whole *S. platensis* microalga in foods. *S. platensis* and other microalgae have already been used experimentally in feed and food products.

\*Corresponding author: Sonam Kushwaha,  
Baba Saheb Bhem Rao Ambedkar University, Lucknow.

**Table 1. Chemical composition of spirulina for 10g**

Chemical composition of Spirulina for 10g dry weight	
Content	Amount
Proteins	6.5 g
Beta-carotene	14 mg
Vitamin C	2 mg
Thiamin (B1)	0.37 mg
Riboflavin (B2)	0.46 mg
Niacin	1.3 mg
Calcium	150 mg
Iron	18 mg
Vitamin E	0.4 mg
Vitamin B 6	0.07 mg
Vitamin B 12	0.02 mg
Phosphorus	67 mg
Magnesium	32 mg
Copper	0.1 mg
Phycocyanin	1,500 mg
Gamma-linoleic acid	100 mg

## METHODOLOGY

The experiment was conducted in the research laboratory of the Department of Food Science and Technology, BBAU, Lucknow & in the analysis laboratory of RFARC (Regional Food Analysis & Research Centre) situated in Lucknow. The different tools & techniques used during experimental process were broadly described in this chapter.

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

**Table 2.1. 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%

### 2.1.1. Spirulina powder

Spirulina powder used in this study was purchased from Tamilnadu. It was a homogenous mixture of Spirulina cultured by the open commercial farms. After harvesting and spray drying, the final product was a green powder.

### 2.1.2. Cookies Preparation

Traditional Iranian cookies (as control) were prepared using the following formulation (% w/w): 50g flour, 12.5g sugar, 13.75g shortening oil, 4.4 g egg, and 0.375 g baking powder. Fortification was conducted by replacement of wheat flour by *S. platensis* biomass powder at 0.5%, 1% and 1.5% concentration levels (w/w). 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.

### 2.1.3. Organoleptic Evaluation

Organoleptic evaluation of cookies was done by 5 trained panelists, after baking. Panelists were used clean white plastic dishes to serve 40 gram of labeled samples randomly on the

palates, in individual booths at room temperature. Cookies were evaluated in terms of different attributes such as flavor, odor, color, texture uniformity, non mouth texture and mouth texture according to 9 point hedonic test\* (9; like extremely and 1; dislike extremely). Finally, total acceptability was calculated according to equation.

### 2.1.4. Statistical Analysis

The 9-point hedonic scale data was analyzed using average score and standard deviation, in which the product with the highest average score and least standard deviation showed highest acceptability. The data was analyzed using chi-square test. The test was performed to show the significant difference in the values of different nutrient contents of control and experimental developed product.

## 3. RESULTS AND DISCUSSION

### 3.1. To examine sensory quality of functional prepared cookies on various parameters

The experimental snacks products of refined wheat and spirulina were characterized as developed product in the present study. The various parameters were incorporated for product development to reach acceptability & edible for human population. For that sensory evaluation process was done by a set of panelist which constituted 5 members in the field of nutrition. For evaluating, a 9-point hedonic scale which is one of the sensory evaluation method used to evaluate any product. Four parameters were used to analyses the acceptability of developed product these are as below-

- Body and texture
- Color and appearance
- Flavor and taste
- Overall acceptability

The total average and standard deviation of individual product was calculated and the best of the five products was put forth for the next phase. Individual markings from each of the panel members for different parameters have been mentioned below.

#### 3.1.1. Flavour and Taste

**Table 1. Total scoring distribution as per flavour and taste**

PANELIST	T1	T2	T3	T4
MEMBER 1	8	8	7	6
MEMBER 2	9	7	6	5
MEMBER 3	8	8	7	4
MEMBER 4	9	8	5	6
MEMBER 5	9	7	6	5
TOTAL	43	38	31	20

Whereas,

T1= Spirulina cookies (95:5)

T2= Spirulina cookies (90:10)

T3= Spirulina cookies (85:15)

The above mentioned table represent score of individual markings by members on the basis of flavour and taste the

minimum average scored is 20 by T4 while maximum is of T1 with an average of 43, which shows the highest acceptability of sample T1 in respect of flavour & taste.

