

Acceptance of novel foods for physical activity practitioners formulated with *Spirulina*

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Abstract : The diet of athletes require higher caloric intake, which should be provided by special food intake. The biomasses of microalgae are innovative alternative natural ingredients that can be used in the development of foods. *Spirulina* is a source of protein and amino acids, antioxidants, carbohydrates, vitamins and minerals. The objective of this study was to evaluate the acceptance and purchase intention to foods developed with *Spirulina* intended for athletes. The microalga added to foods was *Spirulina* sp. LEB 18, which was produced at a pilot plant for *Spirulina* production. Six foods were developed for practitioners of physical activity as an electrolyte replenisher, a muscle recovery supplement and a muscle enhancer; these foods were produced with (0.5%, w/w) and without the addition of *Spirulina*. The acceptance test was conducted in relation to the total impression of the foods with and without the addition of *Spirulina* and the total impression of a similar commercial product. All foods developed with and without the addition of *Spirulina* were accepted by the athletes, which demonstrated that the addition of microalga did not influence the acceptance of the foods. In addition, the results emphasize the likely purchase intent for the formulations of foods incorporated with *Spirulina*.

Keywords: Athletes, microalgal biomass, purchase intention, supplement food.

I. Introduction

The adequate intake of nutrients is essential for good performance in sports. The intake of carbohydrates serves to maintain glycogen stores, which are reduced during exercise [1]. The diet of athletes must have increased caloric intake to meet the energy expenditure imposed by training. Athletes should consider both the quantity and quality of the products that they consume before, during and after training and competition [2].

The protein requirements of athletes are fairly discussed because of both, the increased demand from exercising and the benefits of amino acid supplementation on performance. In addition to the effect on satiety, dietary protein consumption is favored by many athletes due to its role in promoting muscle protein synthesis and functional adaptations when combined with resistance exercise (the progressive and structured training using weights or weight machines) [3]. The supplementation of minerals and vitamins also is important because may be required to cover the increased needs for building, repair and maintenance of lean body mass in athletes [4].

Spirulina is one of the most studied microalgae for use in human food [5]. This microalga has the advantage of being safe for use (Generally Recognized as Safe - GRAS); thus, its use is permitted in food without incurring risks to health. Additionally, *Spirulina* has a nutritional profile that makes it ideal as a food supplement [6]. This microalga has high protein content and the amino acids presents are similar to those recommended by the Food and Agricultural Organization. It also contains vitamins, minerals and pigments in biomass [7-10].

Knowing whether consumers can notice differences between products, and how such differences change their acceptance is very important for development of new products. Amongst the many sensor methods available, hedonic rating is commonly used to measure consumer affective discriminability between multiple products or between a standard product and new prototypes. In the conventional application of hedonic rating, it has long been assumed that the higher the momentary hedonic rating of the sensory experience, the stronger the acceptance of the sensory properties. For this reason, the concepts of hedonic value vs. acceptability are often considered to be interchangeable, and thus, in some of the literatures, 'hedonic testing' is often called 'acceptance testing' [11].

In this context, the objective of this study was to evaluate the acceptance and purchase intention to foods developed with *Spirulina* intended for athletes.

II. Material and Methods

2.1 Biomass of *Spirulina* microalga

The microalga added to foods was *Spirulina* sp. LEB 18, which was produced at a pilot plant for *Spirulina* production. The pilot plant is located on the shores of Mangueira Lagoon (33° 30' 13'' S and 53° 08' 59'' W) in Santa Vitória do Palmar, RS, Brazil [12]. The *Spirulina* biomass was subjected to operations of drying, grinding in a ball mill (Model Q298, Quimis, Brazil) and sieving to obtain particles with a diameter of 53 mm. Subsequently, it was vacuum packed for use in formulations.

2.2 Development of formulations

Six foods were developed for practitioners of physical activity: an electrolyte replenisher, a muscle recovery supplement and a muscle enhancer; these foods were produced with (0.5%, w/w) and without the addition of *Spirulina*. The ingredients were weighed and homogenized using a Y-type mixer (Model TE-201/10, Tecnal, Brazil).

The following ingredients were used to prepare the electrolyte replenisher: sucrose, dextrose, citric acid, tricalcium phosphate, sodium citrate, sodium chloride, potassium phosphate antiwetting agent, nature-identical aroma of lemon, sucralose sweetener and titanium dioxide.

