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Enhancing Nutritional Profile of Chocolate Spread with Millet: A Study on Development of Millet-Based Foods

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Abstract: This research article focuses on the development of millet-based chocolate spread with enhanced nutritional profile. The study begins with the cleaning and grading of raw ingredients, including finger millet, pearl millet, cocoa powder, and honey, to ensure the required quality. The ingredients are then weighed and roasted at 80°C for 2 to 5 minutes, followed by grinding/milling using a mixer method. The study includes the addition of honey and cocoa powder to the millet powder, with all ingredients mixed thoroughly to create a final product. Packaging is also considered in the study. The research highlights the unique health benefits of millets, including their richness in micronutrients, minerals, B vitamins, and nutraceuticals. They are helpful in managing disorders like diabetes and obesity, and their low glycemic index makes them an excellent option for people with diabetes. Additionally, millets are gluten-free, making them a suitable alternative for people with celiac disease or gluten intolerance. Millets are also rich in antioxidants and phytochemicals with anti-inflammatory and anti-cancer properties, making them a valuable addition to diets worldwide. They are a good source of fiber and protein, which can aid in weight management and overall health. Overall, this research aims to create a millet-based chocolate spread that is not only delicious but also promotes good health. The study emphasizes the importance of incorporating nutrient-rich ingredients into everyday foods and encourages the use of locally sourced millets to support the local farming industry.

IndexTerms **- Nutritional, Micronutrients, Minerals, B vitamins, Nutraceuticals, Glycaemic index**

1.INTRODUCTION

Millets are an essential crop for food security, especially in regions with adverse agro-climatic conditions. Despite being nutritionally superior to cereals, their consumption is mostly limited to traditional consumers and lower economic strata. However, the potential benefits of millets are vast and include their ability to broaden genetic diversity in the food basket and improve food and nutrition security. In recent years, researchers have focused on utilizing millet as an ingredient in the development of new and nutritious food products. One such area of interest is the incorporation of millet into chocolate spreads to improve their nutritional profile.

Millet is a gluten-free, nutrient-dense grain that is widely consumed in many parts of the world. It is rich in fiber, protein, vitamins, and minerals, making it a nutritious and healthy ingredient to add to foods. Chocolate spread is a popular food item that is enjoyed by people of all ages. However, it is often high in sugar and fat and lacks essential nutrients. By adding millet to the chocolate spread, the nutritional content can be improved, and it can become a healthier food option.

The study aims to investigate the impact of millet on the nutritional profile of chocolate spread and develop new millet-based food products. The research will explore the sensory properties, acceptability, and shelf life of the millet-based chocolate spread. This research can help in developing new food products that are both nutritious and delicious. Moreover, it can pave the way for a more significant incorporation of millet into the food basket, especially in regions where they are not traditionally consumed.

The research will highlight the unique health benefits of millets, including their richness in micronutrients, minerals, B vitamins, and nutraceuticals. They are helpful in managing disorders like diabetes and obesity, and their low glycaemic index makes them an excellent option for people with diabetes. Additionally, millets are gluten-free, making them a suitable alternative for people with celiac disease or gluten intolerance. Millets are also rich in antioxidants and phytochemicals with anti-inflammatory and anti-cancer properties, making them a valuable addition to diets worldwide. They are a good source of fibre and protein, which can aid in weight management and overall health.Overall, the research aims to create a millet-based chocolate spread that is not only delicious but also promotes good health. The study emphasizes the importance of incorporating nutrient-rich ingredients into everyday foods and encourages the use of locally sourced millets to support the local farming industry. By developing millet-based foods, researchers can improve food and nutrition security while promoting healthier food choices for individuals and communities.

2.MATERIALS AND METHODS

This chapter deals with detailed descriptions of the materials and experimental methods used in the present study entitled "ENHANCING NUTRITIONAL PROFILE OF CHOCOLATE SPREAD WITH MILLET." The study was conducted at the "Department of Food Technology," K.S.Rangasamy College of Technology, Tiruchengode, to achieve the proposed objectives.

2.1 Raw materials

The whole Pearl millet and Finger millet were purchased from a local market, Tiruchengode. Honey and Cocoa powder were

purchased from Jayasurya's departmental store, Tiruchengode.

2.2 Equipment and tools used for processing of products Equipment

We used a hot air oven, glassware, and a mixing blender for our project.

