Development of Low-fat Millet Muffins

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Abstract:
The increasing consumer demand for healthy, functional, and allergen-free foods has driven the need for innovative bakery products. This project aims to develop muffins using millets as the primary flour, completely excluding conventional ingredients such as Maida (refined wheat flour), fats (butter/oil), and refined sugar, which are often linked to lifestyle disorders like obesity, diabetes, and cardiovascular diseases. Millets are nutrient-dense, gluten-free grains rich in dietary fiber, minerals, and bioactive compounds. Their incorporation in bakery products not only enhances the nutritional value but also supports sustainable agriculture.
In this study, various millets including finger millet (ragi), pearl millet (bajra), and jowar were used either singly or in combinations to formulate muffins. Natural sweeteners such as jaggery powder and dates puree were used as healthy alternatives to refined sugar. The product was developed through standard baking procedures and was evaluated based on physical properties, sensory acceptability, texture, shelf life, and nutritional content. The resulting millet-based muffins were found to be soft, palatable, and rich in dietary fiber, calcium, iron, and antioxidants. This formulation presents a promising option for health-conscious consumers, individuals with gluten intolerance, and diabetic patients. The project concludes that millets can be effectively used in place of traditional flours to create bakery products with improved health benefits, without compromising consumer acceptance

.**Keywords:** Millet, muffins, bioactive compounds, formulation, gluten free.

1.Introduction:

Bakery products have long been an essential part of daily diets worldwide due to their convenience, variety, and deliciousness. Among these, muffins are one of the most popular snack items, often consumed for breakfast or as a quick snack. Muffins are typically made from refined flours, sugars, and fats, providing a quick energy boost. However, with the growing awareness of the negative health impacts of refined sugars, fats, and gluten, there is an increasing shift toward healthier alternatives in the bakery industry. Consumers are increasingly seeking baked goods that not only satisfy taste but also contribute positively to health. Baked products like muffins are veritably popular because they're consumed at breakfast or as a snack. They're sweet largely sweet products, veritably appreciated by consumers due to their good taste and smooth texture. The common blend for preparing traditional muffins is formulated with wheat flour, vegetable oil painting, eggs, sugar and water and/ or milk. Muffins generally present high volume with a pervious structure that confers a spongy texture. This structure is achieved if dioxide carbon gas bubbles are retained in the nonstop phase, contributing to the increase of chuck volume after incinerating. One of the great challenges for carrying high quality gluten-free products is to find acceptable constituents (Sciammaro et al., 2018). Traditional muffins, which are usually made from maida (refined wheat flour), refined sugar, and high amounts of fats, pose several health concerns. Maida, being highly processed, is devoid of essential nutrients and is known to have a high glycemic index, which can

spike blood sugar levels. Additionally, refined sugars in muffins contribute to the development of metabolic diseases like obesity, diabetes, and cardiovascular problems. High-fat content in the form of butter or oils used in traditional recipes is another health risk, as it can lead to weight gain and increase the risk of heart disease. Therefore, there is a pressing need for bakery products that are both healthy and nutritious, without compromising on taste or texture. The increasing prevalence of lifestyle-related diseases such as diabetes, heart disease, and obesity has sparked a demand for healthier alternatives in food products. Health-conscious consumers are looking for foods that are not only nutritious but also free from harmful ingredients like refined flour, sugar, and excessive fats. This shift has prompted the search for healthier substitutes in baked goods, and this project aims to meet that demand by developing a healthy version of the muffin. By replacing unhealthy ingredients with more nutritious alternatives, bakery products can contribute positively to consumer health, particularly for those with dietary restrictions such as gluten intolerance or diabetes. Millets are a group of small-seeded cereal grains that have been consumed for centuries, particularly in regions of Asia and Africa. Millets such as ragi, jowar, and bajra have gained recognition for their exceptional nutritional profiles. Hadimani and Malleshi (1993) reported that millets are excellent sources of dietary fiber, minerals (like calcium and iron), and bioactive compounds. They are also gluten-free and low- glycemic, making them ideal for managing diabetes and cardiovascular risks. Ragi (Finger Millet): As per Shobana and Malleshi (2007), ragi is the richest source of calcium among cereals and a good source of natural iron and fiber. Jowar (Sorghum): Research by Taylor et al. (2006) highlighted that sorghum is rich in polyphenols and antioxidants that help reduce cholesterol and control blood sugar levels. Bajra (Pearl Millet): Chandrasekara and Shahidi (2011) found that pearl millet is high in iron, zinc, and antioxidants that strengthen immunity and prevent anemia. They are gaining attention globally as nutritious, gluten-free alternatives to conventional grains like wheat and rice. Millets are high in fiber, essential minerals, and bioactive compounds that offer numerous health benefits, such as reducing the risk of chronic diseases. Compared to conventional grains, millets are more drought-tolerant and environmentally sustainable, making them a suitable choice for farmers in areas facing climate challenges. They are rich in antioxidants and play a significant role in maintaining digestive health, stabilizing blood sugar levels, and preventing diseases like osteoporosis and anemia.

