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# Formulation and evaluation of spirulina (*Arthrospira platensis*) incorporated millet based weaning food

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**Abstract**

Microalgae are promising sources of biologically active compounds that could be used as functional ingredients. The fascinating properties and healthy chemical composition (high-quality proteins, balanced fatty acid profiles, antioxidants) of spirulina make it a preferred functional ingredient. Spirulina, also known as *Arthrospira*, is a non-nitrogen-fixing blue-green alga that is edible. With over 30 years of safety research and a long history of healthy human consumption, it complies with all international food safety and quality regulations. An online survey was conducted to understand the consumer's preference and awareness of spirulina and its related products. Multi millet-based weaning food was developed and spirulina was incorporated at 1.5% and 2%. The organoleptic properties of the weaning mix prepared were analyzed by a semi-trained panelist using a 9-point hedonic scale. One-way ANOVA results showed that there was no significant difference between the control and the samples. Also, sample B with 2% spirulina had the maximum overall acceptability. On calculating the nutrient profile of the weaning mix, it was found that the protein content of sample B (2% spirulina) was relatively higher than the control and sample A (1.5% spirulina).

**Keywords:** spirulina, weaning foods, millets, consumer preference and attitude

## Introduction

Spirulina is a filamentous cyanobacterium that has been used since time immemorial. It is the dried biomass of *Arthrospira platensis* (Karkos 2001) [3]. Spirulina is considered safe for humans as well as animal consumption and it is a rich source of protein (up to 65%). They belong to the category Generally recognized as safe (GRAS) as per the US Food and Drug Administration [1]. They show their optimum growth at 35–37°C and pH of about 10. It can grow naturally in warm regions with alkaline waters (Pelizer *et al* 2002) [7]. Currently, spirulina is used popularly for its high nutrient content and it is marketed worldwide as a food supplement or as an active ingredient in functional foods and beverages. Spirulina contains larger proportions of beta-carotene than any other whole-food; it is rich in B vitamins, minerals, trace elements, gamma-linolenic acid (GLA), chlorophyll, and enzymes; and it is abundant in other nutrients including carotenoids, sulfolipids, and glycolipids (Bob Capelli 2010) [2]. Spirulina, being rich in beta-carotene shall help in reducing the effects caused due to vitamin A deficiency (Lei Li *et al* 2012) [4]. It has been clinically established that spirulina can exhibit anti-inflammatory properties by inhibiting the release of histamine (Yang *et al* 1997) [9]. Spirulina when used along with herbs, shows the ability to suppress various viruses through immunomodulation. The combined antioxidative and immune modulation properties of spirulina helps in the destruction of tumor-forming cells. The extract of spirulina along with zinc is used in the treatment of chronic arsenic poisoning (Misbahuddin *et al* 2006) [6].

Breast milk is not sufficient for meeting the infant's requirement hence weaning foods should be introduced post 6 months. The weaning period is one of the most important stages of a child's growth. It is the phase where dietary transformation occurs and the nutritional needs for growth and brain development are at their highest. Biting and chewing abilities are improved as various tastes and textures are introduced (Sajilata *et al* 2002) [8]. Weaning foods are foods that are modified by processing the ingredients to make them easily digestible for the infant.

Millet-based weaning foods have been on trend for the last few decades. The most commonly consumed cereal-based weaning foods in India are cereal-millet/milk-based. However, these are poor sources of various essential amino acids- Threonine, Lysine, Tryptophan.

Hence, the current study was undertaken to formulate a multi millet-based weaning food with spirulina incorporation to make it balanced and nutritionally dense.

## Methodology

### Survey on awareness and preference of Spirulina and its products

A self-administered questionnaire was prepared to understand the awareness and preference of spirulina-based products. The questionnaire was tested for its validity and a pilot study was conducted. The questionnaire consisted of four sections; The first two sections of the questionnaire consisted of demographic information such as name, age, educational qualification, and occupation. The respondents were classified into four different categories based on age as follows, 18-25 yrs., 26-40 yrs., 41-60 yrs., and 60-65 yrs. The third and fourth part of the questionnaire, consists of detailed questions, to evaluate and understand consumers' knowledge on spirulina, their preference if spirulina-based products are added to their diet.

**Procurement of ingredients**
Spirulina powder was obtained from N.B Laboratories Pvt Ltd, Parsioni District Nagpur, India. Various millets including horse gram, pearl millet, corn millet, foxtail millet, kodo millet, ragi millet, sorghum millet was obtained from local markets at Chennai, Tamil Nadu, India.

**Preparation of Weaning Mix**
The millets were sun-dried for a day for 5 hours. These were later winnowed for removing the unwanted debris present in them. The winnowed millets were roasted at medium flame for 10 minutes. All the millets were milled using the traditional method. The powders were stored in air-tight plastic bags at room temperature. The milled powders were weighed using a weighing machine and were combined as presented in table 1 and stored at room temperature in airtight zip lock plastic bags.

