Original Research Article

'Spirulina' as an Additive for Better Nutrition

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The snacks were prepared by using spirulina as an ingredient with different concentrations. Proximate composition analysis was done to estimate moisture, protein, fat, carbohydrate, ash and energy content of the snacks. Nutritional value of the snacks was found to be increased with increase in the concentration of the spirulina. Organoleptic evaluation led to selection of 5% concentration of spirulina to be better when compared with 10% and 15%. Addition of spirulina not only increased the nutritional value of the product but also influenced the textural properties and quality characteristics.

Introduction

Spirulina (*Spirulina platensis*) is blue - green algae that thrive in warm, alkaline fresh-water bodies. It is cultivated all around the world and is used as a human dietary supplement as well as whole food which are available in tablet, flake and powder form. Spirulina provides a wide range of health benefits almost immediately upon ingestion. It boosts the immune system, lowering cholesterol, heart health, diabetes treatment, wound healing, improving digestive health and as an antidote to depression and anxiety. Spirulina is also a natural detoxifier, oxygenating the blood, and helping cleanse the body of toxins and other impurities that may be causing illnesses or other health complications. Moreover, most research has focused on the health effects of spirulina as a dietary supplement for humans and therapeutic applications: an anti-cancer effect (Mao *et al.,* 2005), a hypolipidemic effect (Narmadha *et al.,* 2012), and a protective effect against diabetes and obesity (Anitha and Chandralekh, 2010). These advantages make spirulina a good raw material for the healthy food.

Inclusion of spirulina as ingredient to the different food materials can improve the nutritional value of that food. Snacks such as cookies have low water content, which protects them from microbial spoilage and provides longer shelf life. Cookies are very popular, easy-to-eat products consumed all over the world. Unfortunately, such products in the market very often contain fat rich in saturated fatty acids and *trans* fatty acids.

However, products with wholegrain flour and dried fruits are becoming more popular due to the consumers' increasing awareness of healthy life style.

Scientific papers report possibilities of using bioactive compounds such as: dietary fibers (Demirkesen, 2016), plant extracts (Mildner-szkudlarz *et al.,* 2009), fruit pomaces in bakery products (Bajerska *et al.,* 2016) and legume flours (Cheng and Bhat, 2016). Addition of such ingredients may very often have adverse impact on textural properties and sensory characteristics.

Addition of spirulina as an ingredient in food not only increase nutritional value of such products but also influence the textural properties and quality characteristics. Addition of even small amounts of Spirulina has a strong impact on sensory characteristics like color, smell, taste and texture of a product (Kumoro *et al.,* 2016). Addition of spirulina to snacks recipes may influence both physical parameters and overall acceptability. The aim of this work was to analyse physical and sensory properties of snacks *viz.* Shankarpali supplemented with different amounts of spirulina.

Materials and Methods

Preparation of spirulina snacks

All the preparations were made at Food technology laboratory, College of Agricultural biotechnology, Ahmednagar, MS, India. Spirulina snacks (Shankarpali) was prepared using spirulina powder (obtained from Spirulina Production Research and Training Centre, Ahmednagar, MS, India) with three different concentrations *viz.* 5%, 10% and 15% along with control with no spirulina (Table 1). Refined and good quality wheat flour was added with spirulina powder and 5% corn floor. Presterilized whey water was used

to prepare dough which was cut into rectangular shape pieces using knief. These were fried in vegetable oil in an open pan and stored.

Estimation of proximate composition

Proximate composition analysis *viz.* Moisture content, Total ash content, Protein content, Crude protein content, Crude carbohydrate, Crude fat and Energy was done for the prepared product according to A.O.A.C., (2000).

Moisture

Moisture content was worked out by subjecting 5 gm sample to oven drying at $110^{o}C$ for 4-5 hrs until the constant weights were obtained. The resultant loss in weight was calculated as percent moisture content using formula, Moisture (%) = $[W_1-W_2/W_1]\times100$, Where, W_1=Initial weight of sample and W_2=Final weight of sample.

Total ash

For estimation of total ash content 5 g sample was weighed into crucible and ignited at low flame till all the material was completely charred. Then it was kept in muffle furnace for 6 hrs at $600^{o}C$ and further cooled in desiccators and weighed. This was repeated till two consecutive weights were constant and per cent ash was calculated using formula, Total ash (%) = $[W_1-W_2/5]\times100$, Where, W_1= weight of crucible with sample and W_2= weight of crucible with ash.

