

Formulation and Evaluation of Protein and Vitamin Rich Snack bar Using Spirulina

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Abstract:

Changes in lifestyle and dietary habits have increased public awareness about healthy food choices. As consumers increasingly seek snacks with nutritional benefits, the snack market is expanding into products such as crisps, crackers, cookies, biscuits, and bars. Snack bars are convenient foods that offer essential nutrients—including carbohydrates, lipids, proteins, and minerals along with desirable sensory qualities. They are considered a healthy option because they provide functional nutrients, have a long shelf life, and show reduced microbial spoilage. Spirulina, a unicellular microalga rich in 50–70% protein and contains all essential amino acids, fatty acids, vitamins, and minerals, is widely recognized for its health benefits. It exhibits anticancer, antioxidant, antiviral, and immunomodulatory properties and has shown positive effects on conditions such as malnutrition, diabetes, obesity, anemia, and inflammatory or allergic reactions. The Food and Drug Administration (FDA) considers spirulina safe for consumption. In this study, snack bars were formulated using dry ingredients (Bengal gram, peanut, oats, puffed rice, desiccated coconut, soy isolate, spirulina, and cardamom powder) along with a binding syrup made of corn syrup and honey. Increasing spirulina content led to higher levels of ash, fat, protein, and total phenolic content, while moisture, crude fibre, and carbohydrate levels decreased with higher spirulina incorporation.

Keywords: Protein-rich ingredients, dietary supplements, immunomodulation, malnutrition, lipid modulation.

INTRODUCTION:

Spirulina is a unicellular microalgae which grows in fresh water, in salt water, as well as in brackish bodies of water. The growth of the spirulina is much better in a highly alkaline environment of pH range 10-12. Spirulina is a natural source containing the highest amount of protein which is five times that of meat. Spirulina comprises 50-70% protein including all essential amino-acids, essential fatty acids, polysaccharides, vitamins particularly vitamin B12, β -carotene and minerals such as iron. Spirulina has various health benefits like anticancer, antioxidant, antiviral, immunomodulation properties and also has positive effects on malnutrition, diabetes, obesity, anaemia, inflammatory allergic reactions.

The Food and Drug Administration (FDA) has certified spirulina as GRAS (Generally Recognised as Safe), allowing its usage as food or a food supplement. This study's objective is to create high-protein nutrition bars enhanced with spirulina by using various ingredients with proteins, lipids, carbohydrates, and minerals that give them good nutritional and sensory qualities. Since spirulina, Bengal gram, peanuts,

and soy protein isolate are all great sources of high-quality protein, they were chosen as essential components for the development of protein-rich snack bars.

Snack bars are impressive due to their availability of supplements, offering advantages such as compactness, taste, and convenience. Their low moisture content contributes to a longer shelf life and reduced risk of microbial deterioration. These ready-to-eat products are effectively utilized for their functional nutrients. Snack bars are often enhanced with various protein, fibre, or energy-dense ingredients (Siddique et al., 2018). The growing awareness of health, shifting socio-economic needs, and the lack of time to prepare balanced meals have led to an increase in demand for processed and convenient foods. Nutritious energy bars, which are a nutritionally well-rounded convenient option, have gained significant popularity since the 1980s (Mridula et al., 2011 and Yadav and Bhatnagar, 2015).

Ingredient	Main Function	Key benefits
Spirulina	Nutritional enrichment	High protein, antioxidant
Oats	Base Ingredient	Fibre ,energy
Nuts	Protein + fat	Healthy fats, minerals
Seeds	Functional nutrition	Omega-3, fibre
Sweeteners	Binding + taste	Energy, minerals
Coconut	Texture + fat	Quick energy
Protein powder	Protein boost	Muscle support
Cocoa	Flavour	Antioxidants
Dried fruits	Taste + texture	Vitamins

MATERIALS AND METHODS:

RAW MATERIAL:

1. Treated Soy Flour:

Treated soy flour is commonly used in spirulina protein bar as it improves the Nutritional value, texture and shelf life of product.

- Assumed Nutrient Profile(per 100g)-
 - (a) Protein- 45.0 g
 - (b) Fat- 20.0 g
 - (c) Carbs- 30.0 g
 - (d) Fibre- 5.0 g
 - (e) Energy- 450.0 kcal



2. Sprouted Moong Flour:

Sprouted moong flour used in spirulina protein bar as it enhance the nutritional quality, digestibility and taste of product.