The final formulation of the muscle enhancer included maltodextrin, dextrose, creatine, nature-identical aroma of lemon, citric acid, tricalcium phosphate antiwetting agent, acesulfame potassium and sucralose sweeteners and titanium dioxide.

The muscle recovery supplement formulation contained the following ingredients: maltodextrin, milk whey protein concentrate 80% (w/w), dextrose, vitamin and mineral premix [magnesium sulphate monohydrate (magnesium), ascorbic acid (vitamin C), ethyl tocopherol (vitamin E) and zinc sulphate monohydrate (zinc)], medium chain triglycerides, nature-identical aroma of lemon, guar gum thickener, citric acid, acesulfame potassium and sucralose sweeteners.

2.3 Sensory Analysis

The acceptance test was conducted in relation to the total impression of the foods with and without the addition of *Spirulina* and the total impression of a similar commercial product. Therefore, a nine-point hedonic scale employed, and the behaviours of consumers were assessed regarding the possible purchase of these foods using a five-point scale [13]. The sensory analyses were performed at a sport gym with a target audience and 40 untrained panellists. The samples were prepared in accordance with the consumption recommendation. The results were evaluated using an analysis of variance with 95% confidence, and the mean difference was obtained by the Tukey test.

III. Results and Discussion

The first stage of this work was to define the concentration of *Spirulina* will be added to the food. Sensory tests with 0.5 (w/w) and 1.0% (w/w) of *Spirulina* in electrolyte replenishers were performed to determine the concentration of *Spirulina* added to the formulations (Table 1). Samples with 0.5% (w/w) and without *Spirulina* showed no significant difference ($p > 0.05$). However, the sample with 1.0% (w/w) of *Spirulina* present difference between the others ($p < 0.05$). Thus we opted for the concentration 0.5% (w/w) of *Spirulina* which obtained greater acceptance and better homogenization (data not shown).

Table 1 Total acceptance and mean scores of electrolyte replenisher with different concentrations of *Spirulina*

Samples	Acceptance (%)	Mean scores*
Replenisher without <i>Spirulina</i>	78	7,03 ± 1,54 ^a
Replenisher with 0.5% (w/w) of <i>Spirulina</i>	87	7,83 ± 1,04 ^a
Replenisher with 1.0% (w/w) of <i>Spirulina</i>	63	5,69 ± 2,21 ^b

Legend: * Results with the same letters in the same column indicate no significant difference at a 95% confidence level by the Tukey test.

After to define concentration of *Spirulina* sensory tests were performed with the products developed (electrolyte replenisher, a muscle recovery supplement and a muscle enhancer). The developed foods were subjected to a sensory analysis and a sensory analysis of a similar commercial product to verify the acceptance rate (Table 2) and purchase intention for likely consumers (Fig. 1 and 2).

Table 2 Total acceptance and mean scores of foods

Samples	Acceptance (%)	Mean scores*
Commercial replenisher	78	7.0 ± 1.4 ^a
Replenisher without <i>Spirulina</i>	79	7.1 ± 1.2 ^a
Replenisher with 0.5% (w/w) of <i>Spirulina</i>	74	6.6 ± 1.7 ^a
Commercial maltodextrin + creatine	76	6.8 ± 1.7 ^a
Enhancer without <i>Spirulina</i>	73	6.6 ± 1.5 ^a
Enhancer with 0.5% (w/w) of <i>Spirulina</i>	71	6.4 ± 1.8 ^a
Commercial recovery supplement	55	4.4 ± 2.1 ^b
Recovery supplement without <i>Spirulina</i>	73	6.5 ± 1.5 ^a
Recovery supplement with 0.5% (w/w) of <i>Spirulina</i>	72	6.5 ± 1.7 ^a

Legend: * Results with the same letters in the same column indicate no significant difference at a 95% confidence level by the Tukey test.

The mean scores that were awarded by panellists for the replenishers and enhancers with and without the addition of *Spirulina* and for the commercial product showed no significant differences ($p > 0.05$). The developed muscle recovery supplements yielded total acceptance means that were superior to the acceptance means of the commercial product, with scores above 6.0, whereas the commercial product yielded acceptance means below 5.0. All foods developed with and without the addition of *Spirulina* were accepted by the panellists [14]. The muscle recovery supplements had total acceptance means above 5.0.

