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Enrichment of Vanilla Ice-cream with Spirulina Powder

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***Abstract*: Spirulina is a rich source of nutrients specially essential amino acids, essential fatty acids, pigments like carotenoids, minerals and vitamins and thus can potentially represent an important and significant staple in the human diet. The present work focuses on enrichment of vanilla ice cream with *Spirulina* with its addition in concentrations of 25%, 50%, 75% and 100% for ice cream preparation. With increase in level of Spirulina addition there was improvement in nutritional profile, and increasing protein content was observed It also gave natural light green color to ice cream enriched with it. Ice cream prepared by addition with *Spirulina* had comparable scores for sensory parameters with that of control.**

***Keywords*: ice cream, *spirulina*, vanilla.**

1. Introduction

Nutrition and health are important deciding factor when consumers purchase dairy products. Driven by increasing incomes and health consciousness value addition to dairy products has witnessed a significant increase over the past few years. In all over world Ice cream is considered a food for enjoyment, rather than a basic food. Therefore, fortification of ice cream with nutrients or other organic substances should be supported. To fulfill body demand of protein and other important vitamins and minerals Dairy products enriched with minerals, proteins and essential fatty acids can be manufactured using cyanobacteria. It also gives natural colour to ice cream enriched with it. In the present investigation, it is of interest to explore the effect of *Spirulina* on characteristics of ice cream.

2. Materials

Milk (Buffalo), Milk cream, Sugar, Corn flour, Vanilla essence, GMS powder, CMC powder, ware was procured from local market of Baroda Gujarat. Spirulina strain culture was procured from K. K. Wagh college of Agricultural Biotechnology, Nashik.

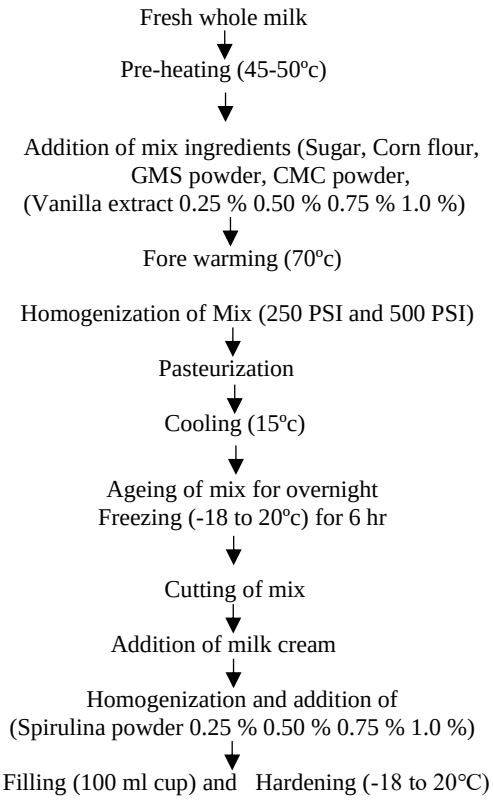
3. Methods

A. Growing of spirulina culture its maintenance and powder preparation

5 ml mother culture was mixed initially with 1000 ml designed culture medium. The designed medium composition was: NaCl :2.0 g., NaHCO3 :16.0 g., NaNO3 :2.0 g., K2SO4 :1.0 g., KH2PO4: 0.5 g., FeSO4: 100 mg per liter water (boiled and chilled) with pH value of 10.5. The culture was agitated with water pump with natural illumination for 7 days and observed the intensity of green color. Once culture got dense intensity yield. Spirulina culture was strained with muslin cloth. Collected biomass was allowed to dry under sunlight for 5 to7 days or in hot air oven at 50 to 70°C. After completely loss of moisture dried mass was grinded manually with mortar and pestle. To obtain powder form of spirulina.

B. Ice Cream Preparation

The ice cream was prepared as per standard procedure narrated by Sukumar De (1977). Some modifications are done to improve texture of ice cream.



