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Formulation of Fortified Millet Chikki Using Selected Millet Grains

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Abstract

Fortified Millet Chikki is a nutritionally enriched snack crafted from millet grains, an ancient gluten-free staple. This innovative take on traditional chikki blends the goodness of millets with essential nutrients, catering to modern health-conscious consumers. Since, millets are known to be rich in fiber, vitamins, and minerals, it provides a sustainable source of energy while promoting digestion and overall well-being. Through fortification, key nutrients like iron, calcium, and vitamins are added, addressing prevalent deficiencies and enhancing nutritional value .This study is put up to focus at providing additional nutrition to the people in easy, ready to eat, sweet desert form. Fortification leads to fulfill additional vitamins and mineral in food so that it can prevent malnutrition and deficiencies in population. Sorghum (Sorghum bicolor), pearl millet (Pennisetum glaucum) and finger millet (Eleusine coracana) are selected because of easy availability and nutritional properties .These fortified millet chikki can be consumed by any age group as an additional source of nutritive food.

Introduction

Revsiting the likeness of sweet in every indian meal, pursues the note that traditional indian sweets are of great interest. A critical analysis over the consumption and nutritonal analysis of the traditional made sweets have shown that the content and materials used are mostly with a perspective of less health benefits. Whereas, when we transform it into fortified products and value addition to the pre-developed food, gives kind attention **(Ramashia *et al.*, 2021)**. Millets are the ancient form of grains widely used worlwide. The ultimate change is people's lifestyle has brought in various kind of attention in use of millets for dietary supplements. With numerous benefits of all kinds of millets in existence, it has been found that widely used millet are pearl millet, finger millet, sorghum, foxtail, proso, kodo, etc. **(Sharmila and Elango 2024)**. These grains are extremely rich woth various biological functions such as antioxidant properties, antisclerogenic and anti inflammatory properties. Usage of food and it's products has brought the concern of food security globally. Hereby, millets have also proven as the most sustainable form of grains that has high nutritional content along with advantageous health solutions. But despite the nutritional benefits, there has been underuse of millets in large scale. Lack of awareness and optimum use of millets can lead to under developed sustainable environment. Millets are often referred to as Super food and its production can be seen as an approach for sustainable agriculture and a healthy world **(Singh and Sood 2020)**. Multidimensional benefits associated with millets can address the issues related to nutrition security, food systems security, and farmers' welfare. Further, many unique features linked with millets makes them a suitable crop which is resilient to India's varied agro-climatic conditions. Citing these factors, the year 2018 has already been declared as the National Year of Millets and India has called for declaring 2023 as the "International Year of Millets".

The aim of this study finds objectifying product development process of fortified millet chikki using selected millet of great interest and of high nutritional benefits.

Literature Review

(Tripathi *et al.*, 2023) studied that millets are esteemed for their healthy benefit incorporates nutrients, minerals, carbohydrates, and dietary filaments source and potential medical advantages. They have gained attention in recent years due to their remarkable nutritional composition and potential health-promoting properties. The presence of bioactive compounds, such as antioxidants and polyphenols, are investigated for their role in supporting these health benefits.

In recent years, there has been a significant surge in product development utilizing millets, driven by a growing awareness of their nutritional benefits, environmental sustainability, and cultural significance. Millets, such as sorghum, pearl millet, and finger millet, are gluten-free grains rich in fiber, protein, vitamins, and minerals **(Dekka *et al.*, 2023)**.

(Yousaf *et al.*, 2021) discussed the major facts that one prominent trend is the development of millet-based snacks and ready-to-eat foods. These include millet chips, crackers, and cereal bars, offering healthier alternatives to traditional snacks. Millet flour is also being used in baking, replacing refined wheat flour in bread, muffins, and cookies. Moreover, millets are finding their way into beverages like millet-based beers and malted drinks, appealing to health-conscious consumers seeking gluten-free options. Another emerging trend is the incorporation of millets into baby foods and nutritional supplements, capitalizing on their nutritional density and suitability for individuals with dietary restrictions.