With regard to purchase intent among the 40 panellists, 79.5% of the panellists and 92.3% of the panellists had a positive attitude towards the purchase of electrolyte replenishers with *Spirulina* and without *Spirulina*, respectively (Fig. 1).

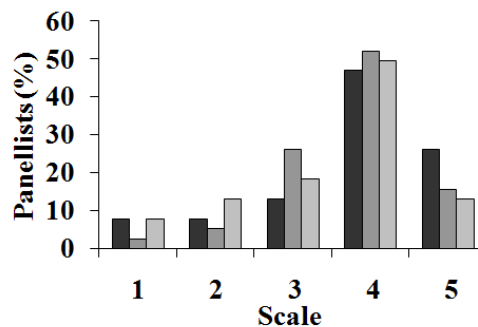


Figure 1 Purchase intent of panellists with regard to a commercial electrolyte replenisher (■), replenisher developed without *Spirulina* (■) and with *Spirulina* (■) (1 - certainly not; 2 - probably not; 3 - maybe; 4 - probably yes, and 5 - certainly yes)

Fig. 2 shows that 82.5% of the panellists who rated the muscle enhancers had a positive attitude towards the purchase of the commercial product and that 87.5% of the panellists had the same attitude regarding the product developed with *Spirulina*. Similarly, 77.5% of panellists would buy the product without the added microalga. As shown in Fig. 3, 58.5% of the panellists and 53.6% of the panellists had positive attitudes towards the purchase of the muscle recovery product with *Spirulina* and without *Spirulina*, respectively, whereas only 19.4% of the panellists would purchase the commercial product.

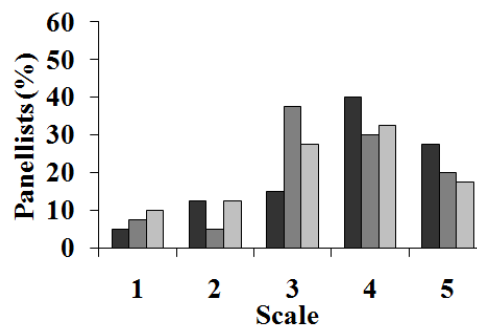


Figure 2 Purchase intent of panellists with regard to a commercial muscle enhancer (■), muscle enhancer developed without *Spirulina* (■) and with *Spirulina* (■) (1 - certainly not; 2 - probably not; 3 - maybe; 4 - probably yes, and 5 - certainly yes)

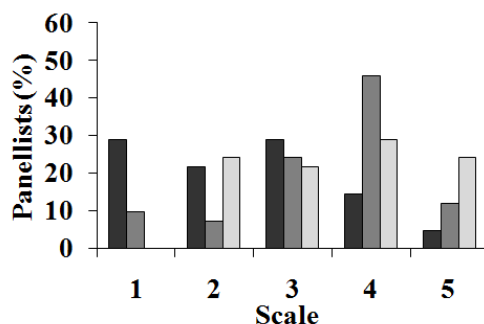


Figure 3 Purchase intent of panellists with regard to a commercial muscle recovery (■), muscle recovery developed without *Spirulina* (■) and with *Spirulina* (■) (1 - certainly not; 2 - probably not; 3 - maybe; 4 - probably yes, and 5 - certainly yes)

Previous studies have demonstrated the reasonable acceptance of some foods developed with added *Spirulina*. Lemes *et al.* [15] evaluated the enrichment of *Spirulina* in wheat flour for the development of pasta. The sensory quality of this product was considered satisfactory ("liked a lot") and high purchase intent ("probably buy"). Figueira *et al.* [16] produced breads that lacked gluten but were enriched with *Spirulina* and discovered no significant difference in the preference for the bread with 3 or 5% (w/w) of *Spirulina*. Morais *et al.* [17] produced chocolate cookies with 1% (w/w) of *Spirulina* and determined that more than 50% of the panellists would buy these cookies. Thus the results of this study show that addition of *Spirulina* was determined to have no influence on the acceptance of these products. Also, it became evident the likely purchase intent for the formulations of foods incorporated with microalgal biomass.

IV. Conclusion

All developed products with *Spirulina* were accepted by the target public with acceptance above 70%. The athletes also had positive attitudes towards the purchase of the products with microalgal biomass. Thus based on analysis sensory the *Spirulina* biomass can be added in foods for athletes without to influence the opinion of consumers likely.

Acknowledgements

The authors are grateful to the Coordination for the Improvement of Higher Education Personnel (CAPES) for their financial support.

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