*2.*3 Materials

The basic ingredients are Pearl millet, Finger millet, Cocoa powder and Honey.

2.4 Ingredient optimization

The composition ingredients used in the preparation of Chocolate spread are incorporated with millet in the following table

Sl. No.	Ingredients	Sample1 (g)	Sample2 (g)	Sample3 (g)	Sample4 (g)	Sample5 (g)
1.	Pearl Millet	25	20	20	15	30
2.	Finger Millet	25	20	20	15	30
3.	Cocoa Powder	50	60	50	70	40
4.	Honey	50	50	60	50	50

2.5 Process Flow chart

Ingredients: Pearl millet, finger millet, Cocoa powder, Honey Roasting of Millet: To remove the excess moisture content and improve the flavor DIAGRAMMATIC FLOW CHART FOT PREPARATION OF Chocolate Spread incorporated with millet.

Cleaning & Grading

↓

Weighing the raw ingredients of the required Quality

(Finger millet, Pearl millet, Cocoa powder, Honey)

↓

Roasting 80°C

(80°C for 2 to 5 minutes)

↓

Grinding / Milling

(Mixer method)

↓

Sieving

(Disk mill 0.2mm to 0.5mm)

↓

Addition of Ingredients

(Honey, Cocoa powder)

↓

Mixing(All the ingredients)

↓

Packaging

3. ANALYSIS

3.1 Procedures adopted for the proximate composition of the samples

The control Chocolate spread sample and Chocolate spread incorporated with millet flour are subjected to chemical analysis i.e., moisture, ash, carbohydrates, protein, fiber, iron, and calcium.

3.2 Determination of Moisture content

The moisture content of the sample was determined using the AOAC (2000) method. First, a petri dish with a lid was weighed. Next, 10 g of the sample was weighed into the petri dish and evenly spread for uniform drying. The oven was then set at 100 to 105°C, and the petri dish with the sample was placed inside the oven with the lid open for 15-17 hours. Afterward, the petri dish was allowed to cool in a desiccator with the lid open for 1-2 hours. The petri dish with the sample was weighed, and this process was repeated for all samples until a constant weight was achieved.

$$\text{Moisture (\%)} = \frac{\text{Difference in the weight}}{\text{Weight of the sample}} \times 100$$

3.4 Determination of total protein

The protein content of the sample was determined using the conventional MicroKjeldahl digestion and distillation method as outlined in AOAC (2000). To begin the procedure, precisely 0.5 g of the sample was weighed and transferred to a Kjeldahl flask, ensuring that none of the material adhered to the neck of the flask. A catalyst mixture of approximately 1 g and 5 ml of concentrated sulphuric acid were added to the flask. The flask was placed in an inclined position in the digestion chamber and heated for approximately 4-6 hours until the liquid became clear, displaying a green-blue color. After digestion, the contents in the flask were allowed to cool, and the digestion material was quantitatively transferred to a vacuum-jacketed flask of the micro Kjeldahl distillation apparatus. The ammonia liberated by the addition of 10 ml of 40% NaOH during heating was absorbed in 20 ml of boric acid containing 2-3 drops of a mixed indicator in a 100 ml conical flask. The distilled ammonia was then titrated against 0.1 N HCl, and the blank was run in a similar manner.

$$\text{Nitrogen (\%)} = \frac{\text{Normality of HCl} \times \text{Volume of 0.1 N HCl} \times 14}{\text{Weight of sample} \times 1000} \times 100$$

$$\text{Crude protein (\%)} = N \times 6.25$$

3.5 Determination of ash content

According to the AOAC (2000) method, the ash content of the sample was determined. First, accurately weighed 5 grams of the sample were placed in a porcelain crucible which was previously heated to approximately 600°C and cooled. The crucible was heated for 6-8 hours at 600-700°C in a muffle furnace. After cooling in a desiccator, the crucible was weighed. To ensure complete ashing, the crucible was reheated for 1-2 hours in a muffle furnace, allowed to cool and then weighed. This process was repeated until consecutive weights were the same and the ash appeared grayish-white in color.

$$\text{Ash (\%)} = \frac{\text{(Initial weight of empty crucible)} - \text{(Final weight of the empty crucible with ash)}}{\text{Weight of sample}} \times 100$$

