



“Research And Development Of An Innovative Product - Finger Millet Doughnut”.

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Abstract

The Finger Millet Doughnut was developed with the purpose of value addition of millet based Finger Millet. The product was created with the purpose of designing a nutritionally dense solution that can effectively prevent a range of health issues and ultimately lead to the adoption of a healthier lifestyle. It consists of varied ingredients, mainly millet based Finger Millet. It is Loaded with Calcium and is one of the significant non-dairy sources of calcium. The present investigation was undertaken to develop Doughnut using Finger Millet as main ingredient by replacing conventional unhealthy flour with millet based Finger Millet flour. The sample developed with complete replacement of conventional unhealthy flour with Finger Millet flour achieved highest overall acceptable sensory score.

Key words: Finger Millet, Doughnut, millet.

Introduction

A Doughnut, also known as a donut, is a popular fried dough-based confectionery enjoyed as a sweet treat in many countries. It can be either homemade or purchased from various establishments such as bakeries, supermarkets, food stalls, and specialty outlets. Doughnuts are typically prepared by deep frying a dough made from flour, along with ingredients like water, leavening agents, eggs, milk, sugar, oil/shortening, and natural or artificial flavours. They come in different forms, including ring-shaped or filled, and are often adorned with toppings and flavourings such as sugar, chocolate, or maple glaze. However, it is important to note that Doughnuts made from non-enriched wheat flour may lack certain essential nutritional components.

Millets encompass a diverse collection of small-seeded grasses that are cultivated globally as cereal crops or grains, serving as essential sources of both animal feed and human food. While the majority of millet species are categorized under the Paniceae tribe, there are also several other taxa that include millet varieties. The millets fulfil the hunger of thousands of people especially those who live in the hot and humid climate. Finger Millet, a kind of millet that is widely grown as a cereal in the arid areas of Africa and Asia. Loaded with Calcium: Finger Millet flour is one of the best non-dairy sources of calcium when compared to any other grain. According to the National Institute of Nutrition in India, 100 grams of Finger Millet contains 344 mg of calcium. Calcium is critical for healthy bones and teeth and the prevention of osteoporosis - a disease which weakens the bones. According to Dr. Anju Sood, a Nutritionist based in Bangalore, offering Finger Millet Porridge is highly advantageous for the development of children. (saleh A.S *et al.*,2013)

Controlling diabetes is facilitated by the high polyphenol and dietary fiber content present in the seed coat of this grain, which surpasses that of rice, maize, or wheat. The grain's low glycaemic index helps curb food cravings and regulates digestion, thereby effectively managing blood sugar levels within a safe range. There are many more health benefits of Finger Millet like It reverts skin ageing, battles anaemia, Relaxes the body and also it helps in weight loss.

The Finger Millet flour can then be incorporated as an ingredient for bakery products which enhances the product's nutritional value. At present, there is an increasing interest in millet based products that is associated with health promoting abilities. (Chandra D *et al.*, 2016)

It's high time to develop millet based product with the use of Finger Millet (as a major ingredient). Hence, present investigation was undertaken to develop Finger Millet Doughnut to replace the conventional unhealthy snacks.

Materials

• **Ingredient**

Finger Millet flour, Wheat flour, Sugar, Baking Powder, Yeast, Salt, Milk, Butter, Cocoa powder, and Vanilla Essence were procured from local shop of Pune.

• **Packaging material**

Corrugated Fibreboard Corrugated Case Material (CCM) is utilized as effective packaging material for Finger Millet Doughnut. (Qian M *et al.*, 2021)

• **Equipment**

Equipment's such as weighing balance, microwave oven/baking oven, dough/cake mixer were used for preparation of Doughnut.

Methods

Chemical analysis

Determination of moisture

The moisture content was assessed using the oven drying method. (Willits C O, 1951). The sample of 5gm were crushed and dried in an oven at 100°C to constant weight. After cooling in the desiccators, the sample was weighed again. The loss in weight was recorded as moisture content. (Pearson D, 1976)

$$\text{Moisture}(\%) = \frac{W_1 - W_2}{W_1} \times 100$$

Where,

W1=Initial weight of bottle with sample before drying

W2=Final weight of the sample after drying.