Avoiding gluten and sticking to a diet may seem easy but the major food items are made from wheat like Pasta, cakes, cookies, morning cereals, etc. Avoiding these things would necessitate a radical shift in lifestyle, which not everyone could accomplish. Thus, demand for gluten-free food items is increasing today **(Goyal *et al.*, 2015)**.

The market demand for gluten free foods is increasing due to frequent incidences of celiac disease and increasing awareness on consumption of gluten free foods. Since millet are gluten-free and also excellent sources of micro and macro nutrients such as vitamins, minerals, dietary fibers and phenolic compounds. Taking this topic, **(Selladurai *et al.*, 2023)** highlighted the product development using two millet varieties that are gluten free and outline their nutritional benefits.

Materials and Methods

Formulating and fortifying millet chikki (a traditional Indian sweet made from jaggery and nuts) using selected millet grains involves several steps. Such as follows :

1. Selection of Millets

Sorghum (*Sorghum bicolor*), Pearl millet (*Pennisetum glaucum*) and Finger millet (*Eleusine coracana*) were selected for formulation of chikki as in **Table 1**. Before processing the raw materials, it was ensured that the grains are clean, free from pests, and of high quality. These millet were used as flour by grinding them into powder like material. All the three millet flour was mixed in a clean container before further process.

2. Preparation of Ingredients

Other raw materials like groundnut, jaggery, liquid glucose and Premix of vitamins and minerals were also used for the product development as in **Table 2**. The use of jaggery was of high-quality, ensuring it

is free from impurities. There are many health benefits of jaggery hence, giving it a touch of healthy snacking for all age groups. Depending on the recipe, the ingredients were put for mixing one by one along with the millet flour. The roasted millets were converted into coarse flour using a traditional or modern mill.

3. Jaggery Syrup Preparation

All the ingredients being of different sizes, jaggery syrup was used to bind it into a bar or chikki form. Jaggery with a small amount of water in a thick-bottomed pan was continuously stirred until the jaggery dissolves and reaches a hard-ball stage. Then, gradually the millet-nut mixture along with vitamins and minerals premix was added into the jaggery syrup, stirring continuously to ensure even coating.

4. Cooling and Packaging

At an ambient room temperature, the chikki was allowed to set and settle down in form of a bar which was further cut into specific sized bars. The cooled chikki was then sent for further evaluation by storing in an airtight containers to maintain freshness.

5. Fortification

The millet chikki developed hereby underwent Nutrient Fortification to enhance the nutritional value, using premix of vitamins and minerals.

Table 1 : Proportion of millet flour

Millet	Percentage (%)	Quantity(Kg.)
Sorghum flour	40	60
Pearl millet flour	40	60
Finger millet flour	20	30
Total	100 %	150Kg.

Table 2 : Formulation of fortified millet chikki of 2500 gm lot-

Ingredients	Amount	Percentage
Jaggery	1175 gm	47%
Peanut	1000 gm	40%
Millet balls	250 gm	10%
Liquid glucose	75 gm	3%
Premix of vitamin and mineral	25 gm	1%

Flow chart of preparation of Fortified Millet Chikki -

Procurement of raw material

⇩

Processing of millet ball

⇩

Cleaning and Roasting of other ingredients (Groundnut and Jaggery)

⇩

Preparation of jaggery syrup

Mixing of Millet ball, Groundnut, liquid glucose

Fortification with premix of vitamin and mineral

Transfer of mixer in stainless steel tray for cooling and cutting into desired size

Packing in polypropylene pouches

Nutritional Evaluation of Fortified Millet Chikki

A. Determination of calcium-

Analysis of calcium was done by IS 5949:1990.

The most prevalent mineral in the body is calcium. Humans require calcium for the development and maintenance of strong bones, and teeth and bones contain 99% of the calcium in the body. It is also required to keep the brain and other body parts communicating in a healthy way. It affects how muscles move and how the heart works. Low calcium consumption is widespread throughout the world and can cause osteomalacia in adults and nutritional rickets in children. Foods enhanced with calcium may increase calcium intake. All life stages have substantial calcium requirements. The dietary reference values are designed to take into consideration the requirements for development, growth, maintenance of health, and functioning.

