International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 9, Issue 14, 2017, pp.-4091-4094.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

QUALITY CHARACTERISTICS OF NOODLES ENRICHED WITH *Spirulina platensis* POWDER

SAHARAN VATSALA* AND JOOD SUDESH

Department of Foods and Nutrition, College of Home Science, CCS Haryana Agricultural University, Hisar, 125004
*Corresponding Author: Email-vatsala.saharan@gmail.com

Received: March 03, 2017; Revised: March 15, 2017; Accepted: March 16, 2017; Published: March 24, 2017

Abstract- Supplementation of noodles with *Spirulina platensis* powder was done at 2, 4, 6 and 8% levels to improve its nutritional quality. Developed enriched noodles were found organoleptically acceptable by the panelists up to 6% level. With regard to nutritional quality, among the fortified noodles, 6% *Spirulina* supplemented noodles yielded higher contents of protein (15.60%), fat (9.82%), crude fibre (3.29%), ash (1.87%), carbohydrate (69.42%) and energy (428.46 kcal/100g). Fatty acid profile of 6% *Spirulina* enriched noodles were found superior than the other supplemented noodles. These were as palmitic, oleic, α-linolenic and γ-linolenic acid 42.00, 17.44, 1.05 and 2.10% of total fatty acids, respectively. Total and available minerals were also found higher in 6% *Spirulina* supplemented noodles i.e82.10, 378.49, 139.40, 6.69 and 2.32 mg/100g of calcium, phosphorus, magnesium, iron and zinc, respectively, whereas, *in vitro* availability of iron, calcium and zinc were found as 51.33, 54.00 and 59.79%, respectively.

Keywords- *Spirulina platensis* powder, Noodles, Supplementation, Organoleptic acceptability, Nutritional quality.

Citation: Saharan Vatsala and Jood Sudesh, (2017) Quality Characteristics of Noodles Enriched with *Spirulina platensis* Powder. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 9, Issue 14, pp.-4091-4094.

Copyright: Copyright©2017 Saharan Vatsala and Jood Sudesh, This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Academic Editor / Reviewer: Apriyanto Mulono, Jadhav P.V.

Introduction

In this era of industrialization and new technologies, the life style of the people has changed. Now people demand ready to eat foods products like pasta, macroni, noodles, different types of breads. Among ready to eat foods, junk food form an important part of their diet. These products are rich in starch, fat and energy but depleted in other nutrients [1].

Human nutritional and dietary requirement understanding and an optimal provision of the same area of primary importance. Changing lifestyles, eating habits and unavailability of nutrition sources contribute to an increasing incidence of malnourishment and other health risks. As the source for most nutritional requirements is the diet, it is necessary to look into the aspect of supplements that will boost the health status of individuals. Given this current scenario, it is necessary to find a way to provide cost-effective nutritional and dietary supplements. One such nutritionally dense supplement, along with a wide range of macro and micronutrients of human health benefits is *Spirulina* [2].

The microorganism called "*Spirulina*" was so named this because of its spiral filament-like appearance under the microscope (and is classified as cyanobacterium). The nutritional composition of *Spirulina* may vary according to the growing conditions. *Spirulina* has an exceptionally high protein content (on the order of 60-70% of its dry weight), of which 90% is digestible. *Spirulina* contains all the essential amino acids in high amounts. The biological value of algae protein varies according to the algae species. According to limiting scientific evidence available, *Spirulina* might be a source of protein for human nurture especially in the situation of protein malnutrition. *Athrospira platensis* was originally collected from Lake Chad, Africa while *Arthrospira maxima* was originally collected from Lake Texcoco, Mexico. This alga can also be produced, processed and distributed, on a small scale, by local farming networks in less developed countries. Village ponds and lakes or land with soil conditions unsuitable for conventional crops can be used [3].

