Development of spirulina-incorporated milkshake and its sensory evaluation on standard scale

Abstract

Spirulina, a nutrient-dense algae, is known for its high protein content, vitamins, and antioxidants, making it an ideal candidate for fortifying everyday food products.This study investigated the preparation method and sensory evaluation of spirulina-incorporated milkshakes, focusing on four formulations: T0 – (Control),T1 (spirulina milkshake), T2 (Spirulina-banana milk shake), and T3 (Spirulina-cardamom milkshake). Each milkshake was prepared using 50ml toned milk, vanilla powder 2.5%, xanthan 0.1% and sugar 10%. The spirulina powder was first evaluated by incorporating at 0.5%, 1.0%, and 1.5% levels and the most acceptable and significant level 0.5% was used in all three formulations. The sensory characteristics of the formulations were evaluated through a panel of judges using a standardized scoring system. The results indicated that the 0.5% spirulina-cardamom milkshake received the highest sensory ratings, suggesting a favourable flavour profile. This study demonstrates the potential of incorporating spirulina into dairy products, contributing to nutritional enhancement while maintaining sensory appeal.

Keywords: Spirulina, Milkshake, Banana,Cardamom, Toned milk.

Introduction

India is the largest producer of milk in the world and it's production has rallied from 55 Million tones in 1991-92 to 230 million tones in 2022-23 [1].Now a variety of milk-based beverages are being introduced into the market and their reach among the consumers have increased in the recent years.Milkshake is one of the beverages that has attracted most consumers due to its unique taste, made by blending milk with other ingredients. Milkshake can be customized according to the preference of an individual by blending with other ingredients like nuts, fruits, chocolate syrup, ice creams, biscuits along with milk. All these ingredients make a thick, sweet, cold mixture called milkshake which is on trend among the consumers [5].

Spirulina was first discovered by Spanish Scientist Hernando Cortez and Conquistadors in 1519. Cortez observed that Spirulina was eaten at the tables of the Aztecs during his visit in Lake Texcoco in the Valley of Mexico. Pierre Dangeard discovered the health benefits of Spirulina who observed that flamingos were surviving by consuming blue-green algae. Botanist Jean Leonard supported the findings of Dangeard and people soon started to commercialize spirulina to reap its benefits [8]. It is an edible biomass of cyanobacteria, blue green algae for both humans and animals. The awareness and consumption rate of spirulina is widening due to its astonishing nutritional profile and medicinal properties. Spirulina contains 55-70% protein, 15-25% polysaccharides, 5-6% total lipids, 6-13% nucleic acids and 2.2- 4.8% minerals per 100 g. It also contains various minerals like calcium, potassium, magnesium, manganese, iron,

nickel, chromium, copper, sodium, zinc, selenium, and other essential fatty acids. Spirulina has antimicrobial, anti-inflammatory and anti-oxidative properties. Thismakes spirulina a functional food to combat malnutrition and health related problems [2].

Spirulina is rich in antioxidants, especially lycopene. Strong antioxidant lycopene fights free radicals. Eating foods rich in lycopene reduces the risk of heart disease, stroke, and some types of cancer, diabetes, and premature aging [10]. Spirulina is fast emerging as a complete answer to the varied demands due to its imposing nutrient composition which can be used for therapeutic uses. The United Nations in a world food conference declared that Spirulina as the best food for future, and it is gaining popularity nowadays [7].Spirulina is considered as a 'superfood' [11].Spirulina is the richest source of proteins. Spirulina is abundant in plant protein, which makes up 60% to 70% of its weight [9].

Banana is one of the earliest crops cultivated by man and remains a staple food crop for millions of people in the tropical world. Bananas are monocotyledonous plants, belonging to the genus Musa of the family Musaceae in the order Scitamineae [13]. Bananas are edible fruits which are consumed daily for their benefits as they contain major sources of potassium and calcium. It helps to enhance the heart health, manages blood pressure and enhances the personal mood of an individual [6]. Cardamom is anaromatic spice that is used in day-to-day activities for enhancing the flavor and taste of the food.It contains high levels of antioxidants and vitamin c, niacin, magnesium and potassium [4]. The main use of sugar in food products is for sweet taste but they have other important roles such as preservative, texture modifier. Vanilla is a flavoring ingredient used inbaking,tea, ice cream, flavoredjuice and other food products for making product more delicious and tastier. Dietary fibre is a key ingredient widely used nowadays while developing nutritionally designed foods due to its significance in health promotion and technological impact [12].Despite having high calorie content primarily from carbohydrates and dietary fiber, bananas are poor in protein and fat. Vitamins C, A, B1, B2, and B6, as well as minerals, such as magnesium, phosphorus, calcium, and iron could be also found in bananas. Banana consumption could be associated with a reduction in the risk of gastrointestinal diseases, regulation of carbohydrate metabolism, and weight control [14, 15].