Determination of ash content

Total ash content of sample was estimated by using direct-heating method of muffle furnace. (Marshall M R, 2010)

$$\text{Ash}(\%) = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Determination of protein content

The protein content was estimated by using micro kjeldahl method. (Maehre H K *et al.*,2018)

$$\text{Nitrogen}(\%) = \frac{(\text{Sample titrate} - \text{Blank titrate}) \times \text{Normality of HCL} \times 14 \times 100}{\text{Weight of sample} \times 1000}$$

$$\text{Protein \%} = \text{Nitrogen \%} \times 100$$

Determination of fat

Fat was estimated by using Soxhlet apparatus method (Eller F J and King J W, 1996)

$$\text{fat}(\%) = \frac{\text{Thimble with sample} - \text{empty thimble}}{\text{Weight of sample}} \times 100$$

Determination of carbohydrate

The estimation of total carbohydrate content was conducted using the Anthrone method. (Ludwig T G and Goldberg H J, 1956)

Determination of Energy value

Energy value was determined using formula given below. (Kromann R P, 1967)

$$\text{Energy value} = (\text{carbohydrate} + \text{Protein}) \times 4 + \text{Fat} \times 9$$

Organoleptic Evaluation

Semi-trained judges utilized nine-point hedonic scales to conduct organoleptic evaluation, assessing factors such as colour, flavour, texture, taste, and overall acceptability. (Sharma H R and verma, 2006)

Fig-1: A process flow chart illustrating the preparation of Doughnuts.

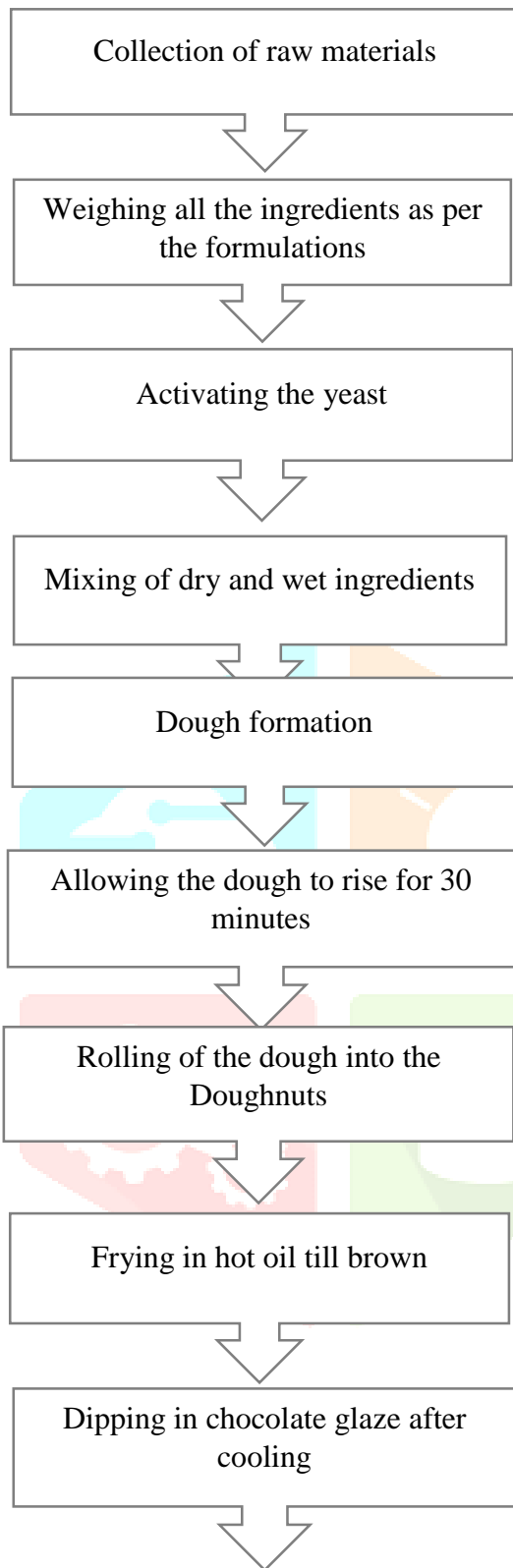


Table-1: Composition**Makes 20 to 22 Doughnuts**

Sr.No	Ingredients	Quantity (20 to 22 makes)
1	Finger Millet	66g
2	Wheat	66g
3	Butter	8g
4	Yeast	5g
5	Sugar	130g
6	Milk	200ml
7	Vanilla Essence	3g
8	Dark compound Chocolate	200g

