Revitalizing Nutrient-Dense Millet-Amaranth Waffle Sandwich with Probiotic-Infused Cream- A Comprehensive Functional Foods Analysis

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Abstract: *This research paper investigates the development of a nutritious breakfast option using millet (Ragi), amaranth (Rajgira), and probiotic-infused cream in waffle formulation. Emphasizing their high protein, fiber, and micronutrient content, the study optimizes sensory attributes. Chemical analyses encompass pH and acidity assessments, while biochemical evaluations include gram staining and catalase tests. Despite challenges in achieving diverse probiotic strains, the study underscores the product's potential as a health-promoting breakfast, integrating traditional grains with functional ingredients.*

Key words: *Millet, Ragi, amaranth, waffle, probiotic-infused cream, sensory evaluation, nutritional analysis, pH, acidity, gram staining, catalase test*

INTRODUCTION: In the 2023 International Year of Millets, it was emphasized how important millets are for the security of food in Asia and Sub-Saharan Africa. Because of their nutritional value and ecological resilience, varieties like finger millet, sorghum, and pearl millet deliver high fiber, protein, and vital minerals that help with digestion, weight management, and disease prevention. Superior protein and nutrients promoting bone density, cholesterol reduction, and muscle regeneration can be found in amaranth, a pseudo-cereal. [1]. When consumed in moderation, probiotics—which are live bacteria—improve digestive and immunological function. Probiotics like *lactobacillus a*nd *bifidobacterium* improve gastrointestinal and immunological function, lowering the risk of chronic illness. When combined, probiotics and millets provide a variety of health advantages that improve general well-being. [2].

LITERATURE REVIEW: Consuming food in reaction to unpleasant feelings instead of hunger is referred to as emotional eating, and it frequently entails the consumption of fatty and sugary meals that satisfy hedonistic and physiological demands. Foods high in fats and carbohydrates can influence reward and pleasure centers in the brain. Sweet, fatty foods are associated with emotional eating because they elevate emotional states and improve mood, respectively. Because satiety signaling is disrupted in modern surroundings, binge eating during stress leads to people consuming huge amounts of food rapidly and feeling out of control. This is particularly challenging for young, overweight people. Sugar-filled foods also affect mood swings; women and adolescents tend to eat more sweets as a means to cope with their unpleasant feelings. Women who are obese may not feel full for longer, which could result in overindulgence. [3]. The Old English term wefan, referring to "to weave," was where the word "waffle" first appeared. What defines waffles is the shape the iron takes on. In Europe, waffles were typically served plain or with condiments like cinnamon, jam, or a classic pudding sauce consisting of butter, sugar, and wine.
Nonetheless, because sugar maples were so prevalent in the New World, maple syrup was also frequently used as a topping. [4]. Indian millets are drought-tolerant, nutrient-dense grains from the Poaceae family that thrive in India's arid and semi-arid regions. They are critical to the country's ecological resilience and economic stability, providing vital food and fodder for millions of resource-poor farmers. These millets, sometimes known as "coarse cereals" or "cereals of the poor," outperform traditional staples like wheat and rice in terms of protein, vitamin, and mineral content. Because of their low glycemic index and gluten-free nature, they are beneficial nutritional options for people who have diabetes or celiac disease. [5]. Finger millet (Eleusine coracana), also known as nachni or ragi, is rich in Vitamin B3, folate, calcium, and iron, essential for human health. It offers antioxidant benefits and contains vital

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amino acids. Widely used in weaning foods, it provides sustained energy due to its slow digestion. Its high fiber content supports digestive health, prevents intestinal cancer, diabetes, hypercholesterolemia, and aids in relieving constipation. [6]. Amaranth, often referred to as Rajgira or Ramdana, is a pseudocereal that is prized for having a high protein content and phytosterols, which help lower cholesterol. It has a 6-9% oil content, which is high in healthy unsaturated fatty acids like linoleic acid. Amaranth is a rich source of important minerals that support overall vitality and skeletal health, including calcium, phosphorus, magnesium, potassium, and iron. Strong antioxidants found in it, such as phenolic chemicals and squalene, prevent cellular damage and guard against long-term illnesses. since of its high fiber content, amaranth is good for those with diabetes since it helps with blood sugar regulation, digestion, and constipation prevention. [6]. Probiotics are beneficial microorganisms recognized by the FAO and WHO for their health-promoting effects when consumed in sufficient quantities. [7] They survive the gastrointestinal tract due to their resistance to bile and stomach acid, with Lactobacillus being a prominent genus used widely in fermented foods. Classified as Generally Recognized as Safe (GRAS), Lactobacillus species play crucial roles in supporting digestive health by colonizing the gut and competing with harmful bacteria. They ferment food, producing beneficial byproducts that aid digestion and overall well-being, particularly beneficial after antibiotic use or in conditions affecting gut health. [8], [9].
Probiotics enhance digestive functions, support nutrient absorption, and contribute to overall health by reducing the impact of harmful substances in the digestive system. [10].

MATERIALS: Probiotic strains were sourced online from the National Dairy Research Institute (NDRI), ICAR. The ingredients used include ragi flour, amaranth flour, Morde compound dark chocolate, Tropolite whipping cream, Amul butter, Amul milk, baking powder, baking soda, powdered sugar, and probiotic culture.