According to Popkin (2001), the high consumption of bakery products made with refined flour and sugar has contributed to the rising incidence of obesity, diabetes, and heart disease. Traditional muffins are often rich in saturated fats and simple carbohydrates, leading to poor dietary outcomes. Millets require less water and are drought-resistant crops. According to FAO Report (2018), promoting millets can enhance food security, improve nutrition, and support sustainable agriculture, especially in regions facing climate change.

This study is significant because it addresses the growing demand for gluten- free, low-fat, and low-sugar bakery products. The development of millet-based muffins that are both healthy and tasty could fill a niche in the market for nutritious snack options. Furthermore, this project aligns with the global movement toward sustainable agriculture by promoting the use of millets, which are drought-resistant and have a smaller environmental footprint than other staple crops like wheat and rice.

2. Materials and Methods:

The Millets and other raw materials were purchased from the local market of Coimbatore district, Tamil

Nadu, India.

2.1 Materials Required:

The necessary elements for Millet Muffins were gathered. (Ingredients: Jaggery, Pearl millet flour, Finger millet flour, Jowar Flour, baking powder, baking soda, Oil and Vanilla Essence).

2.2 Methods:

Scaling of Ingredients:

All the ingredients based on the required quantity were weighed is showed in table 1.

Ingredients	Measurements
Jaggery	100g
Jowar flour	80g
Pearl Millet Flour	80g
Finger Millet Flour	80g
Baking Powder	5g
Water	150ml
Baking soda	2g
Oil	50ml
Vanilla Essence	6drops

Table 1: Scaling of Ingredients

2.3 Method of Preparation:

The method preparation of millet muffins is shown in fig 1.