B. Determination of Iron-

Analysis of iron was done by IS 14433:2006

As a component of hemoglobin, an erythrocyte (red blood cell) protein that carries oxygen from the lungs to the tissues, iron is a mineral that is found naturally in many foods, added to some food products, and sold as a dietary supplement . Iron also supports healthy connective tissue and muscle metabolism as a part of myoglobin , another protein that carries oxygen.

C. Determination of vitamin A-

Analysis of vitamin A was done by IS 5886:1970

The term "vitamin A" refers to a class of fat-soluble retinoids, which include retinol and retinyl esters . Immune function, cellular communication, growth and development, and male and female reproduction are among the functions of vitamin A . Vitamin A supports the growth and differentiation of cells and is essential for the normal formation and upkeep of the heart, lungs, eyes, and other organs. Preformed vitamin A (retinol and retinyl esters) and provitamin A carotenoids are the two forms of vitamin A found in the human diet . Foods derived from animals, such as dairy, eggs, fish, and organ meats, contain produced vitamin A . Plant pigments known as provitamin A carotenoids include beta-carotene, alpha-carotene, and beta-cryptoxanthin.

D. Determination of vitamin B1-

Analysis of vitamin B1 was done by IS 5398:1969

One of the water-soluble B vitamins is thiamin, sometimes known as thiamine. Another name for it is vitamin B1. In addition to being added to certain food products, thiamin can be found naturally in some foods and as a nutritional supplement. This vitamin is essential for energy metabolism, which in turn

affects cell growth, development, and function. The primary metabolically active form of thiamin, thiamin diphosphate (TDP; sometimes called thiamin pyrophosphate), makes up around 80% of the about 25–30 mg of thiamin found in an adult human body. Although the large intestine's bacteria also produce free thiamin and TDP, it is currently uncertain how much of these bacteria contribute to thiamin nutrition. TDP is a necessary cofactor for five enzymes that are involved in the metabolism of lipids, amino acids, and glucose.

E. Determination of vitamin B2-

Analysis of vitamin B2 was done by IS 5399:1969

One of the water-soluble B vitamins is riboflavin, or vitamin B2. In addition to being added to certain food products, riboflavin can also be found naturally in some foods and as a nutritional supplement. Two important coenzymes, flavin adenine dinucleotide (FAD) and flavin mononucleotide (FMN; sometimes called riboflavin-5'-phosphate), require this vitamin as a necessary component. FAD or FMN make up more than 90% of the riboflavin found in food; the remaining 10% is made up of the free form, glycosides, and esters . The proximal small intestine is where most riboflavin is absorbed . Beyond 27 mg, the body retains very little riboflavin in the kidneys, liver, and heart and absorbs very little of it through single doses. When too much is eaten, it either isn't absorbed or the little that is is eliminated in the urine.

F. Determination of vitamin B3-

Analysis of vitamin B3 was done by IS 5400:1969

Among the water-soluble B vitamins is niacin, sometimes referred to as vitamin B3. Nicotinic acid (pyridine-3-carboxylic acid), nicotinamide (niacinamide or pyridine-3-carboxamide), and their related compounds, including nicotinamide riboside, are collectively referred to as niacin . Numerous foods naturally contain niacin, which is also added to some food products and sold as a dietary supplement. The primary metabolically active form of ingested niacin is converted by all bodily tissues into the coenzyme nicotinamide adenine dinucleotide (NAD). More than 400 enzymes in the body—more than any other coenzyme produced from a vitamin—need NAD to catalyze processes . In all tissues other than skeletal muscle, NAD is also transformed into another active form, the coenzyme nicotinamide adenine dinucleotide phosphate (NADP)

G. Determination of vitamin C-

Analysis of vitamin C was done by IS 5838:1970

Water-soluble vitamin C, sometimes referred to as L-ascorbic acid, is added to certain foods, found naturally in others, and accessible as a dietary supplement. Since humans cannot endogenously generate vitamin C like most animals can, it is a necessary dietary component.