Crude protein

Protein content was determined by estimating the per cent nitrogen according to A.O.A.C., (2000) with Kjeldahl's method and then converted into protein content as, % Crude protein content = nitrogen content x 6.25.

Carbohydrate

For estimation of crude carbohydrate (DNS method) about 0.1g sample was weighed into 25ml volumetric flask.1.3ml of 62% perchloric acid was added with continuous shaking for 20 minutes to homogenize the mixture completely. The volume was made up to 25 ml using distilled water. The solution was filtered and 1ml of the filtrate was transferred to 10ml volumetric flask and diluted to volume with distilled water. 11ml of this working solution was taken into a clean test tube and 5ml of anthrone reagent was added. Absorbance of the standard glucose was recorded at 630nm and the value of the carbohydrates was calculated using the formula, % carbohydrates = 25× Absorbance of sample/Absorbance of standard ×1g.

Crude fat

Crude fat content was analysed with Soxhlet's method. One gram of the dried sample was transferred to a paper thimble, plugged at the opening with glass wool and placed into a thimble holder. 200 ml of petroleum ether was taken into a previously dried and weighed round-bottom flask and this was assembled together with the thimble holder and its contents. The Quickfit condenser was connected to the Soxhlet Extractor and refluxed for 16 hours on low heat on a heating mantle. The flask was then removed and the solvent evaporated on a steam bath. The flask containing the fat was heated at 105°C in an oven for 30 minutes, cooled in a desiccator and the weight of the fat collected determined and expressed as percentage crude fat using the formula, Crude Fat (%) = Weight of Fat/ Weight of original sample × 100

Energy is calculated by multiplying protein and carbohydrate content by 4 and fat content by 9. Total energy = 4 (Protein content+ carbohydrate content) + 9 fat content.

Organoleptic evaluation

Prepared spirulina snacks with three different concentrations of spirulina powder was evaluated for acceptance for its appearance, colour, texture, odour and taste. This evaluation was done by a panel of six members using 5 point hedonic scale.

Results and Discussion

Proximate composition of spirulina snacks

Snacks prepared using spirulina with different concentrations *viz.* 5%, 10% and 15% (Fig. 1) were subjected to proximate composition analysis (Table 2). No significance difference was observed in control ant treatments for Moisture, carbohydrate and ash content. However, protein and fat content were observed to increase with increase in the spirulina concentration, with significant difference, suggesting role of spirulina.

Fig.1 Snacks prepared with different concentrations of spirulina

Table.1 Ingredients used for spirulina snacks

Group	Refined wheat flour(g)	Spirulina (g)	Corn flour (g)
Control	100	-	-
T_1 (5%)	90	5	5
T_2 (10%)	85	10	5
T_3 (15%)	80	15	5

Table.2 Proximate composition of value added product

Parameter*	Control	T_1 (5%)	T_2 (10%)	T_3 (15%)
Moisture (%)	5.15 ± 0.03	4.86 ± 0.10	5.12 ± 0.14	5.31 ± 0.64
Protein (%)	17.42 ± 0.18	21.18 ± 0.61	23.90 ± 0.73	24.27 ± 0.95
Carbohydrate (%)	20.40 ± 0.41	19.11 ± 1.00	17.19 ± 1.03	18.29 ± 2.32
Fat (%)	2.23 ± 0.06	2.95 ± 0.13	3.27 ± 0.22	3.70 ± 0.07
Ash (%)	54.5 ± 0.46	52.10 ± 0.38	50.67 ± 0.69	48.17 ± 0.91

*Mean of 3 replications

Table.3 Organoleptic acceptability of value added product

Proportion of Spirulina powder	Score of Sensory Evaluation					
	Appearance	Colour	Texture	Odour	Taste	Over all acceptability
T_1 (5%)	5	5	4	4	4	4.4
T_2 (10%)	4	4	4	4	3	3.8
T_3 (15%)	4	4	4	4	3	3.8

Vijayarani *et al.,* (2012) also found higher protein content in developed product (pasta) using spirulina. Sharma and Dunkwal (2012) also observed increased crude protein content in developed product with the inclusion of spirulina. Thus, spirulina is confirmed to be a promising additive to be used for snacks preparation. Consumption of such snacks on daily basis can reduce the problem of malnutrition from all the age groups.

Organoleptic evaluation

Snacks with 5 % spirulina had more acceptance than other concentrations. In case of T2 (10%) and T3 (15%), snacks was not preferred mainly because of its appearance and colour which was darker than control and T1 (Fig. 1 and Table 3). Moreover, those were not accepted for its texture, odour and taste as well because it deviated a lot from the control.

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