Sensory evaluation

The sensory evaluation of different organoleptic characteristics (Amerine M A *et al.*,2013) i.e., Colour and appearance, mouth feel, taste, flavour and overall acceptability were carried out by trained panellists on 9 - point Hedonic scale. The individual organoleptic properties were used to calculate the average score

Table-2

Parameters	S1	S2	S3	S4
Colour and appearance	8	8	7	8
Flavour	8	8	8	7
Texture	8	7	8	8
Taste	9	9	8	9
Overall acceptability	8	8	8	8

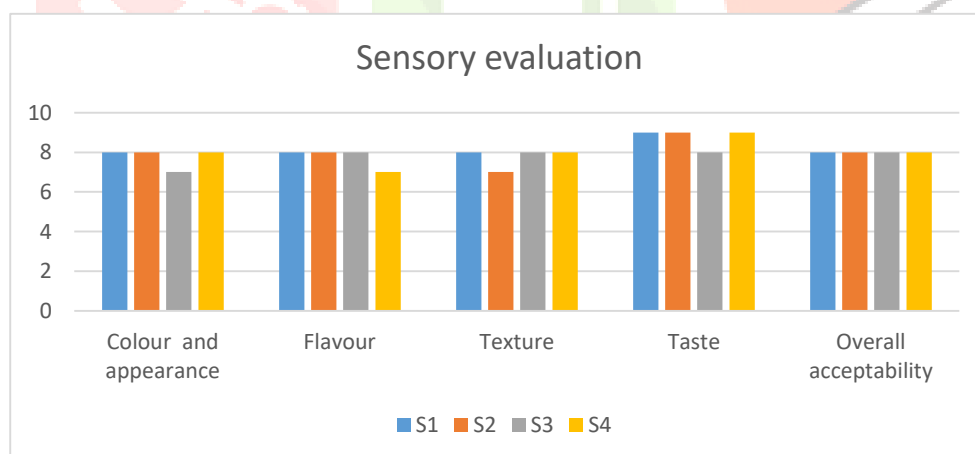
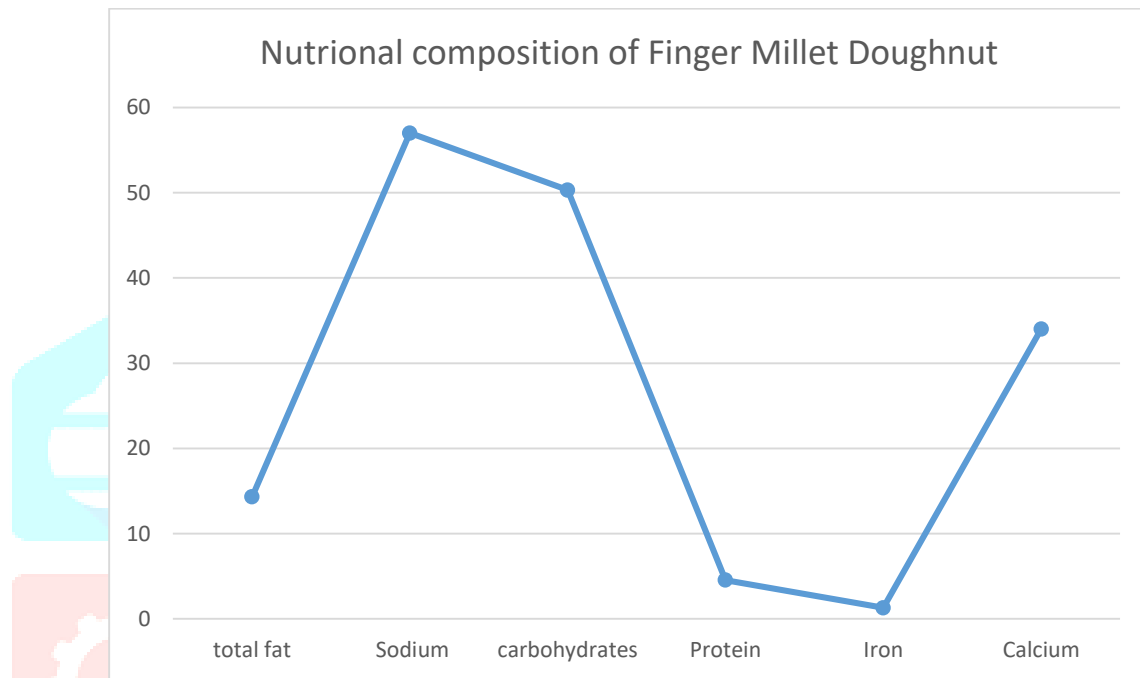
**Fig-2: Graph of sensory Analysis of samples**