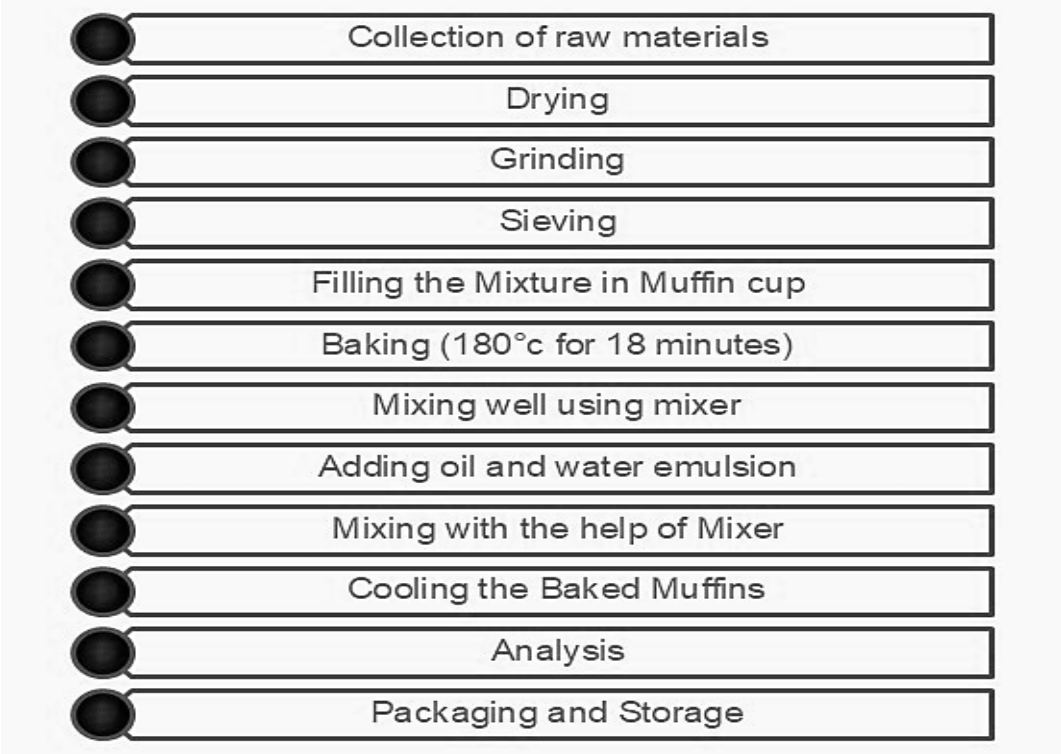

Figure 1: Preparation of Millet Muffins

2.3.1Beating and Mixing

In the preparation of millet muffins, beating and mixing play a crucial role in achieving a smooth and aerated batter. Pearl millet, finger millet, and jowar flours are gluten-free, so gentle but thorough mixing is needed to avoid a dense texture. Initially, jaggery is dissolved in a warm oil-water emulsion to create a uniform sweet base. This emulsion helps in evenly distributing moisture and fat throughout the flours. The flours are then gradually added to the emulsion, and the mixture is beaten moderately to ensure all ingredients are well incorporated without forming lumps. Proper beating helps improve the texture and consistency of the batter, resulting in soft and moist millet muffins**.**

2.3.2 Filling

According to the muffin cup Size, Fill the mixture in Cups. More than half of the cup can be filled with the Mixture. Each and Every cup should contain the same amount of dough mixture, otherwise some cup will be overbaked and some will half bake. So, these should be avoided.

2.3.3 Muffin Tin

Tap the filled muffin cup so that the filling is equally filled. After tapping place the muffin cups in Muffin tray/tin.

2.3.4 Baking

Before keeping the Muffin tin the Oven should be preheated. After that Muffin tray kept placed in oven, the dough mixture should be baked. The optimal temperature for Muffin is 180°C for 18 minutes.

2.3.5 Cooling

The baked Muffin was cooled to room temperature and then the analysis and packaging is done.

2.3.6 Packaging

Muffin are then placed in Plastic Muffin Boxes

2.4 Proximate Analysis:

The raw materials, i.e. finger millet and pearl millet grains were analyzed for physical characterictics such as colour and bulk density. Chemical constituents (Moisture, crude fat, carbohydrates, crude protein, ash, crude fibre) were determined following A.A.C.C. (2000), A.O.A.C (2000) and Raghuramulu et al., (1993).

2.5 Sensory Evaluation

9-point hedonic scale used for sensory evaluation of three muffins sample. There were total 100 panel members – 10 trained nutrition faculty members, 10 untrained non-nutrition faculty members, 20 nutrition students, 20 non nutrition students of Vanita Vishram University Surat and 40 others peoplwere asked to rate them based on degree of preference on a 9-point hedonic scale. To evaluate the product attributes (appearance, texture, taste, color, flavor, overall acceptability). All untrained members were given training to evaluate muffins.

3.Results and Discussion:

3.1 Formulation Trials

Three trial batches were developed by varying the composition of millet flours and oil content to obtain a nutritious low-fat muffin with good sensory acceptability.

Trial 1

Ingredient	Amount (g/ml)
Pearl millet flour	50 g

Finger millet flour	50 g
Jowar flour	50 g
Jaggery	60 g
Oil	20 ml
Water	80 ml
Baking powder	2 g
Vanilla essence	1 ml
Salt	0.5 g

The product had a **dry and crumbly texture** due to a higher proportion of pearl millet flour and relatively low water content. Although the appearance was acceptable, the mouthfeel was unsatisfactory. This trial highlighted the need for improving moisture retention and balancing flour ratios.

