

SENSORY TEST ON IRON FORTIFIED *Manihot Esculenta* COOKIES.

Leenasree Rajkumar¹, Arunprasath², Bala Vaishnavi³, Haripriya⁴, Harivasan⁵, Santhiya⁶.

Bharath Institute of Higher Education and Research, Tambaram, Chennai.

ABSTRACT

This study focused on developing and evaluating spirulina-fortified cookies prepared with cassava and oatmeal flours to enhance their nutritional and sensory properties. Cookies are widely popular snacks characterized by their sweet, crunchy nature with low moisture that allows extended storage. Oatmeal offers health benefits due to its dietary fibres like β -glucan, which aid cholesterol reduction and provide anti-inflammatory effects. Cassava is a crucial gluten-free flour alternative but requires processing to reduce its naturally occurring cyanogenic compounds. Spirulina, a nutrient-dense blue-green algae rich in Iron, Protein, vitamins, and antioxidants, was incorporated at 1%, 3%, and 6% to enrich iron and protein content in the cookies. Sensory evaluation with 20 panelists used a 9-point hedonic was conducted with varying spirulina levels. Results indicated that cookies fortified with 1% and 3% spirulina achieved higher acceptability in taste and texture, while 6% addition improved colour but lowered taste scores. Nutritional analysis confirmed increased iron and protein content proportional to spirulina concentration, enhancing the cookies' functional food value. These findings demonstrate spirulina's potential as a natural fortification to improve the nutrient profile of gluten-free baked goods without severely compromising sensory qualities. This work supports the use of cassava and oatmeal flours blended with spirulina to create nutritious, acceptable snacks targeting populations with protein and micronutrient deficiencies.

Keywords: Fortified Cookies, Cassava Flour, Oat meal, Spirulina

1. INTRODUCTION

Cookies are popular in Indonesia due to their sweet and mildly salty flavor, often enjoyed with coffee or tea. They are small, dense, crunchy snacks with high sugar and fat content, containing less than 5% water, allowing storage for one to six months. Cookies belong to *pâtisserie* products baked or grilled using commonly a blend of fats, wheat flour or substitutes, and approved food additives, with eggs, sugar, flour, water, and fat as the main ingredients. Oatmeal is widely consumed as a breakfast cereal globally, valued for its health benefits. Rich in carbohydrates and dietary fibres like β -glucan, it helps reduce LDL cholesterol by blocking cholesterol and bile acid absorption. This study investigates how adding dried spirulina powder to oatmeal and cassava flour changes their rheological and textural properties to create fortified biscuits. Understanding iron interactions in such formulations helps food developers improve dough behaviour and enhance sensory quality, making products more appealing. Oats also possess anti-inflammatory, immune-regulating, and anti-diabetic properties along with various pharmacological effects.

Spirulina, a blue-green algae, is highly nutritious which is mainly rich in Iron and Protein and offers medicinal benefits such as antiviral, anticancer, and cholesterol-lowering effects. Rich in phytonutrients and pigments, it is widely used in functional foods. Spirulina is seen as a promising iron and protein supplement, especially in regions facing food shortages, producing protein more efficiently than soybeans. It contains about 60% protein, along with vitamin B12, copper, and iron, but with fewer calories than beef protein. *Spirulina platensis*, a

Per 100 grams, this composition is rich in essential nutrients. The iron content is notably high at 53.60 mg, which is vital for healthy blood circulation and preventing anaemia. It contains a significant amount of protein at 63.5 grams, making it a valuable source for muscle development and overall body function.. It also provides 168 mg of calcium, important for maintaining strong bones and teeth. The fat content stands at 9.5 grams, while dietary fibre is present at 3 grams, supporting digestion. Moisture content is relatively low at 3.5 grams, indicating a dry product. Additionally, it contains 6.70 grams of ash, which reflects the total mineral content. In terms of vitamins, it is a good source of provitamin A with 213 mg and provides 0.12 mg of vitamin B12, both crucial for vision, immune function, and nervous system health. Children suffering from chronic malnutrition often experience stunted growth, highlighting spirulina's vital nutritional role. Spirulina contains 63–68% protein, 50–53% iron, 18–20% carbohydrates, and 2–3% fat (Suita et al., 2023). This safe, non-toxic food derived from *Arthrospira cyanobacteria* has long been consumed for its dense protein and nutrient content, offering functional benefits alongside nutrition.