Table-3: Proximate composition of Finger Millet Doughnut

Parameters	Value (g/100g)
Total fat	14.31g
Sodium	57mg
Carbohydrates	50.31g
Protein	4.54g
Iron	1.3mg
Calcium	34g

**Fig-3: Proximate composition of Finger Millet Doughnut**

Procurement of Raw Material

The quality of raw materials directly affects the quality of the product, Hence proper selection and purchase of raw materials is an important decision.

The raw material required for the production of Finger Millet Doughnut is well defined. By using the finalized recipe of the product, we prepared Finger Millet Doughnut. We procured raw materials from various sources i.e., Finger Millet flour, Wheat Flour and Milk. We brought the packaging material from the wholesale plastic shop which is in Pune.

Raw Materials include-

Finger Millet flour, Wheat flour, Sugar, Baking Powder, Yeast, Salt, Milk, Butter, Coco powder and Vanilla Essence.

Finger Millet

1. **Abundant in Calcium:** Among various grains, Finger Millet flour stands out as an exceptional non-dairy source of calcium. As per the National Institute of Nutrition in India, 100 grams of Finger Millet contains 344 mg of calcium. Calcium is critical for healthy bones and teeth and the prevention of osteoporosis - a disease which weakens the bones. (Shobana S *et al.*,2013)
2. **Helps in Controlling Diabetes:** The grain's seed coat is abundant in polyphenols and dietary fibres as compared to rice, maize or wheat. The low glycaemic index lessens food cravings and maintains the digestive pace, consequently, keeping blood sugar within the safe range. "It is best to add it to your morning meal or have it for lunch in order to keep your system on track the whole day.

Nutritional Value per 100g

- Calories 354 kcal
- Total Fat 3.4g
- Saturated Fat 0.7g
- Polyunsaturated Fat 2g
- Monounsaturated Fat 0.7g
- Cholesterol 0mg
- Sodium 5mg Potassium 40mg
- Carbohydrates. 80g
- Dietary Fibre 2.7g
- Sugars 0.6g
- Protein 13g

As mention above, Finger Millet's nutritional value per 100g is not too high in calories as it only provides 354 kcal per 100g serving. According to a study published on Research Gate, it is one of the essential plants that provides crucial amino acids such as isoleucine, tryptophan, threonine, methionine, and valine, which can prove to be beneficial for vegetarians as well as vegans alike.

Gluten free Wheat Content

WHY GLUTEN-FREE WHEAT FLOUR? Gluten Sensitivity/Intolerance Many people who do not have the coeliac disease can still experience uncomfortable symptoms when they consume gluten. This is known as non-coeliac gluten sensitivity or gluten intolerance.

