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Formulation of Spirulina based Macaroni and their Nutritional, Physical, Sensory and Microbiological Analysis

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ABSTRACT: The aim of this work was to study the enrichment of Spirulina platensis in wheat flour to prepare Macaroni. The 5% Spirulina incorporated Macaroni were evaluated for the centesimal composition, microbiological contamination, sensorial acceptance and technological characteristics. The nutrient content of Spirulina incorporated Macaroni was analyzed and it contains 8.67 % of moisture, 0.398 % of ash, 374 k cal / 100 g of energy, 13.10 % of protein, 31.60 % of carbohydrates, 4.21 mgs of iron, 297.98 mg of calcium and 120.92mgs of phosphorous. Developed Spirulina incorporating Macaroni had significant difference in its nutritional composition when compared with the control. The sensory analysis of the developed Macaroni using Spirulina showed that 5% Spirulina incorporated product got the maximum mean score due intensification of colour and odour. The Developed Spirulina incorporating Macaroni were subjected to microbial analysis for fungi and bacteria for one month and found to be safe

Key words: Spirulina incorporating Macaroni, Sensorial Acceptance, Technological Characteristics.

I. INTRODUCTION

India is home to the largest number of hungry people in the world. The Global Hunger Index (GHI) 2010 ranks India at 67 out of 122 countries; whereas the '2012 The deficiency of essential vitamins and minerals, which mostly affect pregnant women and children between 3 months and 6 years when the growth needs are the highest. These deficiencies can cause diseases like kwashiorkor (physical troubles: pale face, members oedemas) and marsmus (WHO, 2008).

Nowadays, food industries need new food ingredients obtained from natural sources and developed novel functional foods or nutraceuticals. Microalgae now combine the traditional and new biotechnologies where microalgal biomass can be used as a source of proteins, biochemical's, lipids, polysaccharides and colorants (Athukorala et al., 2006). Among microalgae species, Spirulina utilized as food in the area around Lake Chad for long time ago and marketed as a healthy aliment in the United States and Japan (Borowizka, 1998). Spirulina (Arthrospira) is a blue-green algae found in alkaline Lakes around the world. The name "Spirulina" is derived from the Latin word for "helix" or "spiral", referring to the physical structure of the organism. Spirulina is one of the cleanest, most naturally sterile foods found in nature. It has been used as feed for fish, poultry and farm animals (Tragut et al., 1995; Abdulqader et al., 2000)

The philosophy of food as medicine is more relevant today than ever before. Health and nutrition are the most important contributory factors of human index measure in any country. India is passing through the phase of economic transition while the problem of malnutrition continues to be a major problem. "Youth are the future holders of any nation." So healthier growths of them mean better development of the nation, but in Uttar Pradesh the condition of children and females are dismal, the adolescent girls are more affected. Addition of a healthy amount of complete protein in our diet is very important. Spirulina is gaining more attention from medical scientists as a nutraceutical and source of potential pharmaceutical. Spirulina is one of the great super foods. It is approximately 65 to 71 percent complete protein in its natural state. This is higher than virtually any other unprocessed food. Spirulina is nutrient rich super food for super health. Super food can be defined as foods that

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have health promoting benefits and disease preventing properties over and above their nutritional value. It is the most nutritious concentrated whole food source found in nature.

The Spirulina platensis was recognized a "wonderful food for health" since it contain high proteins (55-70%), (Umesh and Sheshagiri, 1984; Sanchez and Bernal, 2006), bioactive compounds such as, essential fatty acids (4-7%) like, linolenic and Y-Linolenic acid (Borowitzka, 1998; Othes and Pire, 2001; Sanchez and Bernal, 2006; Kumar et al., 2012), vitamins like, provitamin A, vitamin B complex, B1 (thiamine), B2 (riboflavin), B3 (nicotinamide), B6 (pyridoxine), B9 (folic acid), B12 (cyanocobalamin), vitamin C, vitamin D and vitamin E (Richmond, 1992; Belay, 1997), bio-pigments like phycocyanin and chlorophyll-a (Achmadi and Tri-Panji, 2000; Manojkumar et al., 2011)

It is motile multicellular filamentous blue-green algae and reproduces by binary fission. Spirulina is a non nitrogen-fixing blue-green alga and cell wall made of mucopolysaccharide its soft and easily digestible nature, which makes it safe for human consumption. Spirulina is capable of growing in high alkalinity with the presence of carbonate, bicarbonates and inorganic nitrogen (Aiba and Ogawa, 1977; Yang et al., 2010). The ability of Spirulina to grow in hot and alkaline environments ensures its hygienic status, as no other organisms can survive to pollute the waters in which this alga thrives.

Spirulina, is the most widely exploited economic microalgae (Ciferri, 1983; Mosulishvili et al., 2002). Because it's rich in protein contents, essential fatty acids, vitamins, minerals (Tokusoglu and Unal, 2003), and polysaccharides (Zhang et al., 2010), Arthrospira was claimed to be an ideal food and dietary supplement in the 21st century by Food and Agriculture Organization of the United Nations and World Health Organization. Recently, Arthrospira attracts more interests on its potential medical and biodiesel application (Khan et al., 2005; Bermejo-Bescos et al., 2008; Bachstetter et al., 2010; Cheong et al., 2010; Khola and Ghazala, 2012). Some of the best worldwide known Spirulina producing companies are: Earthrise Farms (USA), Cyanotech (USA), Hainan DIC Microalgae Co., Ltd (China), Marugappa Chattier Research Center (India), Genix (Cuba) and Solarium Biotechnology (Chile) (Belay, 1997).

II. MATERIALS AND METHODS

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

Product development: The Macaroni was processed on this formulation with special wheat flour. Spiruina based Macaroni were developed in Aaho Food Industry, Jabalpur M.P.