Now days consumers demand food products made of low-fat, sugar-free, low-salt, supplemented with vitamins, minerals and free from synthetic additives. The challenges directed towards the food industry will be to fulfill the needs of the challenging world market and to meet new consumer product needs. Today consumers are demanding on ever broadening selection of snacks food. At present low nutrient content snack foods are available. Extrusion has become a very important role in food processing operation. Extrusion cooking technology is a high temperature-short time processing for the development of new innovative products. It minimizes energy, time and cost [4]. Hence, the study was undertaken to prepare a value added noodles by incorporating nutrient dense *Spirulina platensis* powder. It is an excellent source of good quality protein (60-70%) with all essential amino acids in perfect balance and also provide high concentration of minerals and B-complex vitamins specially vitamin B_{12}. *Spirulina* contains many molecules as phycocyanin, β-carotene and xanthophyll pigments, α-tocopherol and phenolic compounds, which are responsible for the free radical scavenging activities of these microalgae, as shown by several authors for *in vitro* and *in vivo* experiments [5].

Materials and Methods

Procurement of raw materials

Spirulina platensis powder was purchased from Herbo Nutra, Wholesale Trader from New Delhi. Wheat variety (WH-1105) was procured from Wheat and Barley Section of Department of Genetics and Plant Breeding, CCSHAU, Hisar. Other ingredients were purchased from local market. The sample of wheat grains was milled in grinding machine to obtain fine flour. The wheat flour was blended with *Spirulina platensis* powder at 2, 4, 6 and 8% levels for development of noodles.

Preparation of noodles

The noodles formula include wheat flour and *Spirulina platensis* powder at 98:2, 96:4, 94:6 and 92:8 (salt 2.0 g, water 50 ml). The following method was adopted to

extrude noodles: The flour was hand mixed with a pre determined amount of water to form stiff dough, which was covered and rested for 30 min. to permit optimum moisture equilibrium and hydration. Then the dough was passed through the rolls to get sheet of 3 mm thickness and again it was passed through the rolls to get final sheet of 1.5 mm thickness. Immediately after the dough sheet was cut into noodle strips, which were taken on trays for drying. The noodles were dried in hot air oven at 50°C temperature for 2-3 h.

Organoleptic acceptability

Organoleptic acceptability of developed noodles were determined by a panel of 10 judges using a nine point Hedonic Rating Scale ranging from like moderately (9) to dislike extremely (1) for each organoleptic characteristics.

Nutritional evaluation of control and *Spirulina* supplemented noodles

On the basis of organoleptic acceptability, *Spirulina* supplemented noodles up to 6% were selected for further nutritional analysis. Proximate composition i.e moisture, protein, fat, crude fiber and ash were determined by AOAC [6]. Total carbohydrates was estimated by calculation method

Total carbohydrate (%) = 100 – [crude protein + crude fat + crude fibre + ash]

Total energy was calculated theoretically by using the following conversion factors 4.0, 4.0 and 9.0 kcal g^{-1} for protein, carbohydrates and fat, respectively [7].Fatty acid composition of *Spirulina* supplemented noodles was determined by the method of gas liquid chromatography [8].Total minerals i.e calcium, iron, magnesium and zinc in acid digested samples were determined by Atomic Absorption Spectrophotometer [9]. Whereas, phosphorus was determined colorimetrically [10]. *In vitro* availability of minerals, iron in the samples were extracted [11], Calcium and zinc were extracted [12].

Statistical analysis

The data were statistically analyzed in complete randomized design for analysis of variance [13].

Results and Discussion

Organoleptic acceptability

Mean scores of control noodles was 'liked very much' by panelists. On increasing the concentration of *Spirulina* powder in wheat flour for development of noodles resulted in decreasing the mean scores of colour of all the supplemented noodles as compared to their respective control. However, up to 6% level, mean scores of colour were found in the category of 'liked moderately' but thereafter on 8% level of incorporations, mean score of colour was 'liked slightly' by the judges. Similar trend was also observed in mean scores of appearance, aroma, texture and taste i.e up to 6% level found at par with control but further increasing incorporation level i.e 8% did not acceptable by the panelists due to dark green in colour, appearance and bitterness in taste [Table-1]. These results are in conformity with those obtained by various workers in extruded and pasta products fortified with *Spirulina* powder [4,14].