METHOD: Recipe Formulation for Probiotic-Infused Waffles

A. Preparing the Waffle

1. Measure all the ingredients and sift both the ragi flour and amaranth flour.
2. Melt the chocolate in a double boiler and blend in some butter.Combine the flour mixture with the melted chocolate and milk. Add sugar, baking powder, and baking soda, mixing until a thick batter forms.
3. Preheat the waffle maker, grease it with butter, and pour the batter into the hot plates.
4. Cook the waffles for about 7-10 minutes until both sides are evenly browned.

B. Incorporation of Probiotics in the Cream

1. Integrate the probiotic culture into the prepared whipped cream.

C. Waffle Sandwich

1. Select two waffle sheets.
2. Spread the probiotic cream on one waffle sheet and top with the other to create a sandwich.

SENSORY EVALUATION

Sensory evaluation was done by 50 semi-trained and untrained panelists on a 7- point hedonic scale. The parameters included were Appearance, Taste, Aroma, Texture, Flavor, Mouthfeel and overall acceptance.

POINTS	SPECIFICATIONS
7	Like extremely
6	Like Moderately
5	Like Slightly
4	Neither like nor dislike
3	Dislike Slightly
2	Dislike Moderately
1	Dislike Extremely

Table 1-Sensory evaluation of Millet based waffle with probiotic-infused cream

CHEMICAL ANALYSIS:

Acidity The titration technique was used to determine the product's titratable acidity.
The NaOH solution was titrated three times against the cream and waffle essence.
pH A pH pen was used to perform it.

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BIOCHEMICAL ANALYSIS:
Gram Staining: Staining by Gram carried out on cultures of milk and cream, utilizing Gram stains to assess the structure of the organism and identify whether it is Gram-positive or Gram-negative.
Catalase Test The catalase test looks for the catalase enzyme, which is responsible for releasing oxygen from hydrogen peroxide (H2O2). It distinguishes between bacteria that generate catalase (like staphylococci) and those that do not (like lactobacilli).

RESULT AND DISCUSSION:
Sensory Evaluation

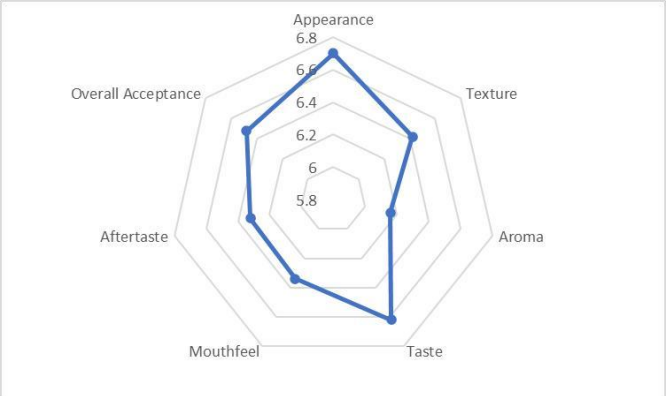

Chart 1- Sensory Evaluation of Millet Waffle with Probiotic-Infused Cream

In a sensory evaluation using a 7-point hedonic scale with 50 respondents, the millet waffle featuring probiotic-infused cream received high ratings across all categories: appearance (6.7), texture (6.42), aroma (6.16), taste (6.62), mouthfeel (6.34), aftertaste (6.32), and overall acceptance (6.48). These results highlight the favorable sensory attributes of the product, indicating strong potential for consumer satisfaction and market success.

Chemical Analysis Acidity (Whole Product): 0.0448 g/100 g indicates fermentation-derived acids enhancing flavor, texture, and shelf life. Lactic Acid (Cream): 0.0072 g/100 g produced by bacteria, contributes to tanginess, pH, and potential health benefits. pH of Cream: 6 slightly acidic, indicative of active probiotic cultures and fermentation quality, supporting product integrity and probiotic viability.

Biochemical Analysis: Gram staining revealed gram-positive rod-shaped organisms, and catalase testing returned a negative result, which are characteristic features of lactic acid bacteria.

RECOMMENDATIONS:
Optimization of Probiotic Formulation: Enhance probiotic viability through advanced strain selection and fermentation techniques to ensure optimal health benefits in the waffle product.
Consumer Education and Awareness: Educate consumers about the nutritional advantages of millets, ragi, and amaranth, emphasizing their high protein, fiber, and essential mineral content, alongside the digestive health benefits of probiotics in the waffle.

CONCLUSION: The developed millet-based waffle, incorporating ragi and amaranth (rajgira) flour with probiotic-infused cream, offers a nutritious option. Sensory evaluation with 50 respondents rated the waffle highly on appearance (6.7), texture (6.42), aroma (6.16), taste (6.62), mouthfeel (6.34), aftertaste (6.32), and overall acceptance (6.48), indicating strong potential for consumer satisfaction and market success.
Biochemical analysis confirmed lactic acid bacteria presence. Chemical tests showed overall acidity (0.0448 g/100 g) enhances flavor and shelf life, while lactic acid in the cream (0.0072 g/100 g) contributes to tanginess and health benefits. The cream's pH of 6 indicates active fermentation, but the probiotic strain concentration was insufficient for probiotic classification.
Despite the probiotic shortfall, the product shows promise as a healthier breakfast option with excellent sensory attributes.

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