- Assumed Nutrient Profile(per 100g)-
 - (a) Protein- 24.0 g
 - (b) Fat-1.5 g
 - (c) Carbs-60.0 g
 - (d) Fibre-8.0 g
 - (e) Energy-350.0 kcal



3. Yoghurt +Buna Chana powder:

Using yogurt and roasted Chana dal (“Buna Chana dal”) in a spirulina protein bar can improve both nutrition and texture.

- Assumed Nutrient Profile(per 100g)-
 - (a) Protein- 34.0 g
 - (b) Fat-6.0 g
 - (c) Cabs-45.0 g
 - (d) Fibre-8.0 g
 - (e) Energy-410.0 kcal

4. Spirulina Powder:

Spirulina is one of the richest natural protein sources, with 55–70% protein by dry weight.

- Assumed Nutrient Profile(per 100g)-
 - (a) Protein-60.0 g
 - (b) Fat-8.0 g
 - (c) Carbs-10.0 g
 - (d) Fibre-3.6 g
 - (e) Energy-290.0 kcal



5. Pumpkin+ watermelon seeds:

Using Pumpkin Seed and Watermelon Seed in a spirulina protein bar adds protein, healthy fats, minerals, and texture. These seeds are highly nutritious and work well in functional snack formulations.

- Assumed Nutrient Profile(per 100g)-
 - (a) Protein-30.0 g
 - (b) Fat-49.0 g
 - (c) Carbs-10.0 g
 - (d) Fibre-6.0 g
 - (e) Energy-5590.0 kcal



6. Jaggery:

Jaggery serves as a natural sweetness and a beneficial source of nutrients, making it a suitable element in spirulina protein bars. When compared to refined sugar, jaggery has trace amounts of bioactive chemicals and minerals that can enhance the bar's nutritional profile.

- Assumed Nutrient Profile(per 100g)-
 - (a) Protein-0.2 g
 - (b) Fat-0.0 g
 - (c) Carbs-98.0 g
 - (d) Fibre-0.0 g
 - (e) Energy-383.0 kcal

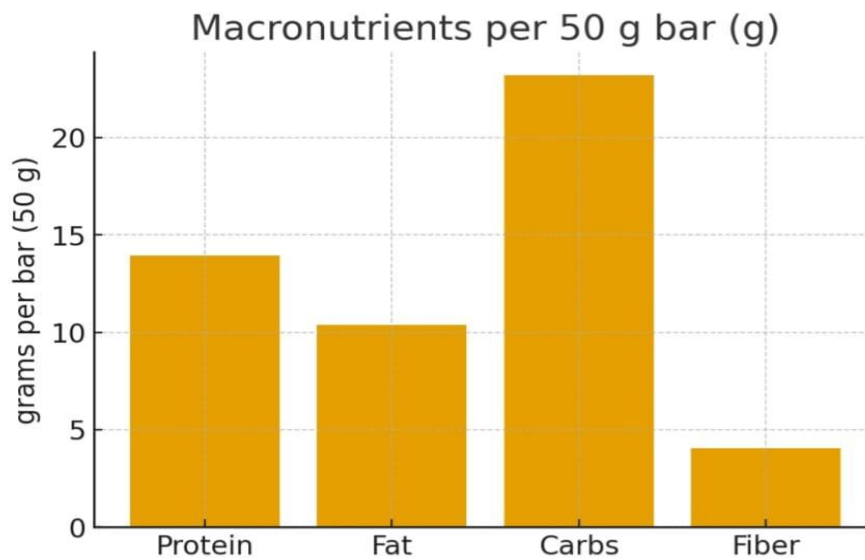


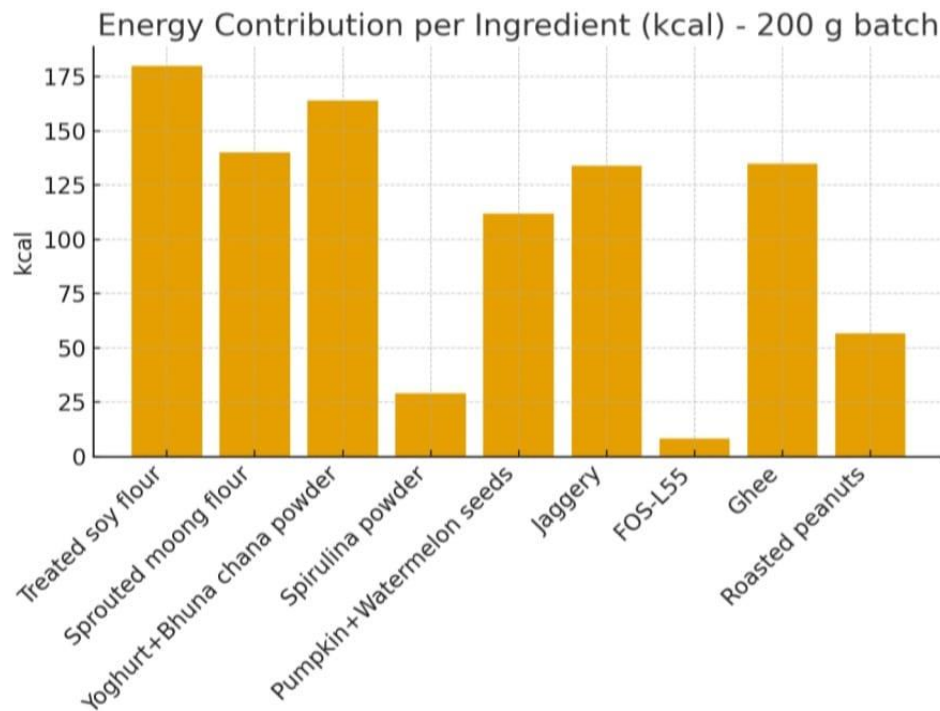
Ingredient-level Nutrient Contribution (per 50 g)