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C. Sensory Analysis

The systematic sensory evaluation was carried out on prepared product having different ratios of spirulina powder and vanilla flavor compared each with control product by 9-point headonic scale the products was judged with standard score card for flavor, body and texture, color and appearance, melting quality and overall acceptability.

D. Physico-Chemical Analysis

Ph, acidity, moisture content, total solid content, ash content, fat content, protein content. All Properties analysis was done with standard procedures of AOAC

E. Microbial Analysis

Microbial analysis of ice cream was done with three different tests.

1) yeast and mould count
2) coliform count
3) viability count

4. Results and Discussion

A. Sensory Evaluation

In sensory attributes color of the control was 7.53 whereas for the experimental sample T1, T2, T3, T4 the score were7, 7.86, 8.06, 7.86 was observed. Appearance of the control ice cream was 7.73, whereas for the experimental sample T1, T2, T3, T4 the score ware 6.8, 7.83, 7.33, 7.81 was observed. Taste of the control ice cream was 7.8, whereas for the experimental sample T1, T2, T3, T4 the score ware 6.73,7.6,7.36.7.66 was observed. Apart from taste flavor of the control ice cream was 7.66, whereas for the experimental sample T1, T2, T3, T4 the score ware 7.1, 7.66, 7.8, 7.93 was observed. Also, Consistency of control ice cream was 7.6, whereas for the experimental sample T1, T2, T3, T4 the score ware 7.2, 7.26, 7.56, 8.43 was observe. Including all overall acceptability of control ice cream was 7.8, whereas the experimental sample T1, T2, T3, T4 the score ware 7.13, 7.66, 7.86, 8.03 was observed.

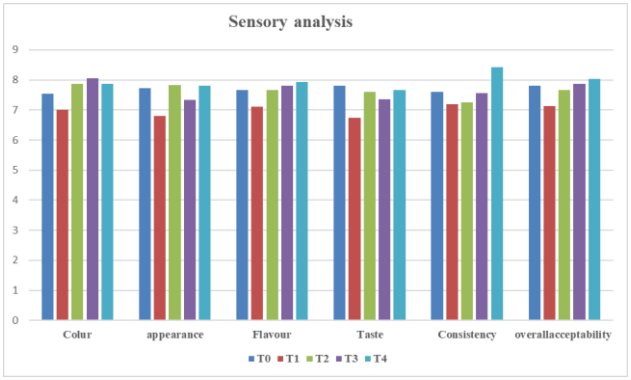

Fig. 1. Sensory analysis

Table 1
Organoleptic evaluation of spirulina ice cream

Sample	Color	Consistency	Taste	Flavor	Appearance	Overall Acceptability
T0	7.53	7.6	7.8	7.66	7.73	7.8
T1	7	7.2	6.73	7.1	6.8	7.13
T2	7.86	7.26	7.6	7.66	7.83	7.66
T3	8.06	7.56	7.36	7.8	7.33	7.86
T4	7.86	8.43	7.66	7.93	7.81	8.03

B. Physico-Chemical Analysis

Fresh buffalo milk used for in making of spirulina ice cream was analyzed for proximate composition like pH, acidity, moisture, fat, protein. And then prepared product was analyzed for physio-chemical constituents such as pH, Acidity, Moisture, Total solid, Ash, Fat, Protein.

Table 2
Proximate analysis of raw milk that used for preparation of spirulina ice cream

pH	6.62
Moisture (gm%)	86.33
Total solid (gm%)	16.07
Titrable Acidity (%)	0.22
Ash (gm%)	0.57
Protein (gm%)	6.46

Table 2 shows the proximate analysis of milk which contains pH of 6.62, moisture (86.33%) owing to milk has a higher moisture content, total solid (16.07gm%), titrable acidity at 0.22 %, where titratable acidity varies from 0.12 to 0.19% in fresh buffalo milk and ash, protein, and percentage of fat present in milk was 0.57 gm %, 6.46 gm%, fat 6.7%.