3.6 Sensory evaluation

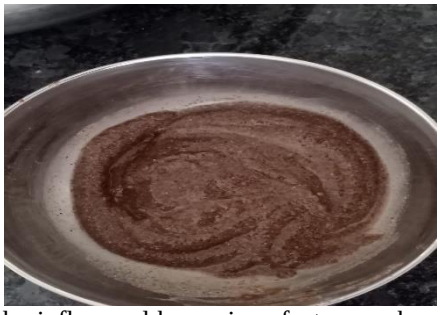
To gather consumer feedback on the overall acceptability of chocolate spread with millets compared to the control chocolate, a sensory evaluation was conducted. A panel of 8 to 10 members was presented with the products and evaluated different sensory attributes including appearance, flavor, taste, texture, and overall acceptability, using a five-point scale where 5 represented strong attributes.

3.7 Statistical analysis

The mean ± SD of three replicates was used to present the data. The nutritive values of the chocolate spread with millets were analyzed using Analysis of Variance (ANOVA) in a Completely Randomized Design (CRD) to determine the differences in response among various levels of substitution. Significant differences were reported at $p \leq 0.05$.

3.8 Storage studies of chocolate spread with millet

In order to assess the quality of the products during storage, shelf-life studies were conducted. Physicochemical and sensory analyses were performed over time.



The shelf life of food products can be influenced by various factors such as preservation methods, types of packaging material, processing conditions, and microbial count. The samples were stored at room temperature, and samples were collected at intervals of 15, 30, 45, and 60 days for physicochemical, sensory, and microbial studies.

4. Results and discussion

4.1 Sensory analysis of Chocolate spread incorporated with millet

Two chocolate spreads were developed using millet flour, cocoa powder, and honey in different combinations. The nutritional content of the spreads was analyzed and compared to conventional peanut spread. Results showed that the millet-based spreads had a higher level of protein, fiber, calcium, iron, and zinc. Sensory evaluation revealed no significant differences in taste, texture, or color between the spreads.

Parameters	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5
Appearance	2	3.58	1.5	2	1.5
Color	2	3.42	2.5	2	2
Flavor	1.5	3.2	2	2	1
Taste	1	3.6	1.5	2.5	3
Texture	2	3.8	2.5	2.5	3
Overall Acceptability	1	4	2	3.5	3

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	6	9.5	1.583333	0.241667		
Column 2	6	21.6	3.6	0.07856		
Column 3	6	12	2	0.2		
Column 4	6	14.5	2.416667	0.341667		
Column 5	6	13.5	2.25	0.775		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	13.71133	4	3.427833	10.47055	4.02E-05	2.75871
Within Groups	8.184467	25	0.327379			
Total	21.8958	29				

The ANOVA results show that there is a significant difference among the groups (p-value < 0.05), as indicated by the F-statistic value of 10.47054583 and a corresponding p-value of 4.01525E-05, which is less than the significance level of 0.05. This suggests that at least one of the samples differs significantly from the others in terms of the mean values of the parameters. Upon further analysis of the mean values for each sample, it can be observed that Sample-2 has the highest mean values for most of the parameters, including Appearance (3.58), Colour (3.42), Flavour (3.2), Taste (3.6), and Texture (3.8). Sample-4 also has relatively higher mean values for most parameters, while Sample-1, Sample-3, and Sample-5 have comparatively lower mean values. Based on the ANOVA results and mean values, it can be concluded that Sample-2 generally has the highest acceptability ratings among all the samples, as it has higher mean values for most parameters. Sample-4 also shows relatively good acceptability, while Sample-1, Sample-3, and Sample-5 may have lower acceptability ratings based on the lower mean values for most parameters.

4.2 Chemical composition of millet flour incorporated spread

Chemical characteristics and quality of cooking by using Chocolate spread incorporated with millet flour were estimated. It was represented in following Table. The chemical constituents like moisture content, CHO, protein content, crude fiber, ash content and iron, and calcium content.

The results obtained in chemical analysis for chocolate spread (control) were moisture 11.13 %, protein 9.52 %, fat 3.82 %, total carbohydrate 71.18 %, crude fiber 1.56 %, calcium mg% 16.24, iron mg% 3.68, ash 1.8 %, respectively. The chemical composition of Chocolate spread incorporated with millet flour (sample 2) was moisture 10.13%, protein 11.31 %, fat 2.28%, total carbohydrate 69.15%, crude fiber3.92%, calcium 28.2 mg, iron 9.64 mg, and ash 1.7%. By comparing the results of chocolate spread and Chocolate spread incorporated with millet flour, the moisture content is low in the sample and will improve the shelf life, protein is also high in the sample, because millets are rich sources of minerals like calcium and iron were significantly increased in the sample because pearl millet and finger millet were used, which are rich in iron and calcium.