Table: 1 Composition of Spirulina Macaroni

S.No.	Ingredients	Quantity (%)
1.	Semolina wheat flour	72
2.	Vegetable oil	4.5
3.	Salt	0.5
4.	Water	18
5.	Spirulina powder	5

Organoleptic Evaluation- Sensory evaluation included selection of semi trained panel using Control and Developed Spirulina Macaroni were subjected to 5 point hedonic test by a panel of 5 judges.

Nutritional Evaluation- Prepared Macaroni was analyzed Moisture, Ash, Protein, Fat, Carbohydrate, Energy, Iron, Calcium and Phosphorous.

Microbial examination: The cultural examination of the Macaroni 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).

III. RESULT AND DISCUSSION:

Table: 2 Organoleptic acceptability of Spirulina Macaroni

Proportion of Spirulina powder	Mean score of Sensory Evaluation

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	Appearance	Colour	Texture	Odour	Taste	Over all acceptability
Control 0%	3.4	4.0	3.9	3.8	4.0	3.8
5% **Spirulina**	3.8	4.1	4.0	3.9	3.7	4.1

Table: 3 Nutritional analysis of control and Spirulina Macaroni

S. No.	**Test Parameters**	**Control**	**Spirulina based Macaroni**	**Requirement as per**
1.	Protein%	12.50%	13.10 %	0.1 to 60 %
2.	Carbohydrate%	32.20%	31.60 %	0.1 to 70 %
3.	Moisture%	8.56%	8.67 %	0.5 to 50 %
4.	Ash%	1.28%	0.398 %	0.001 to 10 %
5.	Calorific Value	373 k cal/100g	374 k cal / 100 g	1 k cal / 100 g to 1000 k cal / 100 g
6.	Acidity %	8.40%	9.56 %	1 to 10 %
7.	Iron mg/100 gm	1.97	4.21	10.60±0.04
8.	Calcium mg/100 gm	223.15	297.98	322.40±0.08
9.	Phosphorous mg/100 gm	59.34	120.92	165.00±0.05

Macaroni Production Unit

Drying

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Spirulina **Macaroni**

Different Media used for microbiological Examination

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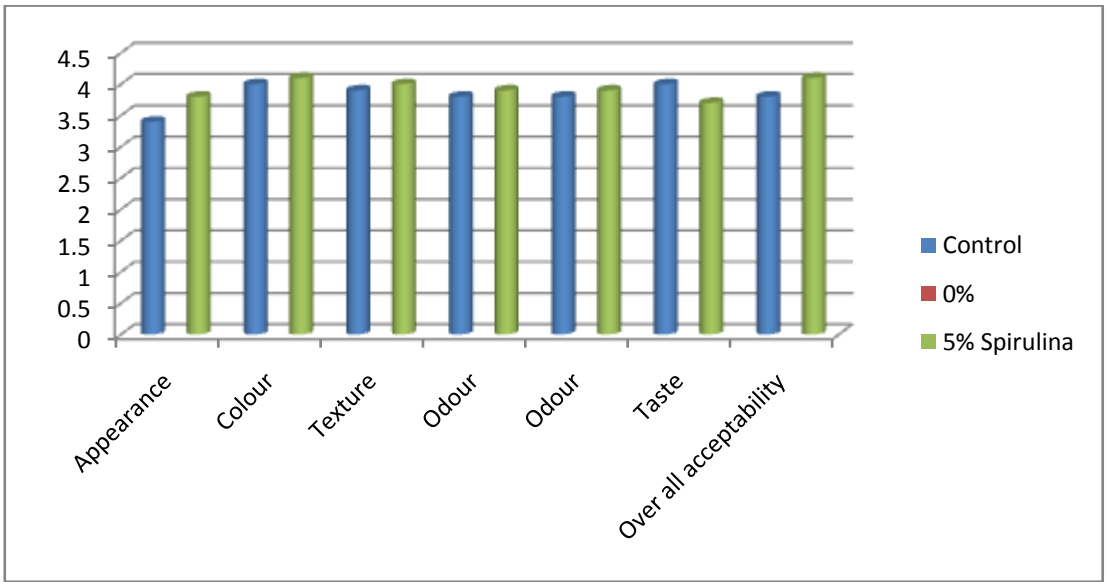
TCBS Agar Plates EMB Agar Plates PDA Agar Plates MacConkey Agar Plates



Organoleptic acceptability of Spirulina Macaroni

Organoleptic Evaluation: Table 2 reveals that control pasta and Spirulina based pasta samples were subjected to organoleptic evaluation by the experts and the results were noted. Spirulina fortified pasta were falling into the liked, disliked or neither like nor dislike. Study reveals that the study of food products from a total of 10 human experts, who has judge the pasta.

Nutritional Analysis: Nutritional analysis was judged under normal condition. Table 3 show that the data of nutritional contents of fortified Spirulina pasta was much higher than control samples.

Shelf life study: Under the present study shelf life of Spirulina pasta was judged on the basis of their organoleptic evaluation, during months, under normal condition.

Storage studies

The storage studies for the control and 5% Spirulina incorporated Pasta samples were carried out for a period of one month. They were analyzed microbially. The total bacterial and fungal counts were enumerated using plated count. EMB, TCBS, MacConkey, XLD and PDA media were used for the determination of Bacteria and fungi count. No contamination was found for the period of one month and the product

IV. CONCLUSION

Pasta can be made by incorporating 5%Spirulina powder. The product is found to be microbially safe till the observed period of three month. This developed Spirulina pasta will not only improve the nutritional status of the community but also solve a number of nutritional problems prevailing in the community if they eatthe storage period of three

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