(Shahbazizadeh *et al.*, 2015; coded for 5%, 10% and 15%)

**3.1.2. Parameter. Body and Texture**

**Table 2. Total scoring distribution as per body and texture**

PANELIST	T1	T2	T3	T4
MEMBER 1	9	8	7	6
MEMBER 2	9	7	6	7
MEMBER 3	9	9	5	5
MEMBER 4	9	5	6	4
MEMBER 5	9	8	7	5
TOTAL	45	37	31	27

Where

- T1= Spirulina cookies (95:5)
- T2= Spirulina cookies (90:10)
- T3= Spirulina cookies (85:15)
- T4= Cookies 100 (Without spirulina)

The above mentioned table represent score of individual markings by members on the basis of body and texture the minimum average scored is 27 by T4 while maximum is of T1 with an average of 45, which shows the highest acceptability of sample T1 in respect of body and texture. (Shahbazizadeh *et al.*, 2015; coded for 5%, 10% and 15%)

**3.1.3. Parameter. Colour and Appearance**

**Table 3. Total scoring distribution as per colour and appearance**

	T1	T2	T3	T4
MEMBER 1	9	8	7	6
MEMBER 2	9	7	6	7
MEMBER 3	8	6	5	5
MEMBER 4	9	7	6	4
MEMBER 5	9	8	7	5
TOTAL	44	36	27	18

Where

- T1= Spirulina cookies (95:5)
- T2= Spirulina cookies (90:10)
- T3= Spirulina cookies (85:15)
- T4= Cookies 100 (Without spirulina)

The above mentioned table represent score of individual markings by members on the basis of colour and appearance the minimum average scored is 18 by T4 while maximum is of T1 with an average of 44, which shows the highest acceptability of sample T1 in respect of colour and appearance. (Shahbazizadeh *et al.*, 2015; coded for 5%, 10% and 15%)

**4.3.4-Parameter. Overall Acceptability**

The above mentioned table represent score of individual markings by members on the basis of overall acceptability the minimum average scored is 22 by T4 while maximum is of T1

with an average of 44, which shows the highest acceptability of sample T1 in respect of overall acceptability. (Shahbazizadeh *et al.*, 2015; coded for 5%, 10% and 15%).

**Table 4. Total scoring distribution as per for . overall acceptability**

	T1	T2	T3	T4
MEMBER 1	9	8	7	6
MEMBER 2	9	9	8	5
MEMBER 3	8	8	7	4
MEMBER 4	9	9	6	3
MEMBER 5	9	8	5	4
TOTAL	44	41	33	22

Where

- T1= Spirulina cookies (95 ;5)
- T2= Spirulina cookies (90:10)
- T3= Spirulina cookies (85:15)
- T4= Cookies 100 (Without spirulina)

The overall acceptability graph represents the acceptance on the basis of all the mentioned parameters, the maximum average scored is by the product A i.e.- control sample.

**Table 5. Overall Calculation**

	A	B	C	D
P1	43	38	31	26
P2	45	37	31	27
P3	44	36	27	18
P4	44	41	33	22
Overall sum	176	152	122	93
Average	44	34	30.5	23.25
S.D	1.65	1.45	1.38	1.20

The respective table which is drawn above shows the overall calculations of average marks given by each panellist in each parameters, with calculated average values & S.D. of each sample on the basis of each parameters.

Where – T1,T2,T3 and T4 was coded samples prepared

P= Parameter (P1= Flavor and Taste, P2= Body and Texture, P3= Color and Appearance and P4= Overall Acceptability)  
 S.D.= Standard Deviation (SD reflex the fluctuation in the marks given by different Members and for different parameter)  
 A scored maximum with highest average and least SD which indicate its highest acceptability among the four prepared experimental samples.

**4. Summary and Conclusion**

Result & discussion chapter in any research work must be compiling with summarization & conclusion section. So, keeping this point this chapter showed every table value with highlighting point, which was done in the present study.

Sweet cookies, nutritious food, can be fortified with addition of a natural microalgal biomass of Spirulina (rich in iron, protein and PUFAs, particularly GLA). Regardless of lower overall acceptability of Spirulina cookies compared to control, increment of antioxidant effects beside to anti-staling properties revealed a food market.

In the overall sensory scores fourth trail were higher among the other ingredient compositions. The intention was to incorporate maximum possible quantity of spirulina mixture in the making of cookies to get good taste. It was observed that sensory scores given by the panel judges aged 30-40 yrs. people for all sensory attributes i.e. it changes from for color and it was obtained by incorporation of spirulina in it.

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