S. No	Chemical Parameters	Control	Sample (S3 Millets Spread)
1.	**Moisture (%)**	5.0 ± 0.68	5.0 ± 0.68
2.	**CHO (%)**	71.18±3.00	69.15±3.08
3.	**Ash (%)**	1.8±0.95	2.2±1.62
4.	**Fat (%)**	3.82±2.14	2.28±1.38
5.	**Protein (%)**	9.52±2.01	11.31±2.14
6.	**Crude fiber (%)**	1.56±0.95	3.92±2.36
7.	**Iron (mg%)**	3.68±0.85	9.64±2.24
8.	**Calories (K.cal)**	328.98±2.33	386.17±3.52

5. SUMMERY AND CONCLUSION

The aim of the present study was to develop a chocolate spread incorporated with millet flour, with the objective of enhancing the nutritional profile of the product. Millets, which are ancient grains, have gained attention in recent years due to their high nutritional value, including being rich in fiber, minerals, and antioxidants. Chocolate spreads are popular food products consumed worldwide, but they are often high in sugar and unhealthy fats. By incorporating millet flour into chocolate spreads, it was hypothesized that the nutritional content of the product could be improved. The study was conducted at the Department of Food Technology, K.S.Rangasamy College of Technology, Tiruchengode. Raw materials used in the study, including pearl millet, finger millet, cocoa powder, and honey, were procured from a local market. The millet grains were first roasted to remove excess moisture and improve flavour. The roasted millet grains were then ground and sieved to obtain millet flour. Honey and cocoa powder were added to the millet flour to prepare the chocolate spread. Three different formulations of the chocolate spread were prepared by varying the type and quantity of millet flour used. The sensory analysis of the chocolate spread was then conducted to evaluate its sensory attributes. The sensory analysis involved a panel of trained sensory evaluators who assessed the chocolate spread samples for appearance, colour, flavour, taste, texture, and overall acceptability using a structured sensory evaluation form. The sensory scores obtained for each attribute were analysed statistically using ANOVA to determine significant differences among the samples. The results of the sensory analysis indicated that the sensory attributes of the chocolate spread were influenced by the type and quantity of millet flour used in the formulation. Sample 2, which had higher amounts of finger millet and cocoa powder, was found to have the highest average scores for most sensory parameters, indicating that it was the most preferred among the samples tested. The nutritional analysis of the developed chocolate spread samples was also conducted to determine their nutritional content. The results showed that the chocolate spread incorporated with millet flour had higher levels of dietary fibre, minerals (such as iron, calcium, and phosphorus), and antioxidants (such as phenolic compounds) compared to the control sample (chocolate spread without millet flour). This indicated that the inclusion of millet flour improved the nutritional profile of the chocolate spread.

6. Conclusion

The present study successfully developed a chocolate spread incorporated with millet flour, with the aim of enhancing its nutritional profile. The sensory analysis results showed that the sensory attributes of the chocolate spread were influenced by the type and quantity of millet flour used in the formulation. Sample 2, which had higher amounts of finger millet and cocoa powder, was found to be the most preferred among the samples tested, based on the sensory scores obtained. This indicated that the formulation with finger millet and cocoa powder was successful in achieving a desirable sensory profile for the chocolate spread.

The nutritional analysis results indicated that the chocolate spread incorporated with millet flour had higher levels of dietary fibre, minerals, and antioxidants compared to the control sample. This suggests that millet flour can be used as a potential ingredient to enhance the nutritional content of chocolate spreads, making them a healthier alternative to traditional chocolate spreads. The inclusion of millet flour, which is a good source of dietary fibre, can also contribute to improved gut health and reduced risk of certain chronic diseases, such as cardiovascular disease and diabetes.

The findings of this study have important implications for the food industry, as there is a growing demand for healthier food products that are not only tasty but also provide added nutritional benefits. The incorporation of millet flour into chocolate spreads can offer a unique selling proposition.

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