"Formulation, Development and Nutritional Evaluation of *Spirulina* based Breads"

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Abstract:

The Organoleptic Evaluation of the developed 5*% Spirulina* incorporated Bread showed the maximum mean score compared to control due intensification of colour and odour. The nutrient content of *Spirulina* based bread was analyzed and it contains 19.9% of moisture, 2.3% of ash, 331.0 Kcal of Calorific Value, 13.4% of protein, 8.6 gms of fat, 50.0% of carbohydrates 9.2 mgs of iron, 98 mg of calcium and 194 mgs of phosphorous. *Spirulina* based bread prepared by incorporating *Spirulina* and Semolina wheat flour had significant difference in its nutritional composition when compared with the control. The developed *Spirulina* based bread were subjected to microbial analysis for fungi and bacteria for three month and found to be safe.

Key Words: Organoleptic Evaluation, malnutrition, micronutrient deficiency, dry weight.

INTRODUCTION

Agriculture is faced with multiple challenges in the 21st century: (i) increase in food production for a growing world population, which is expected to increase by about 2.3 billion people over the next 40 years, mostly in developing countries, ii) insufficient fresh water supply together with land degradation, which causes losses in agricultural productivity, iii) increase of the production of feed- stock for bio energy, iv) adoption of more efficient and sustainable production methods and v) adaptation to climate change. Furthermore, it is presently accepted that malnutrition is a silent massacre. According to United Nations sources, millions of children every year die either from malnutrition or are victims of malnutrition and micronutrient deficiency the lack of key vitamins and minerals with severe consequences on their physical and intellectual development. Moreover, both overweight and underweight people may suffer either from a deficiency or an excess of the intake of nutrients needed for healthy living. Taking into account the above challenges, a future increase of the global production of food and food protein and a combat of malnutrition could be addressed through the development of non-traditional farm products by biotechnological intervention. Such a solution seems today economically viable by supporting the mass cultivation of microalgae rich in protein, vitamins and other functional nutrients known to benefit health. In this respect, *Spirulina* micro alga seems to offer the perfect solution (Sotiroudis *et al*., 2013).

Because of the changing dietary habits of the general public, functional foods are products of interest to many people. Consumers would need to ingest considerably less medicine and artificially produced vitamin and mineral supplements if fermented milks were enriched with vitamins, proteins, essential fatty acids, and trace elements of natural origin. A simple way of attaining this goal is the use of *Spirulina* in the manufacture of cultured dairy foods (Varga *et al*., 2002).

Since centuries *Spirulina* have been receiving increasing interest due to their potential to produce a diverse range of chemicals and biologically active compounds, such as vitamins, carotenoid pigments, proteins, lipids and polysaccharides. For exploration of these potentials of *Spirulina* it should be cultivated in commercial way (Zhang *et al*., 1999).

This alga is protein rich (up to 70% protein by dry weight), contains essential amino acids is easily digestible and is much larger than unicellular alga which simplifies harvesting. The low content of cholesterol and lipids and the presence of minerals, vitamins, carbohydrates, essential fatty acids, sterols and blue pigments, the phycocyanins, which contribute to increase the protein and iron availability have been also proven .Further, the presence of an anti-oxidizing agent as β-carotene and the rare γ -linolenic acids suggests a beneficial therapeutic effect (first of all anti-cancer) of this alga (Ming *et al*., 2011).

The *S. platensis* has been widely used in several countries, it is considered GRAS (generally recognized as safe), without toxicological effects, and it is approved by the FDA (U.S.A.) and ANVISA (Brazil). Countless beneficial effects are attributed to this microorganism, because of its high nutritional value and bioactive compounds, mainly anti- oxidants (Chamorro *et al*., 2008).

Spirulina is a “Super food.” It is the most nutritious, concentrated whole food known to humankind. It has a rich, vibrant history, and occupies an intriguing biological and ecological niche in the plant kingdom. *Spirulina* is truly an amazing food, full of nutritional wonders. Imagine a food that can help regulate blood sugar, blood pressure and cholesterol; a food that can alleviate pain from inflammation and deliver antioxidant activity to ward off life threatening diseases like cancer, Alzheimer’s, heart disease and stroke; a food that helps and protects the liver and kidneys and removes radiation from the body; a food that improves the immune system, alleviates allergies and has been proven to fight many different viruses; a food that helps your eyes and brain; a food that can actually help you lose weight, increase friendly flora in the intestines and improve digestion (Desai *et al*., 2004).