Unsweetened Cocoa Powder

The powder provides many potential health benefits. Health Benefits Cocoa powder provides tons of benefits, especially if your powder is at least 72% cocoa. Here's a look at some of the health benefits of cocoa powder: Improved Cognitive Health Research suggests that adding more cocoa powder to your diet helps to improve your attention, working memory, and general cognition. (Allotey Babington L *et al.*, 2019)

Nutrition Value:

Enriched with Nutrients: Cocoa powder is rich in a variety of essential minerals, including iron, zinc, selenium, and magnesium. Nutrients per Serving

A quarter cup of unsweetened cocoa powder:

Calories: 49

Carbohydrates: 12 grams

Fibre: 7 grams

Protein: 4 grams

Fat: 3 grams

Processing Technology**Equipment For the production of Finger Millet Doughnuts at the commercial level –**

We need to choose the right machinery as a selection of the correct machines will be economical for time-saving production. Weighing Balance Automatic weighing balance is used for weighing ingredients for correct measurement according to the formulation. Microwave oven/ baking oven the microwave oven is used for melting the chocolate for the chocolate glaze that goes on the top of the Doughnuts. Dough/cake mixer the cake/dough mixer is used to mix the Doughnut batter. Proper mixing provides a better texture and a good rise to the Doughnuts. Manual Sealing Machine It is used to seal the aluminium laminated multi-layer pouches filled with product (Dinesh a Kunkari *et al.*, 2023)

Equipment's needed for frying

Heavy and deep pot, preferably with a capacity of 4 to 6 quarts. An electric deep-fryer is not necessary. It is recommended to opt for a cast iron pot, such as a 5.5-quart enamelled cast iron pot, as it retains heat effectively, aiding in the frying process. The light enamel interior of the pot allows for better visibility while frying, reducing the chances of overcooking. However, uncoated cast iron can also be used with caution. The larger the pot, the more oil you'll need, but the upside is that with more oil, the temperature will be more stable and will recover more quickly. Regardless of the situation, it is crucial for the pot to have sufficient depth to accommodate a minimum of 3 inches of oil, with an additional 3 inches of space between the top of the oil and the rim of the pan.

Thermometer: Ensure you have a reliable thermometer capable of accurately measuring temperatures between 350 and 400 degrees Fahrenheit. Deep-fry thermometers that can be conveniently attached to the side of the pot are recommended, although a probe thermometer can also be used effectively.

Spider or skimmer: To facilitate the removal of cooked food from the frying oil, a small spider or skimmer is recommended. A spider is a wok tool featuring a wire mesh basket and a wooden handle, available in various sizes. However, standard-sized spiders may be too large for many pots. Alternatively, a skimmer can be used, typically smaller than a spider, with a flatter basket and tighter mesh. Skimmers are originally designed for skimming foam from stock. (Banks D, 2007)

Splatter screen: While not a necessary item, a splatter screen can be beneficial in minimizing mess during frying. Some newer models even come with filters to help reduce frying odors. For draining fried food, a rack placed over a sheet pan is preferred. While paper towels or plates can be used for draining, they may lead to soggy or greasy results if not used correctly. Additionally, if you wish to maintain the crispiness of a batch of fried food while working on a second batch, a rack and pan setup is highly recommended.

Innovative and Trails

We decided to prepare a Finger Millet Doughnut by addition of Finger Millet, gluten-free wheat flour in specific amount to structure the formulation. We got a good sweet and chocolatey taste. We added cocoa powder, vanilla essence and some baking powder and baking soda and sweeteners. The Finger Millet donuts were totally free from additives which make them more preferable.

Innovativeness

Development Finger Millet donuts with Finger Millet flour, gluten-free wheat flour and cocoa powder which increases the nutritional value. The product is ready to eat healthy snack with the nutrition of healthy millet.

Trial

There were many trials conducted to finalised the formulation. Total 4 trials were conducted out of which the 4th trial [L4] formulation was finalised and used for the final product.

Trials Ingredients	Levels			
	L1	L2	L3	L4
Finger Millet (g)	50	80	66	66
Wheat (g)	100	50	80	66
Butter (g)	12	12	10	8
Yeast (g)	5	5	5	5
Sugar (g)	150	100	120	130
Milk (ml)	100	150	200	200
Vanilla Essence (g)	1	2	3	3
Dark compound chocolate (g)	50	50	50	50

Table-4: Finger Millet Doughnut formulation

Packaging Requirement

Physical protection, barrier protection, containment or agglomeration. (Pereira de Abreu *et al.*, 2012)

Storage Facilities

There are no specific storage facilities required all the raw materials used are self-stable at room temperature. Protection from moisture can be achieved by storing in air tight conditions. The finished product is to be stored in air tight condition away from moisture and sunlight with the right storage, you can keep your donut fresh and fluffy for a minimum duration of 24 hours, and frequently exceeding this timeframe.