Table-1 *Mean score of organoleptic characteristics of Spirulina platensis powder supplemented noodles*

Types of Noodles	Colour	Appearance	Aroma	Texture	Taste	Overall Acceptability
Control (100% WF)	8.30±0.69	8.40±1.29	8.20±0.76	8.30±1.02	8.40±0.58	8.32±0.98
Supplementation level (%) WF : SP						
98 : 2	7.70±1.09	7.80±0.25	7.70±1.27	7.60±1.29	7.80±0.69	7.72±1.15
96 : 4	7.30±0.63	7.60±0.74	7.60±0.29	7.50±0.94	7.60±1.25	7.52±0.32
94 : 6	7.05±1.39	7.05±1.19	7.19±0.99	7.49±0.89	7.09±1.28	7.17±1.19
92 : 8	6.50±0.95	6.70±1.22	6.90±1.00	6.95±1.02	6.50±0.99	6.71±1.26
CD (P≤0.05)	1.11	0.98	1.13	0.89	1.30	1.22

Values are mean ± SE of ten panelists
WF = Wheat flour SP = *Spirulina* powder

Proximate composition and energy content

Proximate composition and energy content of control and *Spirulina* supplemented noodles are presented in [Table-2].

Table-2 *Proximate composition (%) and energy (Kcal/100g) content of noodles supplemented with Spirulinaplatensis powder (dry matter basis)*

Types of Noodles	Moisture	Protein	Fat	Crude fibre	Ash	Carbohydrates	Energy
Control (100% WF)	36.53±0.07	12.03±0.76	9.97±0.78	2.85±0.06	1.82±0.07	73.33±2.96	431.17±3.21
Supplementation level (%) WF : SP							
98 : 2	34.17±1.10	13.22±0.58	9.94±0.82	3.00±0.10	1.83±0.10	72.01±2.41	430.38±2.96
96 : 4	32.77±0.13	14.41±0.59	9.89±0.29	3.16±0.04	1.85±0.03	70.69±1.95	429.41±1.87
94 : 6	30.17±0.15	15.60±1.01	9.82±0.67	3.29±0.06	1.87±0.05	69.42±1.76	428.46±2.50
CD(P≤0.05)	1.86	0.97	NS	0.12	NS	0.62	0.96

Values are means ± SE of three independent determinations
WF = Wheat flour SP = *Spirulina* powder NS = Non-significant

Moisture content of control noodles was 36.53% which significantly (P≤0.05) decreased as the level of *Spirulina* powder increased. This can be attributed due to the addition of *Spirulina* powder in a dried form. Similar results were also reported in *Spirulina* supplemented extruded products [4,15].Protein (12.03%), crude fibre (2.85%) and ash (1.82%) contents in control noodles were found significantly (P≤0.05)lower as compared to *Spirulina* supplemented noodles i.e 13.22 to 15.60% protein, 3.00 to 3.29% crude fibre and 1.83 to 1.87% ash at 2, 4 and 6% supplementation levels, respectively. Whereas, fat content of fortified noodles gradually decreased with increase in the level of *Spirulina* powder in wheat flour. The increase in protein, crude fibre and ash content might be due to very high content of protein (71.90%), crude fibre (9.70%) and ash (3.50%)in *Spirulina platensis* powder as reported in present study. Other researchers also reported similar results in the *Spirulina* supplemented products [16,17].

Carbohydrate and energy content of *Spirulina* supplemented noodles in the present study were found to be significantly (P≤0.05) lower as compared to control noodles because *Spirulina* contained very low i.e. 13.63% carbohydrate and 1.27% fat which contributed lower energy content as compared to control. These results are in agreement with those reported earlier in *Spirulina* enriched products by various workers [17,18].