H. Determination of vitamin B9-

Analysis of vitamin B9 was done by IS 7234:1974

Water-soluble B vitamin folate can be found as a dietary supplement or naturally occurring in certain foods. It can also be added to other foods. The general word for naturally occurring food folates and folates in dietary supplements and fortified foods, including folic acid, is folate (previously known as folacin and occasionally vitamin B9). Food folates are polyglutamates because they are in the tetrahydrofolate (THF) form and typically contain extra glutamate residues. The fully oxidized monoglutamate form of the vitamin, folic acid, is found in most nutritional supplements and fortified foods. Additionally, folate in the monoglutamyl form, 5-MTHF (also called L-5-MTHF, 5-methyl-folate, L-methylfolate, and methylfolate), is included in certain dietary supplements.

Results and Discussion

Pearl millet, finger millet , sorghum and jaggery were used in this study because a possible synergistic relationship is thought to exist between these ingredients. They protect against many same diseases and their health benefits may be increased when they are together in the food products. The use of millets gave the low cost but nutritious product. The results obtained from the statistical analysis concluded that a novel product fortified with millets, jaggery and necessary minerals and vitamins. After the optimization of various ingredients, the product as in **Fig.1** was found to be most favorable because of higher nutrition profile.

Similar results were reported for the nutritional composition of sorghum-finger millet Chakli by **Patekar *et al.*, (2017**) protein and fat content were highest in sorghum-finger millet chakli as compared to the control chakli. The study conducted by **Chavan *et al.*, (2016)** on even the sorghum chakli showed similar kind of nutritional composition. Moreover, **(Nath *et al.*, 2015)** mentioned that according to sorghum varieties, 100 g of jaggery may contain calories 383, sucrose 65-85g, fructose and glucose 10-15g, protein 0.4g, fat 0.1g, and contain traces of vitamins, amino acids, and antioxidants. Nutra chikki developed by **(Pallavi *et al.*, 2014)** had 18% protein, 20% fat, 6.42% Ca, 1.7% Fe, 4000 µg vitamin A and 2660 µg folic acid. Protein digestibility corrected amino acid score of nutra chikki was 0.78 whereas that of control chikki was 0.73. The enriched nutra chikki was evaluated for physico-chemical characteristics such as moisture, texture, peroxide value (PV), fatty acid composition in comparison with control peanut chikki. Nutra chikki, which had initial moisture content of 2–3%, did not alter much up to 60 days of storage at 27 °C and 37 °C. Utilizing a special group of nutrients, flax seed with a combination of healthy fat and high fibre and high in most of the B-vitamins, magnesium and manganese was taken up for the study. An effort was made by **(Shakuntala *et al.*, 2016)** to prepare many food items using linseed in grain and powder form such as linseed chutney powder, linseed holige, ladoo, fried snacks, burfi, nutri ladoo and fortified products like Roti fortified with linseed, chikki, biscuits , salted linseed biscuits, puffed rice ladu, fruit and linseed salad, Porridge and decorative articles.

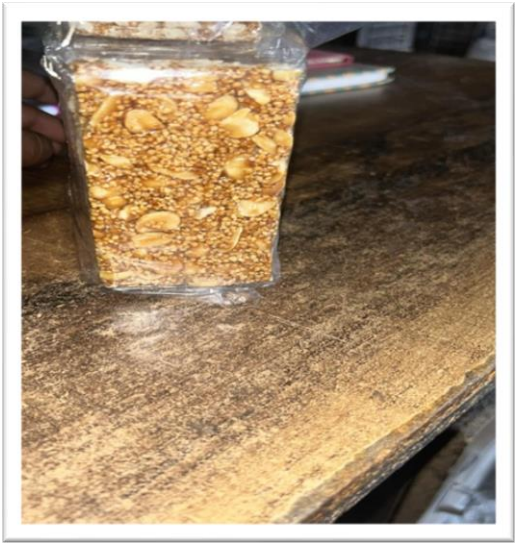

FIG 1- FORTIFIED MILLET CHIKKI

Conclusion

The findings from these analyses underscore the nutritional value of the fortified millet chikki, highlighting its role in providing essential minerals for optimal health. Regular consumption of this

value-added snack can contribute to meeting daily calcium and iron requirements, promoting bone strength, preventing anemia, and supporting overall well-being. This comprehensive nutritional analysis reaffirms the efficacy of fortification strategies in enhancing the nutritional profile of traditional snacks like millet chikki, making them healthier choices for consumers.

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