**Table 1:** Composition of the weaning food prepared (per 100g)

| Ingredient | Control | Sample A | Sample B |
|---|---|---|---|
| Ragi | 22g | 20.5g | 20g |
| Kodo millet | 10g | 10g | 10g |
| Foxtail millet | 15g | 15g | 15g |
| Corn millet | 10g | 10g | 10g |
| Pearl millet | 10g | 10g | 10g |
| Horse gram millet | 20g | 20g | 20g |
| Sorghum | 10g | 10g | 10g |
| Dried ginger powder | 3g | 3g | 3g |
| Spirulina | - | 1.5g | 2g |


**Fig 1:** Mixed millet weaning food-dry

**Preparation of millet weaning foods**

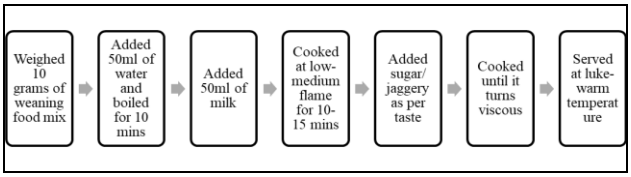


**Fig 2:** Preparation of millet weaning food

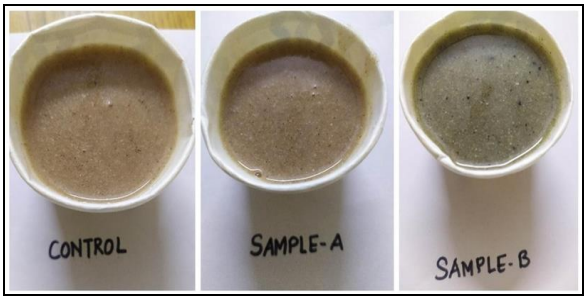


**Fig 3:** Mixed millet weaning food prepared

**Sensory Analysis**
The prepared product was served at lukewarm temperature and it was evaluated by 7 semi trained panelists based on five important parameters which includes appearance, texture, flavour, taste, overall acceptability. The samples were presented in a randomized order to the panel members. Potable drinking water were given to the panel members to use between testing if needed.

**Nutritional labelling of the product**
The Calorific value, carbohydrates, fats, protein, iron, calcium, dietary fiber, phosphorous, beta carotene were calculated using the nutrient values reported by the Indian food composition book (Longvah *et al* 2017) [5] published by ICMR (2017).

**Statistical analysis**
The survey data was presented as percentage and frequency. The data for sensory evaluation was reported in the form of mean and standard deviation. One-way ANOVA was carried out to analyze if there were any significant differences in the sensory parameter of various weaning mix samples. Data analysis was done using Microsoft excel 2010.

**Results and Discussion**
**Survey on consumer preference and attitude towards Spirulina**
An online survey was conducted on consumer awareness and preference towards spirulina and spirulina-based products. Based on convenience sampling a total of 206 respondents (n=206) took part in the survey. The majority of the responses were from women which constituted about 62.1% (128) and the rest 37.9% were male (78). Most of the respondents belonged to the age group of 18-25 years and the student respondents constituted 58.7% (121). 24% of the participants were working in either government or the private sector, 10% of the participants were freelancers, 5% were entrepreneurs and 2% of the respondents were retired professionals. 34.9% of the respondents earned above INR 50,000 and 20 % of the respondents earned below INR 10,000.

**Consumption of spirulina**
Figure 4 depicts that the majority of the respondents i.e., 74% (172 respondents) have consumed spirulina at least once and 17% of the respondents were not sure whether they have consumed it or not. The major reasons why the rest of the population hasn't consumed spirulina could be attributed to lack of knowledge on spirulina and its health benefits, unavailability, or other socio-economic reasons like religion, ethnic beliefs, etc.

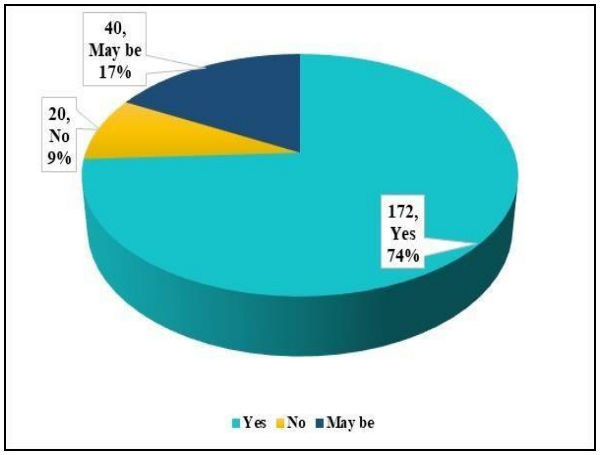


**Fig 4:** Consumption of spirulina

### Consumer's opinion on positive health benefits of Spirulina

When the respondents were questioned on their inclination towards the positive effects of spirulina, 57 respondents strongly agreed and 92 respondents agreed to the fact that spirulina has a positive effect on health. Only 1 respondent disagreed with the health benefit of spirulina. The main reason for the disagreement could be a lack of knowledge on the nutritional significance of spirulina.