Nutrient	Per 50 g Bar
Protein	13.943
Fats	10.4
Carbs	23.225
Fiber	4.065
Energy	239.7

Charts

Macronutrients per 50 g bar:

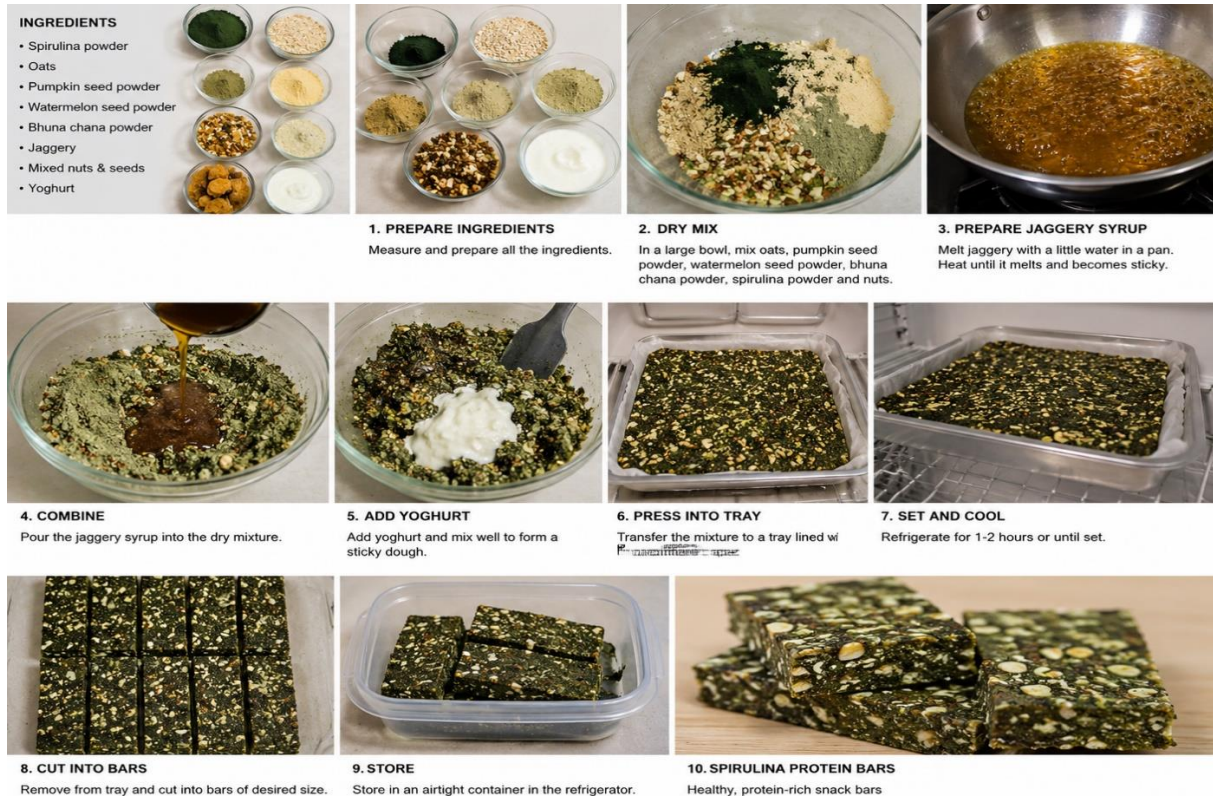




INGREDIENT COMPOSITION (per bar)

INGREDIENT	QUANTITY
Treated fermented soy flour	10 g
Sprouted moong flour	10 g
Yoghurt + Buna chana powder	10 g
Roasted peanut	2 g
Watermelon seed + pumpkin seed	2 g
FOS-L55	6 g
Jaggery	10 g
Ghee	5 g
Spirulina powder	4 g

PROCESSING STEPS:



1. Selection and Cleaning of Raw Materials

- Select good-quality seeds, spirulina powder, and chana dal.
- Remove impurities such as stones, dust, and damaged particles.
- Ensure ingredients are dry and hygienic.