C. Physico-Chemical Properties

Enrichment of vanilla ice cream with spirulina powder", for proximate, sensory, physio-chemical and microbiological analysis. In which it shows a high pH value from treatment T0(6.99), acidity percentage with highest in T4 (0.25), an increase in percent of moisture which was high in T4 (51.67), level of total solid content was decreased with higher in T0 (49.68). Furthermore, ash content of ice cream was higher with treatment T4(0.78), higher fat content was observed in T4 (10.16), higher content of protein in T4 (15.96), maximum acidity found in T4 (0.25), Highest melting resistance was counted in T4 (17.2) these parameter physio-chemical constituents was observed and spirulina enriched vanilla ice cream was stored at refrigeration temperature (-18 ^{o}c). From the present investigation it can be concluded that Spirulina powder offers great potential use in diary industry to enrich dairy products. The mix spirulina powder of treatment T4 was more acceptable than other experimental treatments T1, T2 and T3 due to higher overall acceptability score. It was observed that as the increasing level of spirulina powder and vanilla extract there was also increased in Moisture, Acidity, protein, ash, fat and decreased in pH, total solid of spirulina enriched vanilla ice cream.

D. Microbial Analysis and Shelf Life of Product

1) Viability

Only a cluster of colonies was observed in experimental samples T1 (10^{8}dilution) which was uncountable due to the

Table 3
Physiochemical properties of ice cream

	pH (%)	Acidity (%)	Moisture (%)	Total Solid (Gm)	Ash (%)	Fat (%)	Protein (%)	Melting resistance (min)
T0	6.99	0.2	50.32	49.68	0.64	10.1	7.98	13.4
T1	6.86	0.22	50.66	49.34	0.67	10.12	9.97	13.9
T2	6.91	0.24	51.12	48.88	0.71	10.12	12.77	14.7
T3	6.78	0.24	51.44	48.56	0.75	10.14	13.97	15.6
T4	6.62	0.25	51.67	48.33	0.78	10.16	15.96	17.2

Table 4
Changes in microbial activity during storage of spirulina ice cream

Microbial quality	0 day				15 days				30 days			
	C	E			C	E			C	E		
	-	10^8	10^9	10^{10}	-	10^8	10^9	10^{10}	-	10^8	10^9	10^{10}
Viability	-	-	-	-	-	UC	-	-	-	-	UC	UC
Yeast and mould count	-	10^4	10^5	10^6	-	10^4	10^5	10^6	-	10^4	10^5	10^6
		-	-	-	-	UC	1	-	-	-	UC	-
Coliformcount	-	10^2	10^3	10^4	-	10^2	10^3	10^4	-	10^2	10^3	10^4
		-	-	-	-	-	-	-	-	-	-	-

*C- control, *E-experimental *UC- uncountable, '-'= Nil

Table 5
Cost of production of spirulina ice cream

Ingredients	Cucumber ice cream treatments									
	T0		T1		T2		T3		T4	
	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
Milk (ml)	500	28	500	28	500	28	500	28	500	28
Milk cream (ml)	150	19.5	150	19.5	150	19.5	150	19.5	150	19.5
Powder sugar(g)	150	6	150	6	150	6	150	6	150	6
Corn flour (g)	10	2.5	10	2.5	10	2.5	10	2.5	10	2.5
GMS powder	15	2.4	15	2.4	15	2.4	15	2.4	15	2.4
CMC powder	0.250	0.5	0.250	0.5	0.250	0.5	0.250	0.5	0.250	0,5
Vanilla essence(ml)	0.0	0.0	1.25	1.8	2.5	3.75	3.75	5.4	5	7.5
spirulina powder (g)	0.0	0.0	1.25	3.12	2.5	6.25	3.75	9.37	5	12.5
Total cost (rupees) for 1.5 kg	58.9		63.82		68.9		73.67		78.9	

enormous cluster. After 15 and 30 days of storage it remained same uncountable in T3 (10^9 and 10^{10} dilution) and skeptical to identify and to count, hence it was a fallible result.