Spirulina is about sixty percent complete, highly digestible protein. *Spirulina* contains every essential amino acid. It contains more beta-carotene than any other whole food; it is the best whole food source of gamma linolenic acid (GLA); it is rich in B vitamins, minerals, trace elements, chlorophyll, and enzymes; and it is abundant in other valuable nutrients about which scientists are learning more each year, such as carotenoids, sulfolipids, glycolipids, phycocyanin, superoxide dismutase, RNA and DNA. *Spirulina* supplies nutrients that are lacking in most of our diets. It provides athletes with long-lasting energy and reduces recovery time; it nourishes people who have digestion, assimilation, and elimination problems; it satisfies the appetite as it provides essential nutrients to weight watchers; it enables children and others who don't like vegetables to eat their greens by taking a few tablets; and it helps busy people who don't have time for regular, balanced meals to nourish themselves. People with various health problems swear by *Spirulina* it appears to promote overall health and well being. A gram-per-gram comparison of *Spirulina* shows how powerfully nutritious it is.

Materials and Methods

Procurement of *Spirulina*: *Spirulina* powder was purchased from ''A K Biotech Foods Company'' Tamil Nadu.

Product development: The bread was processed on this formulation with special wheat flour. *Spiruina* based Bread were developed in Oven Classic Food Industry, Jabalpur M.P.

Table: 1 Composition of *Spirulina* based breads:

S.No.	Ingredients	Percentage
1	Flour	100
2	Yeast	2-4
3	Salt	2
4	Sugar	6
5	Fat	4
6	Water	60
7	*Spirulina* Powder (gm)	5

Organoleptic Evaluation- The develop value added Bread was standardised using composite scoring evaluation with the help of experts. Sensory evaluation included selection of semi trained panel using Control and Developed *Spirulina* Bread were subjected to 5 point hedonic test by a panel of 10 judges.

Nutritional Evaluation- Prepared Bread was analyzed Moisture, Ash, Protein, Fat, Carbohydrate,, Energy, Iron, Calcium and Phosphorous(AOAC,1995).

Microbial examination: The cultural examination of the Bread samples for bacteriological analysis was done according to the standard method (ICMSF, 195). The isolation and identification of bacteria were performed as per as recommended by Cowan (1985) and Rahman (1997b).

Result and Discussion

Nutrient composition of standard products *Spirulina* bread was calculated by nutritive values of Indian foods by Gopalan *et al*. (2004). Essential nutrient component such as protein, carbohydrate, fat, minerals, and crude fibre were calculated and presented in Table No. 2 and Table No. 3.

Table no. 2: Nutritional value of *Spirulina* based Bread

S. No.	Nutrient	Control	Nutritive Value of *Spirulina* based Bread
1	Carbohydrate (% by mass)	48.7	50.0
2	Crude fiber (% by mass)	7.1	5.8
3	Protein (% by mass)	10.0	13.4
4	Total fat (% by mass)	7.3	8.6
5	Acidity of fat	0.56	0.62
6	Moisture (% by mass)	24.2	19.9
7	Ash (% by mass)	2.7	2.3
8	Acid insoluble ash (% by mass)	0.7	0.56
9	Sodium (mg)	172	189
10	Potassium (mg)	254	278
11	Calcium (mg)	89	98
12	Phosphorus (mg)	156	194
13	Iron (mg)	7.5	9.2
14	Nutritional value (Kcal per 100g)	300.50	331.0

As compare to control *Spirulina* added bread showed increase in carbohydrate (1.3%), crude fibre (1.3%), protein (6.4%), fat (1.3%), Na (17%), K (24%), calcium (9%), phosphorus (38%), Fe (1.7%) and the total nutritional value of *Spirulina* added bread increases 30.5% in compare to control bread sample,

Table : 3 Microbial load (Total plate count as cfu/ml)of the Bread sample stored in at 35ºC over a period of 30 days