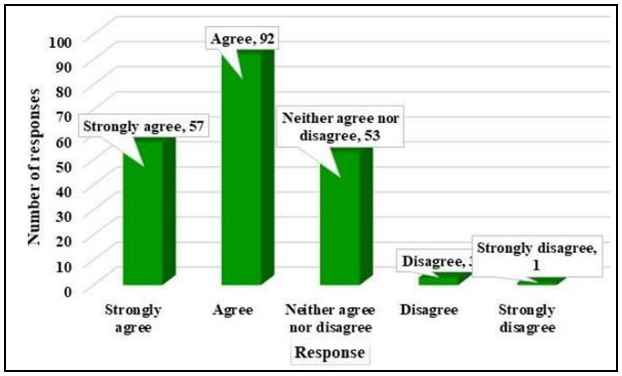


**Fig 5:** Consumer's opinion on positive health benefits of Spirulina

### Consumer awareness of benefits of consuming spirulina

The figure below illustrates that 36.13% of the respondents agreed with the fact that spirulina is a good source of protein. 21.88% of the respondents were aware of the fact that spirulina had anti-oxidant property and 13.99% of them considered it to have anti-inflammatory properties. About 8.14% of the respondents attributed it to lowering blood sugar levels and 8.65% of the respondents think spirulina could reduce blood pressure.

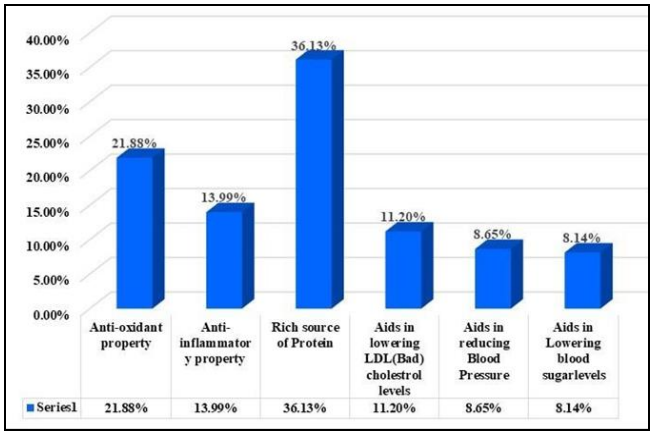


**Fig 6:** Consumer awareness of benefits of consuming spirulina

### Willingness to buy spirulina-based products

Exactly 50% of the respondents (103 respondents) were ready to buy spirulina-based products. Because of increasing consumer awareness of the health benefits of spirulina superfood and the wide variety of natural colors produced by spirulina, the global spirulina market is expected to expand rapidly soon.

### Sensory parameters of Spirulina incorporated instant weaning food

The prepared weaning foods were subjected to sensory analysis. The figure 7 and table 2 illustrates the organoleptic properties of weaning mixes with spirulina incorporation.

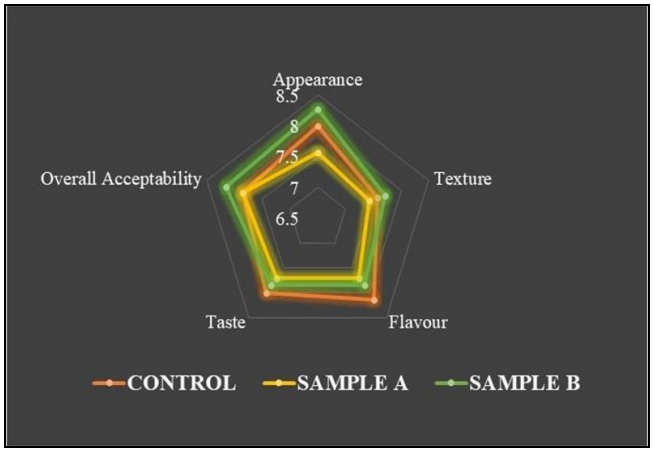


**Fig 7:** Sensory parameters of Spirulina incorporated instant weaning food

**Table 2:** Hedonic scores of the weaning food prepared with spirulina incorporation.

| Sample | Appearance | Texture | Flavour | Taste | Overall Acceptability |
|---|---|---|---|---|---|
| Control | 8 ± 1.06 | 7.57 ± 1.67 | 8.14±1.35 | 8±2.07 | 7.85±1.64 |
| Sample A (1.5%) | 7.57 ± 1.78 | 7.42 ± 1.91 | 7.71±0.88 | 7.71±1.57 | 7.85±1.24 |
| Sample B (2%) | 8.28 ± 0.69 | 7.71 ± 1.38 | 7.85±0.98 | 7.85±1.35 | 8.14±0.98 |

Values are presented as means ± standard deviation of 7 respondents No Significant difference between the samples (One-way ANOVA, $p \geq 0.05$).