Room Temperature

Keeping donuts at room temperature is fine if you plan to eat them within the next day or two. The crucial aspect is to take every possible measure to prevent the donut from being exposed to air. While using a storage bag, squeeze out as much air as possible before you seal it. That will help donuts stay fresher for longer. For the same reason, it can be beneficial to individually bag each donut.

When dealing with multiple donuts, you might encounter difficulty in removing the excess air trapped between them. To give extra protection, you can also wrap it in plastic wrap or greaseproof paper before putting it in the bag or box. However, when using plastic wrap specifically, you may notice that glaze or toppings tend to adhere to it.

In the refrigerator: Keeping donuts chilled is essential. Putting donuts in the refrigerator can also be a good way to keep them edible a little longer.

In the freezer: Freezing is a great option if you're not sure when you're going to eat your donuts. At a temperature of 0 degrees Celsius, freshly baked donuts will be kept indefinitely but to enjoy them at their best, you really want to eat them within one week.

References

- Dinesh. A. Kunkari, Mansi Lokhande and Sandip T Gaikwad. (2023). Traditional and advance Processing technology of millets-A review Journal of Emerging technologies and innovative research, 10(4), 2349-5162.
- Saleh, A. S., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. *Comprehensive reviews in food science and food safety*, 12(3), 281-295.
- Chandra D., Chandra S., & Sharma, A. K. (2016). Review of Finger millet (*Eleusine coracana* (L.) Gaertn): a power house of health benefiting nutrients. *Food Science and Human Wellness*, 5(3), 149-155.
- Qian, M., Liu, D., Zhang, X., Yin, Z., Ismail, B. B., Ye, X., & Guo, M. (2021). A review of active packaging in bakery products: Applications and future trends. *Trends in Food Science & Technology*, 114, 459-471.
- Pearson, D. (1976). *The chemical analysis of foods* (No. Ed. 7). Longman Group Ltd...
- Willits, C. O. (1951). Methods for determination of moisture-oven drying. *Analytical Chemistry*, 23(8), 1058-1062.
- Marshall, M. R. (2010). Ash analysis. *Food analysis*, 4, 105-116.
- Mæhre, H. K., Dalheim, L., Edvinsen, G. K., Elvevoll, E. O., & Jensen, I. J. (2018). Protein determination—method matters. *Foods*, 7(1),
- Eller, F. J., & King, J. W. (1996). Determination of fat content in foods by analytical SFE. *Semin Food Anal*, 1, 145-162.
- Ludwig, T. G., & Goldberg, H. J. (1956). The anthrone method for the determination of carbohydrates in foods and in oral rinsing. *Journal of dental research*, 35(1), 90-94.
- Kromann, R. P. (1967). A mathematical determination of energy values of ration ingredients. *Journal of Animal Science*, 26(5), 1131-1134.
- Sharma, H. R., & Verma, R. (2006). Organoleptic and chemical evaluation of osmotically processed Apricot wholes and halves.

- Amerine, M. A., Pangborn, R. M., & Roessler, E. B. (2013). *Principles of sensory evaluation of food*. Elsevier.
- Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N. G., Anjana, R. M., Palaniappan, L., & Mohan, V. (2013). Finger millet (Finger Millet, *Eleusine coracana* L.): a review of its nutritional properties, processing, and plausible health benefits. *Advances in food and nutrition research*, 69, 1-39.
- Allotey-Babington, L., Kwabong, A. A., Banga, K. B. N. G., Amponsah, S. K., & Asiedu-Gyekye, I. J. (2019). Unsweetened natural cocoa powder: a potent nutraceutical in perspective. In *Theobroma Cacao-Deploying Science for Sustainability of Global Cocoa Economy*. London, UK: IntechOpen.
- Banks, D. (2007). Foodservice frying. In *Deep frying* (pp. 277-289). AOCS Press
- Pereira de Abreu, D. A., Cruz, J. M., & Paseiro Losada, P. (2012). Active and intelligent packaging for the food industry. *Food Reviews International*, 28(2), 146-187.