S. No.	Storage Duration (Days)	Total Plate Count (cfu/g)	*Staphylococcus sp.* (cfu/g)	*Bacillus sp.* (cfu/g)	*Salmonella sp.* (cfu/g)
1	0	0.52	-	<10	_
2	5	2.82	-	<10	-
3	10	3.60	<10	<10	<10
4	17	3.40	<10	-<10	<10
5	22	4.52	<20	<10	<10
6	30	5.85	<20	<20	<20

Table : 4 Microbial load (Total plate count as cfu/ml)of the Bread sample stored in at 35ºC over a period of 7 days

S.No.	Storage duration (Days)	Total Plate Count (cfu/g)	Yeast and mold (cfu/g)
1	0	45	<10
2	2	112	<10
3	4	98	<10
4	7	78	<10

Quality and stability of *Spirulina* cookies and breads

Studies on the quality and shelf life stability of *Spirulina* based breads are very valuable from the view of point of risk assessment. Total viable count or total plate count is used as indicator of bacterial population on a sample. It is widely used to gain the opinion about the hygienic quality microbiological load and shelf – stability of foodstuffs.

The result of microbiological tests showed the presence of bacteria such as *Bacillus*, *Salmonella* and *Staphylococcus*. Result of shelf life studies showed that the total aerobic plate count in *Spirulina based* bread tested over 30 days were below log 4/g throughout the entire test period. The counts were at log 0.49/g on 0

day and remained between a log 2/g and log 3.02/g on 5, 10, 17, 22, 21 and again increased to log 3.77 on day 30 but in bread sample the counts were at log 0.52/g on 0 day and remained between a log 2/g and log 3.6/g on 5, 10 and again increased to log 5.85 on day 30 The *E.coli* and coliform count remained below 10 cfu/g in cookies throughout the entire shelf life testing but in bread the cfu/g were increased after 10 day testing.