2) Coliform count

In each treatment of prepared ice cream, the coliform count was nil which indicates that hygienic conditions adapted during manufacturing as well as the sanitation was carried out which was adequate.

3) Yeast and mould count

The yeast and mould growth in spirulina ice cream was analyzed at the regular intervals *viz.*,10th, 20th and 30th days of storage. Initially there was no yeast and mould growth in spirulina ice cream thus, yeast and mould were absent in fresh ice cream. Then on 15th day of storage in one experimental (T2 -4th dilution) sample there was only a one colony was observed on plate and after that at 30th day (T2-5th dilution, T1-5th dilution, T1-10^4 dilution) of storage uncountable growth were seen on plate.

E. Cost of production of spirulina enriched vanilla ice cream

The cost of spirulina ice cream was worked out by considering the prevailing cost of ingredients only. The cost data are presented in table 5.

5. Conclusion

The present investigation was undertaken for "Enrichment of vanilla ice cream with spirulina powder", for proximate, sensory, physio-chemical and microbiological analysis Sensory attributes was done at the same period of time. According to the sensory attributes all different treatments were accepted.

Results obtained were satisfactory and the spirulina ice cream showed good quality characteristics on pH, Acidity, Moisture, Total solid, Ash, Fat, Protein, melting resistance. The overall acceptability was found with T4 (1.0). From the present investigation it can be concluded that Spirulina powder offers great potential use in diary industry to enrich dairy products The mix spirulina powder of treatment T4 was more acceptable than other experimental treatments T1, T2 and T3 due to higher overall acceptability score. It was observed that as the increasing level of spirulina powder and vanilla extract there was also increased in Moisture, Acidity, protein, ash, fat and decreased in pH, total solid of spirulina enriched vanilla ice cream. Spirulina powder addition also gave natural light green (pista) color to ice cream. it concluded that spirulina added vanilla ice cream with its good quality and more acceptability can be prepared by the addition spirulina powder Sample T4 containing 1.0 % spirulina powder and 1.0 percent vanilla flavor was found most acceptable in the terms of sensory as well as physiochemical scores whereas treatment containing 0.25%, 0.50%, and 0.75 % spirulina also obtained satisfactory results as they were within the acceptable limit. Ice cream can be stored for 30 days due to absence of coliforms and yeast and mould was also lower, and it can be recommended as health food for patients due to spirulina protein benefits.

References

[1] A.O.A.C.(2000) Official methods of analysis. Edited by Horwits W. Association of analytical chemists, Washington.

[2] Amreen, Q. S., Khojare, A., & Jadhao, V. (2017), "Moisture Sorption Characteristics of Banana Shrikhand." *International Journal of Agriculture, Environment and Biotechnology*, *10*(5), 589-596.

[3] AOAC. Methods of analysis, 17th Edition. Association of Official Analytical Chemist Washington DC, USA, 2000.

[4] AOAC. Official methods of analysis for ash. Association of Official Analytical Chemists. 18th Ed. Arlington, VA. 2209, 2005,

[5] AOAC. Official methods of analysis for fat (crude) or ~ 1441 ~ Journal of Pharmacognosy and Phytochemistry ether extract in flour. Association of Official Analytical Chemists. 16th Ed. 3rd Revision. Gaithersburg, Maryland 1997, 20877- 2417.

[6] AOAC. Official methods of analysis for moisture. Association of Official Analytical Chemists. 18th Ed. Arlington, VA. 2209, 2005.

[7] AOAC. Official methods of analysis for protein. Association of Official Analytical Chemists. 18th Ed. Arlington, VA. 2209. 2005.

[8] AOAC. Official methods of analysis for total milk solids. Association of Official Analytical Chemists. 18th Ed. Arlington, VA. 2209, 2005.

[9] Arbuckle, W.S., 1986, Ice cream IV. Ed. AVI Pub. Co., Inc., New York. U.S.A. pp 84-94.

[10] Chang, Y. and Harte L, R. W., 2002. Measurement of air cell distributions in dairy foams. International Dairy Journal, 12: 463-472.