The multi millet-based weaning mix with 2% of spirulina (sample B) had the highest overall acceptability but the ANOVA results showed no significant difference between the control and samples A and B (1.5% and 2% spirulina). The control with no added spirulina was preferred the most for its flavor, sample A was the most preferred for its appearance. The major preference towards sample B might be due to its enhanced color, flavor, and viscous nature of the end product. Incorporation of spirulina at 2% can be inferred as the most preferred product. The result of sensory evaluation can be summarized that sample B was the most accepted among the three.

### Nutritional labelling of weaning mix

The nutritive values were tabulated using calculation method (Indian food composition by ICMR, Longvah *et al*, 2017) [6]. The following parameters were calculated: calories, carbohydrates, fats, protein, iron, calcium, dietary fiber, phosphorous, beta carotene.

**Table 3:** Nutrient value of the weaning foods (per 100g of dry mix)

| | Calories (Kcal) | CHO (g) | Protein (g) | Fat (g) | Iron (mg) | Calcium (mg) | Phosphorous (mg) | Beta carotene (µg) | Fiber (g) |
|---|---|---|---|---|---|---|---|---|---|
| Control | 322.2 | 62.56 | 12 | 2.56 | 4.69 | 148.9 | 256.82 | 4.18 | 6.57 |
| Sample A | 323.01 | 61.82 | 13.14 | 2.52 | 5.49 | 150.2 | 265.7 | 9.4 | 6.4 |
| Sample B | 323.2 | 61.5 | 13.4 | 2.5 | 5.75 | 150.7 | 268.02 | 15.05 | 6.4 |

On comparing the nutrient content of the weaning mix, all the samples had a similar nutrient profile. But of all the variants of weaning mixes, it is evident that there was a significant increase in protein by 1.4g in sample B (with 2% spirulina). The calorific value of control, sample A and sample B were similar. Sample B had high beta carotene due to the greater percentage of spirulina incorporation. Also, sample B had higher levels of fiber content when compared to the other two variants.

**Conclusion**

The survey conducted helped in understanding that most of the participants were aware of spirulina and its health benefits. The current study aimed in utilizing the benefits of spirulina in a multi millet-based weaning mix. A millet-based weaning mix with spirulina was formulated and the sensory characteristics were evaluated. The most preferred weaning mix was sample B which had 2% of spirulina. One-way ANOVA results showed that there was no significant difference between the control and the samples. Hence all the samples can be considered to be equally accepted. The calorific value and the nutrient profile of control, sample A and sample B were similar. Therefore, this study strongly recommends the usage of spirulina in weaning foods due to its accepted sensory characteristics and nutritional properties

**References**

1. Center for Food Safety and Applied Nutrition. Agency Response Letter GRAS Notice No. GRN 000623. U.S. Food and Drug Administration, 2018.
2. Capelli B, Cysewski G R. Potential health benefits of spirulina microalgae,2010:9(2):19-26.
3. Karkos PD, Leong SC, Karkos CD, Sivaji N, Assimakopoulos DA. Spirulina in clinical practice: evidence-based human applications. Evidence- based complementary and alternative medicine, 2011, 531053.
4. Li L, Zhao X, Wang J, Muzhingi T, Suter PM, Tang G *et al*. Spirulina can increase total-body vitamin A stores of Chinese school-age children as determined by a paired isotope dilution technique. Journal of nutritional science,2012:1:19.
5. Longvah T. Indian Food Composition Tables. National Institute of Nutrition. 3rd edition, 2017, 1.
6. Misbahuddin M, Maidul Islam A, Khandker S, Islam N. Efficacy of Spirulina Extract Plus Zinc in Patients of Chronic Arsenic Poisoning: A Randomized Placebo-Controlled Study. Clinical Toxicology,2006:44(2):135-141.
7. Pelizer LH, Danesi EDG, Rangel CDO, Sassano CE, Carvalho JCM, Sato S, Moraes IO. Influence of inoculum age and concentration in Spirulina platensis cultivation. Journal of Food Engineering,2003:56(4):371-375.
8. Sajilata G, Singhal RS, Kulkarni PR. Weaning Foods: A Review of the Indian Experience. Food and Nutrition Bulletin,2002:23(2):208-226.
9. Yang HN, Lee EH, Kim HM. Spirulina platensis inhibits anaphylactic reaction. Life sciences,1997:61(13):1237-1244.