Plate: 1 *Spirulina* powder

Plate: 2 *Spirulina* based Breads

Plate: 3 Different Media used for microbiological examination

Plate: 4 Colonies of *Staphylococcus sp.* grown on Mannitol Salt Agar Plate

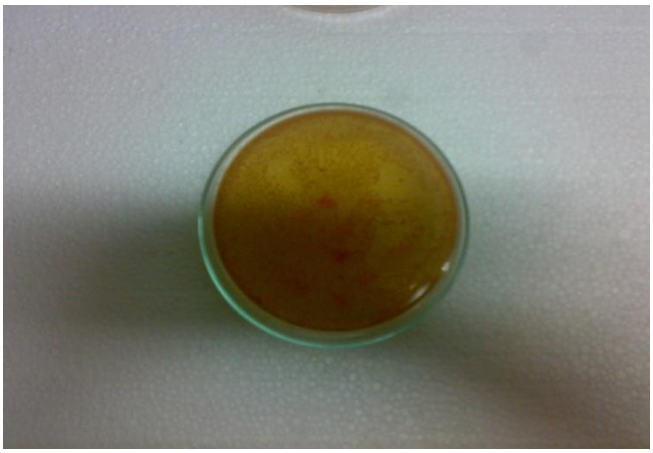


Plate: 5 Colonies of *Salmonella sp.* grown on Salmonella-Shigella Agar Plate

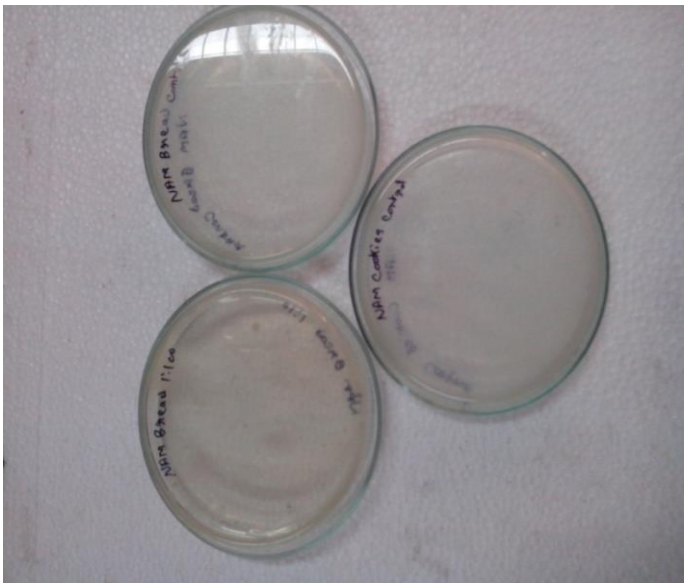
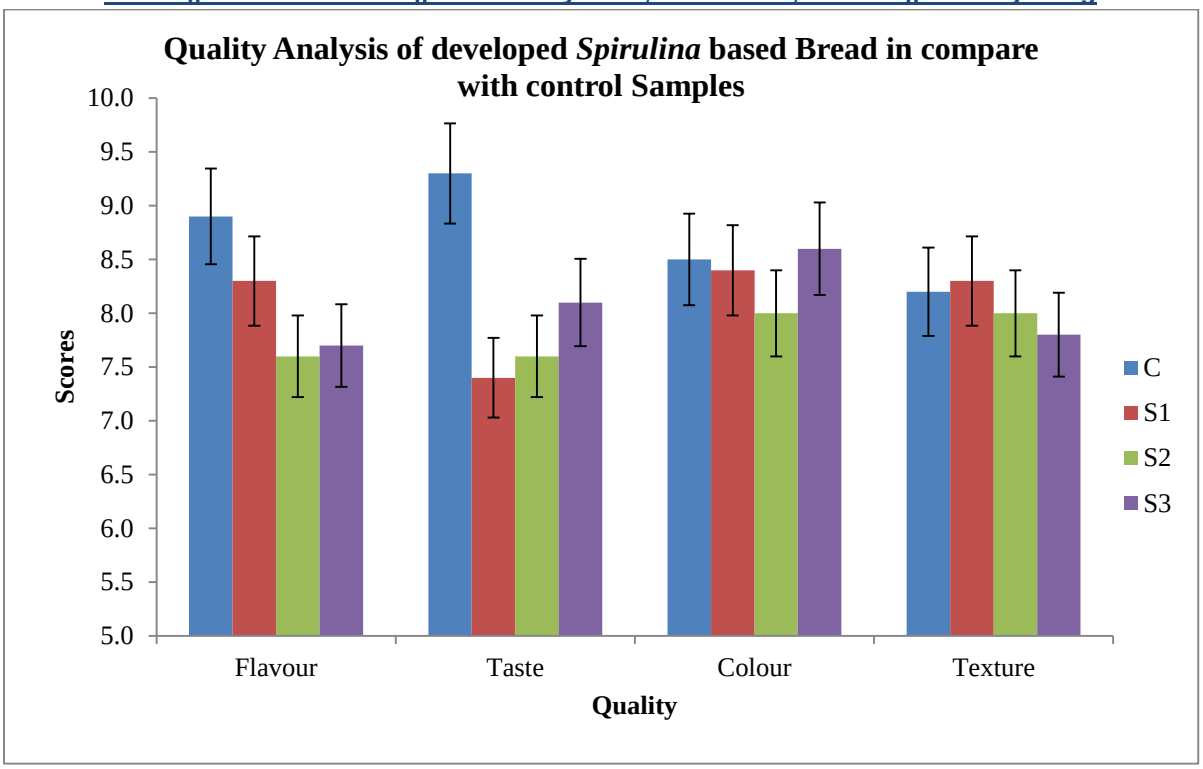


Plate: 6 Colonies of *Bacillus sp.* grown on Nutrient Agar media Plate



Conclusion:

Spirulina has potential for being a wonder food supplement and several leading organizations have praised its beneficial effects. It is the richest nutrient and complete food source found in the world. It contains over 100 nutrients more than any other plant grain or herb.The development of *Spirulina* based breads food product is more nutritious and with satisfactory technology. The increase in protein, fibre and ash content in the formulations showed qualitative and quantitative advantages when compared to the standard methods. The results demonstrate production viability for this alternative food due to its low cost and easy preparation but more importantly nutritional supplements may be more natural, acceptable and feasible method of providing benefits.

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