2. Roasting of Seeds and Chana Dal

- Roast pumpkin seeds and watermelon seeds lightly at **120–140°C for 5–10 minutes**.
- Roast chana dal if additional crispness is required.

3. Grinding / Powder Preparation

- Grind roasted chana dal into fine flour.
- Coarsely grind some seeds for texture.
- Keep spirulina powder separately to avoid nutrient loss from heat.

4. Preparation of Binder Syrup

Heat jaggery with a small quantity of water.

5. Mixing of Dry Ingredients

In a mixing bowl combine:

- Spirulina powder
- Chana dal powder
- Oats
- Roasted seeds
- Yoghurt powder
- Flavouring agents

6. Incorporation of Binder

- Add warm jaggery syrup gradually into dry mix.

- Mix thoroughly until a dough-like consistency develops.

7. Shaping and Molding

- Spread mixture into trays or molds.
- Compress properly using rollers or spatula.

8. Packaging

Package in:

- Laminated foil packs
- Airtight containers
- Vacuum packaging (optional)

EVALUATION PARAMETERS:

1) PHYSICAL PROPERTIES:

APPEARANCE:

- Colour- greenish colour
- Odour- Sweet pleasant
- Taste- sweet
- Texture – smooth and uniform

2) Determination of Moisture Content:

To determine the moisture content of the formulated protein-rich snack bar using the hot air oven method.

$$\text{Moisture content}(\%) = \frac{\text{wet weight} - \text{dry weight}}{\text{wet weight}} \times 100$$

So the Moisture content in formulated bar was found to be 10.04 %

3) Determination of Thickness:

To determine the thickness of the formulated protein-rich snack bar using a thickness tester/ Vernier calliper. And the thickness was found to be around 1.2 ~ 1.5 cm.

4) Determination of Protein content:

The total nitrogen content of the food sample is ascertained using the Kjeldahl method. Protein content is estimated by multiplying the nitrogen amount by a conversion factor (6.25) because proteins contain nitrogen.

$$\text{Protein \%} = \text{Total Nitrogen \%} \times 6.25$$

So protein content in protein bar was found to be 13.943 %

4) Determination of Fat content:

Soxhlet extraction method is used to determine the fat content of formulated protein bar.

FORMULA:

$$\text{Fat content \%} = \frac{W_2 - W_1}{W} \times 100$$

- W₁ = Weight of empty extraction flask (g)
- W₂ = Weight of flask + extracted fat (g)
- W = Weight of sample (g)

So the fat content in given formulated protein bar was found to be 10.4 %

5) Determination of Carbs:

FORMULA:

Carbohydrate % = 100 – (protein + Moisture + Fat + Ash + Fibre)

So the carbs content in given formulated protein bar was found to be 23.225 %

6) Determination of crude fibre:

$$\text{Crude Fibre \%} = \frac{W1 - W2}{W} \times 100$$

Where:

- W1 = Weight of dried residue (g)
- W2 = Weight of ash after ignition (g)
- W = Weight of sample (g)

So the crude fibre content in protein bar was found to be 4.065%

7) Determination of Energy:

Using proximate composition values, calculate the energy (calorific value) of the protein-rich snack bar.

Energy (kcal/100 g) = (4 x protein) + (4xCarbohydrate) + (9xFat)

So the Total energy in Protein bar was found to be 239.7 kcal

CONCLUSION:

The present study successfully formulated a protein- rich snack bar incorporating spirulina as a functional ingredient. The developed snack bar demonstrated enhanced nutritional quality, particularly in terms of protein content, essential amino acids, minerals, and antioxidant properties. Incorporation of spirulina significantly improved the overall nutritional profile while maintaining acceptable sensory characteristics such as texture, colour, taste and aroma within optimized levels.

The study also highlighted the potential of spirulina as a sustainable and cost-effective alternative protein source for the development of value-added functional foods. Among the different formulations tested, the optimized formulation achieved the best balance between nutritional enhancement and consumer acceptability. The snack bar can serve as a convenient, healthy, and ready-to-eat product suitable for health-conscious consumers, athletes, and individuals requiring protein supplementation.

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