Trial 2

Ingredient	Amount (g/ml)
Pearl millet flour	70 g
Finger millet flour	70 g
Jowar flour	70 g
Jaggery	80 g
Oil	30 g
Water	100 ml
Baking powder	2 g
Vanilla essence	1 ml
Salt	0.5g

With adjusted flour ratios and slightly more water, this trial showed **improved texture and softness**. The increase in finger millet flour contributed to a more cohesive structure. However, oil content was still moderately high, and the taste lacked mild sweetness and smoothness.

Trial 3 (Final Formulation)

Ingredient	Amount (g/ml)
Pearl millet flour	80 g
Finger millet flour	80 g
Jowar flour	80 g
Jaggery	100 g
Oil	50 ml
Water	150 ml
Baking powder	2 g
Vanilla essence	1 ml
Salt	0.5 g

Trial 3 was selected as the final product due to its better moisture retention, soft crumb, and good overall sensory acceptability with reduced fat.

3.2 Proximate Composition (Final Product)

Nutrient	Content (%)
Moisture	31.46
Protein	8.67
Fat	9.00
Ash	1.25
Carbohydrates (by difference)	49.62

3.3 Comparison with Standard Muffin

Parameter	Standard Muffin	Low Fat Millet Muffin
Fat (%)	18.0	9.0
Moisture (%)	17.5	31.46
Protein (%)	6.0	8.67
Ash (%)	0.8	1.25
Carbohydrates (%)	57.7	49.62

The developed low-fat muffin has lower fat and higher protein and carbohydrate content compared to the standard, making it nutritionally superior while maintaining acceptable sensory qualities.

3.4 Sensory Evaluation of Developed Muffins

Attribute	Mean Score (out of 9)
Appearance	7.6
Colour	7.6
Texture	6.8
Aroma	7.0
Taste	7.6
Aftertaste	6.8
Overall Acceptability	7.6

3.5 Observations During Processing

- Mixing: Beating jaggery with oil and water formed a smooth emulsion.
- Batter Texture: Millet flours yielded a thick, coarse batter.
- Baking: Muffins rose uniformly; slight browning noted.
- Challenges: Low fat affected softness in Trial 1; improved in later trials by adjusting water.

3.6 Interpretation of Results

- **Fat Reduction**: Successfully achieved with acceptable sensory quality.
- **Nutritional Enhancement**: Higher protein and fiber due to millet flours.
- **Acceptability**: Final product was well-liked by panelists despite reduced fat.
- **Final Verdict**: Low fat millet muffins offer a healthier alternative to traditional muffins without compromising much on taste and texture.

4. CONCLUSION

In this project, low-fat muffins were developed using a combination of millet flours—pearl millet, finger millet, and jowar—along with jaggery as a natural sweetener and very little oil. The main goal was to make a healthier version of muffins that still tasted good and had a soft texture. Three different trials were done by changing the proportions of the ingredients. Out of these, Trial 3 gave the best results both in terms of taste and nutrition.

The final muffin had 31.46% moisture, 8.67% protein, 9.00% fat, 1.25% ash, and around 49.62% carbohydrates. These values show that the product is low in fat but still rich in energy and nutrients. Using millet flours made the muffins healthier, as millets are high in fiber, protein, and minerals. Jaggery was used instead of sugar to add natural sweetness along with some micronutrients.

Compared to normal bakery muffins that have around 15–20% fat, this version had a much lower fat content without compromising on taste.

Sensory evaluation showed that people liked the muffin, with an overall score of 7.6 out of 9. Most liked its appearance, flavour, and colour, while the texture was also considered good. This muffin can be a great option for health- conscious people who want to enjoy baked goods with less guilt. Also, the ingredients are affordable and easy to get, making it suitable even for small- scale or home-based businesses. In short, the final product turned out to be tasty, nutritious, and practical, and it promotes the use of traditional millets in modern snacks.

This study also highlights the importance of incorporating traditional grains like millets into modern food products. Millets are often underutilized despite their rich nutritional profile and health benefits such as being gluten-free, high in fiber, and having a low glycemic index. By using them in a commonly consumed product like muffins, this project demonstrates how traditional ingredients can be adapted to fit contemporary dietary preferences. It also encourages sustainable food choices by promoting local and climate-resilient crops. With increasing demand for functional and healthy snacks, this low-fat millet muffin has strong potential for acceptance in the health food market.

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