Material and Methods –

The required raw materials like milk, sugar, cardamom, Banana were procured from a retail shopand other products likevanilla powder, xanthan, spirulina were procured through online.

T0- Milkshake (Control)

T1 - Spirulina incorporated milkshake

T2 - Spirulina – banana incorporatedmilkshake

T3 - Spirulina – cardamom incorporated milkshake

Initially control milkshake was prepared by incorporating spirulina at0.5 %, 1 %, 1.5% concentrations. On screening, 0.5% was most accepted by the judges hence for further studies 0.5% was used to prepare other treatments.

Procedure

Toned milk with fat (3.0%) and SNF should be of 8.5% was heated and cooled suddenly for pasteurization of milk,banana were cut into small pieces and small quantity of cardamom were grinded into fine powder to make incorporation easier. Other ingredients like sugar, vanilla powder, Xanthan and spirulina which have constant measure were taken separately.And according to the type of milkshake; ingredients were added separately and homogenized by using the mixie.

Chart 1 :Experimental procedure

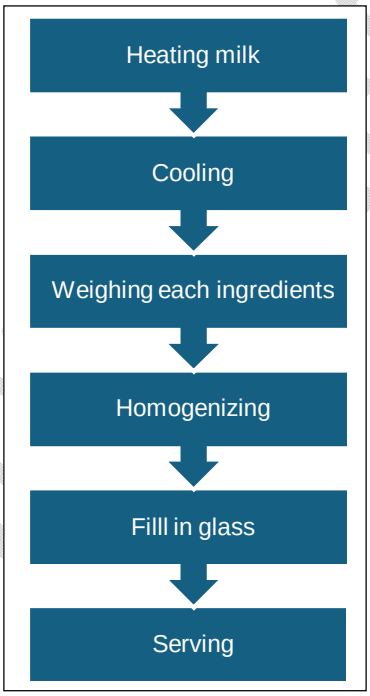

Fig 1 :The figure shows that the different concentration of spirulina milkshake

Then, the treatments were given to judges for evaluating color, texture, mouthfeel, flavor, taste, consistencyafter their intake of meal and overall acceptance of the products by using 9 points hedonic scale.

Statistical Analysis- The mean and standard deviation value was calculated and tabulated.

Result and Discussion

Table :1.Sensory Evaluation of Spirulina incorporated milkshake

Treatments	Color&Appearance	Flavour	Taste	Texture	Overall Acceptability
T_0	8.30±0.68	8.30±0.29	8.30±0.34	7.60 ± 0.54	8.30±0.28
T_1	7.20±0.83	6.60 ± 0.54	6.20 ± 0.44	6.40±0.54	6.60 ±.047
T_2	7.40 ± 0.54	7.20 ± 0.83	7.20±0.83	7.40±0.54	7.30 ± 0.64
T_3	7.40 ± 0.54	7.40 ± 0.54	8.40 ± 0.54	8.20 ± 0.44	7.80 ± 0.54
T_0	**Milkshake (Control)**				
T_1	**Spirulina milkshake**				
T_2	**Spirulina – Banana incorporated milkshake**				
T_3	**Spirulina – Cardamom incorporated milkshake**				

Values are mean ± SD

Colour, and appearance one of the important visual attributes, has been used to judge the overall quality of foods for a long time. If the colour is unattractive, a potential consumer may not be impressed by the other major attributes. The first impression is usually visual and the major part of our willingness to accept a food depends on the appearance. The scores for the colour and appearance T_3 has more acceptance than T_0,T_2&T_1.Texture constitutes a physical property of food stuff apprehended by the eyes, the skin and muscle senses located in the mouth.Flavour is the mingled but unitary experience of sensation produced by a material taken in the mouth perceived principally by the senses of basic smell and by the other cutaneous sensations in the mouth. Cardamom incorporated milkshake was highly acceptable compare to other treatments.Taste is the major attribute, which determines the acceptability of food material. It is not only a sensory response to soluble materials but also tactile sensation of the mouth.

Spirulina incorporated milkshakes colour& appearance, flavour, texture, taste and overall acceptability T_3 has more acceptance than T_0,T_2&T_1.. Cardamom has imparted theflavor and taste to spirulina incorporated milkshake and has completely masked the original odor of spirulina. Whereas,the other two treatments had aspirulina odor dorminancy.Spirulina platensis revealed to be a good stable ingredient when the desired colour is green [16].The banana and pineapple spirulina smoothie were similar to this study[17].The spirulina cookies proved to be acceptable smell, color, appearance, texture and taste[18].