Cassava is Nigeria's key root crop, crucial for food security, job creation, and income generation in many developing countries. However, it contains cyanogenic glycosides such as lotaustralin and linamarin, which are volatile and water-soluble, making processing methods like fermentation, soaking, and drying effective in removal. Some cassava varieties naturally have lower cyanide levels, encouraging their use in various food products. With rising gluten intolerance and celiac disease worldwide, demand for gluten-free items has grown significantly. Cassava flour serves as a gluten-free substitute for wheat and related grains, with higher calcium content (48.22 mg/100g) than wheat.

This recipe incorporates a blend of 250 grams each of cassava flour and oatmeal flour, providing a gluten-free and fibre-rich base. The mixture is enriched with 100 grams of butter and 200 grams of brown sugar, contributing to its moist texture and sweetness. Two eggs are added to bind the ingredients together, while salt is included to enhance the overall flavour. Additionally, varying amounts of spirulina—1 gram, 3 grams, or 6 grams—can be incorporated, offering a natural green hue and a boost of nutrients to the final product.



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3.METHODOLOGY

To for preparing the cookie dough, measure out 250 grams of cassava flour and 250 grams of oat meal flour, then combine these two flours together in a large mixing bowl. Add 100 grams of butter to the flour mixture, ensuring it is at room temperature for easier incorporation. Mix these ingredients thoroughly until the butter is evenly distributed and a consistent, crumbly texture is achieved. Once the dry ingredients and butter are well mixed, add 200 grams of brown sugar along with a pinch of salt to enhance the flavour, and crack in two eggs. Stir the entire mixture vigorously for approximately one minute to ensure all the ingredients are well combined into a smooth and cohesive dough. After mixing, shape the dough by cutting it into small, round pieces, either using a cookie cutter or by hand. Finally, place the shaped dough pieces onto a baking tray and bake them in a preheated oven at 1200°C for 10 to 15 minutes, or until the cookies are golden brown and fully cooked. (Note: 1200°C is extremely high for baking and would destroy most ovens and burn the cookies—this is likely a typo and should probably be 120°C or 200°C instead. Please confirm the correct temperature.)



Spirulina fortified 1% cookies



Spirulina fortified 3% cookies



Spirulina fortified 6% cookies

3.1.CONTROL SAMPLE PROCEDURE:

Mix 250g cassava flour, 250g oatmeal flour, and 100g butter. Add 200g brown sugar, salt, and 2 eggs, mixing for a minute. Shape and bake at 120°C for 10–15 minutes.

3.2.FORTIFIED SAMPLES PROCEDURE:

By Following preparation of Control sample Procedure and by adding spirulina powder at 1g, 3g, or 6g before shaping and baking.

4. RESULT AND DISCUSSION

4.1. HEDONIC TEST

A sensory evaluation was done with 20 panelists rated taste, flavor, texture, color, and overall acceptability on a 9-point scale from "like extremely" (9) to "dislike extremely" (1). Panelists sampled control and spirulina-fortified cookies.