Fatty acid profile of control and *Spirulina* fortified noodles is presented in [Table-3]. The results of fatty acid profile of *Spirulina* powder supplemented noodles were indicated that stearic and linoleic were found lower in supplemented noodles as compared to control noodles. Whereas, α-linolenic and γ-linolenic acids, were not detected in control noodles but supplemented noodles had higher amounts of them. Among the supplemented noodles, 6% *Spirulina* incorporated noodles had maximum amount followed by 4 and 2% supplemented noodles. The values of α-

linolenic and γ-linolenic acid ranged from 0.35 to 1.05 and 0.70 to 2.10% total fatty acids in 2, 4 and 6% *Spirulina* supplemented noodles. Hence, in the present study, fatty acid profile of noodles significantly improved on increasing the fortification level of *Spirulina* powder in wheat flour might be due to higher amount of α-linolenic acid (14.80% of total fatty acid), γ-linolenic acid (30.00% of total fatty acids), palmitic acid (30.50% of total fatty acids) and oleic acid (10.60% of total fatty acids) in *Spirulina* powder as reported in the present study. Similarly, other workers [3,19] also reported higher amount of these fatty acids in *Spirulina* which resulted in enhancing the fatty acid profile of *Spirulina* supplemented products.

Total and available mineral contents of control and *Spirulina* fortified noodles is presented in [Table-4 and 5].

Table-3 *Fatty acid profile (% of total fatty acids) of noodles supplemented with Spirulina platensis powder (dry matter basis)*

Types of Noodles	Palmitic	Stearic	Oleic	Linoleic	α-linolenic	γ-linolenic
Control (100% WF)	40.48±1.09	18.40±1.23	15.14±0.91	11.92±1.89	ND	ND
Supplementation level (%) WF : SP						
98 : 2	40.88±1.95	18.06±1.02	15.54±1.60	11.52±1.49	0.35±0.05	0.70±0.09
96 : 4	41.28±0.93	17.73±2.10	16.34±1.12	11.00±1.15	0.70±0.07	1.40±0.08
94 : 6	42.00±2.04	17.00±0.93	17.44±1.53	10.70±2.37	1.05±0.04	2.10±0.05
CD (P≤0.05)	0.22	0.19	0.31	NS	0.16	0.23

Values are mean ± SE of three independent determinations
WF = Wheat flour SP = *Spirulina* powder NS = Non-significant ND = Not detected

Table-4 *Total mineral contents of Spirulina platensis powder supplemented noodles (mg/100g, dry matter basis)*

Types of Noodles	Calcium	Phosphorus	Magnesium	Iron	Zinc
Control (100% WF)	47.68±2.63	352.00±6.59	129.00±3.21	4.01±0.43	2.21±0.10
Supplementation level (%) WF : SP					
98 : 2	59.16±1.86	360.81±6.20	132.19±3.41	4.92±0.73	2.24±0.16
96 : 4	70.62±1.22	369.69±4.59	136.20±3.50	5.85±0.29	2.27±0.05
94 : 6	82.10±3.52	378.49±4.62	139.40±2.65	6.69±0.89	2.32±0.15
CD (P≤0.05)	2.59	4.75	1.06	0.85	NS

Values are means ± SE of three independent determinations
WF = Wheat flour SP = *Spirulina* powder NS = Non-significant

Table-5 *Available minerals of Spirulina platensis powder supplemented noodles (%, dry matter basis)*

Types of Noodles	Iron	Calcium	Zinc
Control (100% WF)	46.00±2.14	50.31±4.59	55.20±4.13
Supplementation level (%) WF : SP			
98 : 2	47.12±3.45	51.87±3.40	56.73±4.47
96 : 4	49.73±1.40	53.43±2.73	58.26±1.74
94 : 6	51.33±2.35	54.00±6.98	59.79±2.96
CD (P≤0.05)	1.00	0.16	1.13

Values are means ± SE of three independent determinations
WF = Wheat flour SP = *Spirulina* powder

Spirulina fortified noodles exhibited significantly(P≤0.05)higher amount of calcium, phosphorus, magnesium and iron as compared to control noodles. Zinc content was differed non-significantly. As on increasing the level of *Spirulina* supplementation resulted in significant improvement in total minerals. Among the supplemented noodles, 6% *Spirulina* supplemented noodles had significant (P≤0.05) higher amount than 4 and 2% supplemented noodles. It might be due to addition of *Spirulina* powder which contained many folds higher mineral contents than wheat flour as reported in the present study. These results are also in agreement with those reported by other workers in *Spirulina* supplemented pasta [4,20].

In vitro availability of calcium, iron and zinc were also found higher in all the three types of supplemented noodles as compared to wheat flour based noodles. It might be due to absence of phytic acid in *Spirulina* powder which are known to bind the divalent cations and hence reduce their bioavailability [21].