[11] Cottrell, I.L.J., Pass, G and Phillips, O.G., 1980. The effect of stabilizers on viscosity of an ice-cream mix. J. Sci. Food. Agric., 31:1066-1070.

[12] De Sukumar, 1977, Outlines of Dairy Technology-Ice Cream, Oxford University Press, pp 193-194.

[13] Henrikson, R., 2009. Earth food *spirulina*. Ronore Enterprises, Inc., Hana, Maui, Hawaii.

[14] Moorhead, K., Capelli, B. and Gerald, R. C. 2006. Spirulina Nature's Super food, 2ndedition. Published by Cyanotech Corporation.

[15] Pour-EI, A., 1981. Protein functionality: classification, definition and methodology. IN: Protein functionality in foods. Ed. J.P. Cherry, American Chemical Society, Symposium Series, Washington, D.C., pp. 1-19.

[16] Richmond, A., 1996. Open system for the mass production of photoautotrophic microalgae outdoors, Physiological principles. J. Appl. Phycol, 4:281-283.

[17] Robinson., R.K., Carl, A. B. and Pradip, D. P., 2000. Encyclopedia of food microbiology. In: Single- Cell Protein/The algae. Academic press, A Harcourt Sc. and Tech. Company. Vol. 3, pp 2025-2026.

[18] Sofijan, R. P. and Hartel, R. W., 2004, Effects of overrun on structural and physical characteristics of ice-cream. International Dairy Journal, 14(3): 255–262.

[19] Shilpa, V., 2009. Influence of casein fractions, their peptides on quality of ice cream. Thesis submitted to the KVAFSU, Bidar. Enterprises, Inc., Hana, Maui, Hawaii.

[20] Moorhead, K., Capelli, B. and Gerald, R. C. 2006. Spirulina Nature's Super food, 2ndedition. Published by Cyanotech Corporation.

[21] Pour-EI, A., 1981. Protein functionality: classification, definition and methodology. IN: Protein functionality in foods. Ed. J.P. Cherry, American Chemical Society, Symposium Series, Washington, D.C., pp. 1-19.

[22] Richmond, A., 1996. Open system for the mass production of photoautotrophic microalgae outdoors, Physiological principles. J. Appl. Phycol, 4:281-283.

[23] Robinson., R.K., Carl, A. B. and Pradip, D. P., 2000. Encyclopedia of food microbiology. In: Single- Cell Protein/The algae. Academic press, A Harcourt Sc. and Tech. Company. Vol. 3, pp 2025-2026.

[24] Sofijan, R. P. and Hartel, R. W., 2004, Effects of overrun on structural and physical characteristics of ice-cream. International Dairy Journal, 14(3): 255–262.

[25] M. S. Miranda, R. G. Cintra, S. B. M. Barros, and J. Mancini-Filho, "Antioxidant activity of themicroalga *Spirulina maxima*," *Brazilian Journal of Medical and Biological Research*, vol. 31, pp. 1075-1079, 1998.

[26] M. Khan, S. Varadhara, L. P. Gansesa, J. C. Shobha, M. U. Naidu, and N. L. Parmandi, "C-Phycocyanin protects against ischemia-reperfusion injury of heart through involvement of p38 and ERK signaling," *Am. J. Physiol. Heart Circ. Physiol.*, vol. 290, no. 5, pp. H2136-H2145, 2005.

[27] Romay, C., J. Armesto, D. Remirez, R. Gonzales, N. Ledon, and I. Garcia. 1998. Antioxidant and Anti-inflammatory Properties of C-phycocyanine from Blue-green Algae. *Inflam. Res*. 47: 36–41.

[28] Sarada, R., M. G. Pillai, and G. A. Ravishankar. 1999. Phycocyanin from *Spirulina* sp.: Influence of Processing of Biomass on Phycocyanin Yield, Analysis of Efficacy of Extraction Methods and Stability Studies on Phycocyanin. *Process Biochem.* 34: 795–801.