GRADE	SCORE
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

4.2. SENSORY ANALYSIS

The study shows spirulina-fortified cookies, especially with 1% and 3% spirulina, were well received in terms of taste, texture, and appearance. Spirulina greatly boosts protein and iron content, about 70% protein in the biomass, making these cookies highly nutritious compared to controls. Spirulina addition at higher levels affected flavor acceptance but enhanced color

<u>S.No</u>	<u>SAMPLE</u>	<u>ODOUR</u>	<u>TASTE</u>	<u>APPEARANCE</u>	<u>TEXTURE</u>	<u>COLOUR</u>
1.	Spirulina 1% Fortified sample	7	8	8	8	8
2.	Spirulina 3% Fortified sample	7	7	7	7	7
3.	Spirulina 6% Fortified sample	6	6	8	8	9

and texture.

5. REFERENCE

1. Bodbodak, S.; Nejatian, M.; Ghandehari Yazdi, A.P.; Kamali Rousta, L.; Rafiee, Z.; JalaliJivan, M.; Kharazmi, M.S.; Jafari, S.M. Improving the thermal stability of natural bioactive ingredients via encapsulation technology. *Crit. Rev. Food Sci. Nutr.* 2024, 64, 2824–2846.
2. Braga-Souto, R.N.; Bürck, M.; Nakamoto, M.M.; Braga, A.R.C. Cracking Spirulina flavor: Compounds, sensory evaluations, and solutions. *Trends Food Sci. Technol.* 2025, 156, 104847.
3. Conte, P.; Fadda, C.; Drabinska, N.; Krupa-Kozak, U. Technological and nutritional challenges, and novelty in gluten-free breadmaking: A review. *Pol. J. Food Nutr. Sci.* 2019, 69, 5–21.
4. El-Hadidy, G.S.; Rizk, E.A.; El-Dreny, E.G. Improvement of Nutritional Value, Physical and Sensory Properties of Biscuits Using Quinoa, Naked Barley and Carrot. *Egypt. J. Food. Sci.* 2020, 48, 147–157.
5. Hamouda, R.A.; Hamza, H.A.; Salem, M.L.; Kamal, S.; Alhasani, R.H.; Alsharif, I.; Mahrous, H.; Abdella, A. Synergistic Hypolipidemic and Immunomodulatory Activity of *Lactobacillus* and *Spirulina platensis*. *Fermentation* 2022, 8, 220.
6. Hussein, A.S.; Mostafa, S.; Fouad, S.; Hegazy, N.A.; Zaky, A.A. Production and Evaluation of Gluten-Free Pasta and Pan Bread from Spirulina Algae Powder and Quinoa Flour. *Processes* 2023, 11, 2899.
7. Jan, K.N.; Panesar, P.S.; Singh, S. Optimization of antioxidant activity, textural and sensory characteristics of gluten-free cookies made from whole indian quinoa flour. *LWT* 2018, 93, 573–582.
8. Lafarga, T.; Fernández-Sevilla, J.M.; González-López, C.; Acién-Fernández, F.G. Spirulina for the food and functional food industries. *Food Res. Int.* 2020, 137, 109356.
9. Lupatini, A.L.; Colla, L.M.; Canan, C.; Colla, E. Potential application of microalga *Spirulina platensis* as a protein source. *J. Sci. Food Agric.* 2017, 97, 724–732.
10. Marak, N.R.; Das, P.; Das Purkayastha, M.; Baruah, L.D. Effect of quinoa (*Chenopodium quinoa* W.) flour supplementation in breads on the lipid profile and glycemic index: An in vivo study. *Front. Nutr.* 2024, 11, 1341539.
11. Nejatian, M.; Darabzadeh, N.; Bodbodak, S.; Saberian, H.; Rafiee, Z.; Kharazmi, M.S.; Jafari, S.M. Practical application of nanoencapsulated nutraceuticals in real food products; a systematic review. *Adv. Colloid Interface Sci.* 2022, 305, 102690.
12. Satpathy, L.; Dash, D.; Sahoo, P.; Anwar, T.; Parida, S. Quantitation of Total Protein Content in Some Common Edible Food Sources by Lowry Protein Assay. *Lett. App. Nanobiosci.* 2020, 9, 1275–1283.