Conclusion

It may be concluded from the present study that *Spirulina* powder fortified noodles upto 6% were found equally acceptable in terms of organoleptically characteristics as compared to wheat flour based noodles, it also revealed that noodles developed with supplementation of 6% *Spirulina* powder contained significantly higher nutrients than noodles prepared with whole wheat flour. Hence, there is need for creating awareness among the people about the nutritional and health benefits of *Spirulina* incorporated extruded products for those who are fond of eating junk food and suffering from malnutrition.

Acknowledgement/Funding: I would like to thanks my major advisor Dr. (Mrs.) Sudesh Jood, Professor and Head, Department of Foods and Nutrition, College of Home Science, CCS Haryana Agricultural University, Hisar-125004 for her guidance during my research work.

Author Contributions: Both author equal contributed

Abbreviations: Mentioned

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest: None declared

References

[1] Chauhan A. and Intelli (2014) *International Journal of Nutrition and Agriculture Research*, 1(2), 93 - 98.
[2] Ravi M., Lata De S., Azharuddin S. and Paul S.F.D. (2010) *Nutrition and Dietary Supplements,* 2, 73–83.
[3] Tang G. and Suter P.M. (2011) *Journal of Pharmacy and Nutrition Science*, 1(2), 111-118.
[4] Vijayarani D., Ponnalaghu S. and Rajathivya J. (2012) *International Journal of Health Science and Research*, 2(4), 42-47.
[5] Patel A., Mishra S. and Glosh P. (2006) *Indian Journal of Biochemistry and Biophysiology*, 43, 25-31.
[6] AOAC. (2000) Official Methods of Analysis of Association of Official Analytical Chemists. Washington, D.C.
[7] Paul A.A and Southgate A.D. (1979) The composition of food. 4th Edition, Elsevier North, Holland Biomedical Press, Amestrdam. pp, 5-11.
[8] Vasudev S., Yadava D.K., Malik D., Tanwar R.S. and Prabhu K.V. (2008) A simplified method for fatty acid analysis of oilseeds. Division of Genetics;

Division of Agricultural Chemicals, Indian Agricultural Research institute, New Delhi-110 012.
[9] Lindsey W.L. and Norwell M.A. (1969) *Agronomy Abstract,* 61, 84-89.
[10] Chen P.S., Tosibara T.Y. and Warner H. (1956) *Anals of Chemistry,* 28, 1756-1759.
[11] Rao B.S.N. and Prabhavathi T. (1978) *American Journal of Clinical Nutrition*, 31, 169-173.
[12] Kim H. and Zemel M.B. (1986) *Journal of Food Science*, 51, 957-963.
[13] Sheoran O.P. and Pannu R.S. (1999) Statistical Package for agricultural workers. "O. P. Stat" College of Agriculture, Kaul, CCS Haryana Agricultural University, Hisar. India.
[14] Lemes A.C., Takeuchi K.P., Carvalho J.C.M. and Danesi E.D.G. (2012) *Brazilian Archives Biology Technology*, 55, 15-25.
[15] Ponciano G.Y. (2015) *International Journal of Current Research in Bioscience and Plant Biology*, 2(5), 92-100.
[16] Figueira F.S., Crizel T.M., Silva C.R. and Salas-Mellado M.M. (2011) *Brazil Journal of Food Technology*, 14(4), 308-316.
[17] Selmo M.S. and Salas-Mellado M.M. (2014) *International Food Research Journal*, 21(4), 1523-1528.
[18] Minh, N.P. (2014) *International Journal of Multidisciplinary Research Development*, 1(4), 36-44.
[19] Abd El Baky H.H., El-Baroty G.S. and Ibrahem E.A. (2015) *Nutrition Hospitalaria,* 32(1), 231-241.
[20] Mamatha B., Namitha K., Senthi A., Smitha J. and Ravishankr G. (2007) *Food Chemistry*, 101, 1707-1713.
[21] Chaudhary H. (2011) Nutritional and sensory evaluation of bakery products development from composite flour. M.Sc. Thesis, Dept. of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, India.