Conclusion

Since it is a preliminary study tostandardizethe potential of this microalgae in creating a nutritious and sustainable beverage. Spirulina has proven to be an excellent while adding in a milkshake.Spirulina can be effectively blended with banana and cardamom to create a delicious and refreshing drink that appeals to a wide range of consumers. Moreover, Spirulina's ability to thrive in diverse environments and its low water and land requirements make it an attractive solution for sustainable food production.As the world continues to face challenges related to food security, environmental degradation, and human health, innovative products like Spirulina milkshakes can play a vital role in addressing these issues.

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1.

2.

3.

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Reference

1. TheNationalDairy Development Board's (NDDB) https://www.nddb.coop/information/stats/milkprodindia
2. Deepak KumarKoli, ShaliniGaurRudra, Arpan Bhowmik, and Sunil Pabbi, Nutritional, Functional, Textural and sensory Evaluation of spirulina Enriched Green Patsa: A Potential Dietary and Health supplementary, National Centre For Biotechnology Information, doi: 10.3390/foods11070979 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8997815/
3. Lana Burgess,Spirulina: Dosage,eye health, oral health, and more, Medicalnewstoday https://www.medicalnewstoday.com/articles/324027
4. Samy Mohamed Galal, Nashwa Fathy Sayed Morsy, Cardamom in Food Applications, Research Gate,DOI:10.1007/978-3-031-35426-7_18 https://www.researchgate.net/publication/373785116_Cardamom_in_Food_Applications
5. OnurGuneser, YoncaKaragulYucee,Engineering of Milk-Based Beverages: Current Status, Developments, and Consumer Trends, ScienceDirect ,2019 https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/milkshakes#:~:text=Industrial%20process%20for%20the%20production,%2Dtime%20pasteurization%20(HTST)
6. Jamie Putman, Bananas: Nutrition Facts, Health Benefits, and More, Oct 16 2022 ,https://www.everydayhealth.com
7. Pulz,M.O., & Gross, W.(2004). Valuable products from Biotechnology of micro algae, Applied Microbiology Biotechnology,6, 635-648.
8. Ugwu, C. U., Aoyagi, H., & Uchiyama, H. (2008). Photobiorectors for mass cultivation of algae. Bioresource Technology .99, 4021-4028.
9. Balasubramani, R., Gupta, S. K., Cho, W., Kim, J., Lee, S., Jeong, K.Choi, H. (2016). Microalgae potential and multiple roles-current progress and future prospectsan overview. Sustainability, 8(12).
10. 10.Ramírez-Rodrigues MM, Estrada-Beristain C, Metri-Ojeda J, Pérez-Alva A, Baigts-Allende DK. Array. Sustainability. 2021;13(12):6849
11. S. Priyanka1, R. Varsha1, Riya Verma1, A. Surendra Babu The Spirulina; a spotlight on its nutraceutical properties and food processing applications.Journal of Microbiology, Biotechnology and Food Science,2023.20xx : x (x) e4785.
12. Puupponen-pimiä, r.; nohynek, l.; ammann, s.; oksman-caldentey, k.m. and BUCHERT, J. Enzyme-assisted processing increases antimicrobial and antioxidant activity of bilberry.Journal of Agricultural and Food Chemistry, (2008). vol. 56, no. 3, p. 681-688.

13. Venkataramana R.K., Sampangi-Ramaiah M.H., Ajitha R., Khadke G.N., Chellam V. Insights into Musa balbisiana and Musa acuminata species divergence and development of genic microsatellites by transcriptomics approach. Plant Gene. 2015;4:78–82.
14. Wang S., Lin T., Man G., Li H., Zhao L., Wu J., Liao X. Effects of anti-browning combinations of ascorbic acid, citric acid, nitrogen and carbon dioxide on the quality of banana smoothies. Food Bioprocess Technol. 2014;7:161–173.
15. Falcomer A.L., Riquette R.F.R., de Lima B.R., Ginani V.C., Zandonadi R.P. Health benefits of green banana consumption: A systematic review. Nutrient. 2019;11:1222.
16. Hosseini, SeyedeMarzieh, SaeedehShahbazizadeh, kianoushkhosravi-Darani and Mohammad Reza Mozafari (2013). Spirulina plantensis: food and function, 9 : 89-183.
17. Ramkumar, C., Anushree, G. V., Shravya, G. N.(2018) Spirulina Incorporated Pineapple and Banana Smoothie, International Journal of Creative Research Thoughts, 6 : 11 – 13.
18. Ghaly, Abdel, Amal Hammouda and Mariam Al Hattab (2015), Development and sensory evaluation of Spirulina chocolate chip oatmeal. Internat. J. Bioprocess &Biotechnological Advancements, 1(2) : 63-73.