[29] Duangsee, R., N. Phoopat and S. Ningsanond. 2009. Phycocyanin Extraction from *Spirulina platensis* and Extract Stability under Various pH and Temperature. *As.J.Food and Agro-Industry*. 2(4): 819–826.

[30] Martelli, G., C. Folli, L. Visai, M. Daglia and D. Ferrari. 2014. Thermal Stability Improvement of Blue Colorant C-phycocyanin from *Spirulina platensis* for Food Industry Applications. *Process Bichemistry*. 49: 154–159.

[31] Minea, R., M. Brasoveanu, M. N. Grecu, and M. R. Nemtamu. 2006. Preliminary Studies on Irradiated Spirulina. *Rom. J. Phys*. 51(1–2): 141–145.

[32] Chisti, Y. (2016). Large-scale production of algal biomass: raceway ponds. *In Algae biotechnology*, 21-40, Springer, Cham.

[33] De Smet, P. A. G. M. (1997). Spirulina species. *In Adverse Effects of Herbal Drugs*, 129-135, Springer, Berlin, Heidelberg

[34] Ansuya Devi, M., G. Subbulakshmi, K.Madhavi Devi and L.V. Venkatraman. 1981. Studies on the proteins of mass cultivated Blue-green alga (*Spirulina platensis*). *Journal of Agriculture and Food Chemistry*, 29: 522-525

[35] Krishnakumari, M. K., H. P. Ramesh and L. V. Venkatraman. 1981. Food safety evaluation. Acute oral and dermal effects of the algae *Scenedesmus acutus* and *Spirulina platensis* on Albino rats. *Journal of Food Protection*, 44: 934 - 935.

[36] Krishnakumari, A.V. 1982. Amino acid pattern and acceptability of a blue green alga (*Spirulina platensis*) grown on different media and protein quality evaluation as tested on young albino rats. M.Sc., Thesis, Madras Univ., pp.1-56.

[37] Balasubramanya, N.N and S.R. Sampath. 1994. Protein efficiency ratio (PER) of alga *Spirulina*. *The Indian Dietetics*, 21:165-167.

[38] Orio Ciferri and OrsolaTinoni. 1985. The biochemistry and Industry potential of *Spirulina*. *Annual Review of Microbiology*, 39:503-526.

[39] Sundararaman, M., H. I. Averal, M.A. Akbarshaand G.Subramiyan. 1994. Bioactivity of marine cyanobacteria in the animal-based- systems modulation of food intake, body weight and some haematological characters. *Annals of Applied Biology*, 1259 (1): 195-206.

[40] Venkataraman, L.V., G.Suvarnalatha, M.K. Krishnakumari and P. Joseph. 1994. *Spirulina platensis* as retinal supplement for production against hexachloro cyclohexane toxicity in Rats. *Food Science and Technology*, 31(5):430-432.

[41] Jose, P.L. G. Zulpa – de caire, Mc Zaccaro-de-mule and M.M. Storni-De-Cano. 1998. Lactic acid bacteria growth promoters from *Spirulina platensis*. *International Food Microbiology*, 45 (3): 225 - 228.

[42] Naidu, K.A. R. Saratha, C. Manoj, M.Y. Khan, K.N. Swamyum, G.A. Vishwanath, G. Murthy, Ravishankar and Leela Srinivas.1999. Toxicity assessment of Phycocyanin – a blue colourant from blue green alga *Spirulina platensis*. *Food Biotechnol*ogy, 13(1): 51 - 56.

[43] Hirajashi T. 2002. Activation of the human innate immune system by *Spirulina*: augmentation of interform production and NK cytoxicity by oral administration of hot water extract of *Spirulina platensis*: *Int Immunopharmahol.*, 222:423-34.

[44] Ogawa, T and G. Teuri. 1970. Blue green algae *Spirulina*. *Journal of Fermentation Technology*, 48:361.

[45] Cifferi, O. 1983. *Spirulina*. The edible microorganism. *Microbial Reviews*, 47(4): 551-578.