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Studies on the effect of variation of different types of powdered millet on quality attributes of muffins

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Abstract

In the whole world, millets are found to be one of the oldest cultivated crops in gaining popularity as a nutritious and healthy food due to its high nutritional value and great application scope in the bakery industry such as muffins. In this study, we discuss the nutritional profile, textural analysis and microbial study of the millet based muffin. This muffin has been prepared by mixing three different millets on different levels i.e., pearl millet flour, finger millet flour and little millet flour. The different samples were prepared in various treatments viz., M1, M2, M3 in the ratios of (Pearl millet flour: Finger millet flour: Little millet flour) 10:10:20, 10:15:15, and 10:20:10 respectively. Among all the three samples M2 was found to give an appropriate study. The moisture, fat, protein, carbohydrate and ash were 22.19, 17.53, 12.65, 45.60 and 1.93 respectively. The multi-millet muffin adversely affected the hardness, cohesiveness, springiness and chewiness as compared to the control sample which was (100%) wheat based. There was no alteration in the physical appearance of the millet muffins as there was no microbial growth found on the muffins for 60 days at ambient temperature.

Keywords finger millet, muffins, millets, nutritional profile, pearl millet

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Introduction

A diverse change in the manner of living and eating patterns of today's generation has spread a massive market for processed food products. Amidst these food products, baked products are the most important classification which has gained popularity such as cakes, bread, biscuits, pastries, and muffins in tremendous increase. Out of all the other bakery products, muffins are pleasant baked products recognized by consumers of all peer categories, mostly children because of their delightful flavor and fluffy texture [1]. According to the studies, the term "muffin" might have come from the Greek bread "Maphula" or old French "mou-pain" which means soft bread. They are also known as "Quick bread muffins" or "American muffins" individual-sized, cupcake-shaped desserts [2]. The energy dense content and excessive eating of cake leads to obesity. Consumer awareness of nutritional and health programs has their desire for low levels of calories and high-fiber diets. Numerous high-fiber additions have been used in a wide range of meals, particularly baked goods, to address consumer desire for higher fiber content in foods

without losing favored sensory qualities [2]. Different types of millet like Kodo millet, little millet, and finger millet are found to be higher in phenolic content and dietary fiber. As the nutrients and energy sources in millets are highly available, food security policies, agriculture industries, and scientists are indicating more awareness of the production and processing of millets to eliminate hunger from the world by the higher standard of its application.

The presence of gluten in wheat flour makes wheat flour one of the major ingredients in the preparation of muffins. For the structure and flour processing quality of baked products, gluten is considered to be the most important protein part of wheat. People dealing with celiac disease, which is found to be a chronic disorder known as gluten intolerance, are advised not to take wheat flour and all the diets they take should be free from gluten [3]. According to the studies, gluten content is not found in barnyard millet and is highly considered in fiber content and total minerals. It has a huge capability for developing value added baked products that can also be eaten by gluten-intolerant people. Usually, bakery products are prepared using wheat flour, which has the least amount of necessary nutrients. Replacing wheat flour with the flour obtained from vegetables, fruits, and gums, helps in increasing the nutritional value of the product. According to the studies it was found that very less studies have intensely evaluated the effect of fat replacers on nutritional values as well as organoleptic attributes of muffins, especially using novel ingredients like carrot pomace powder and fenugreek gum [4].

Millet studies depict significantly superior nutritional attributes. Serve as an excellent source of energy, crude fibers, carbohydrates, ash, soluble and insoluble dietary fibers, as well as soluble and insoluble fats, proteins (ranging from 8% to 19%), dietary fibers (approximately 1.2 g per 100 g), antioxidants, and fats (between 3% and 8%) with improved fat digestibility. Furthermore, millets are considered to be an incredible origin of essential minerals such as phosphorus, potassium, magnesium, zinc, copper, iron and manganese, with concentrations reaching 2.3 mg per 100 g [5].

Pearl millet is considered to be an important cereal crop due to its nutritional richness and its potential to produce in adverse climatic conditions [5]. This millet has the proper proportion of protein, with a huge combination of threonine and tryptophan as well as (but adequate) leucine, than other cereals. Pearl millet mainly helps a lot for the products for celiac which is a severe abnormal absorption disorder of the digestive tract caused by the intake of gluten in the genetically presude individual [6]. Pearl millet has a high content of magnesium which is considered to reduce the chance of stroke and heart attack by balancing the blood pressure. Bajra also holds some plant lignans that get transformed into animal lignans in the body. These lignans are also helpful for heart disease problems. Bajra is also known for controlling your cholesterol levels. Roti's prepared from bajra can also be eaten by patients suffering from cholesterol problems because it has a large amount of fiber, which goes a long way in lowering the bad cholesterol in the bloodstream [7].

Finger millet (ragi) is highly grown in the southern part of India. The finger millet flour (FMF) is eaten in the form of flat breads, dumpling like dosa and roti. The nutritional component of finger millet (per 100 g) is found to be proteins 7.3%, fat 1.3%, calcium 344 mg %, minerals 2.7%, total dietary fiber 11.5%, iron 3.9 mg % and phosphorus 283 mg % [8-9].

Little millet is a highly nutritious food source that is often underestimated due to its small size. It is a significant source of nutraceutical components, including phenols, tannins, and phytates, along with other nutrients [10]. Little millets should be regarded as a necessary food for nutritional security because they include a good amount of protein (7.7 g/100 g), are extremely rich in carbohydrates (67.0 g/100 g), fat (4.79 g/100 g), and minerals and vitamins [11]. Little millet has a similar fat content (4.7 g), crude fiber content (7.7 g), iron content (9.3 mg), and phosphorus content (220 mg) per 100g to cereals and other millets [4]. Little millet's low glycaemic index is mostly attributable to its high dietary fiber content. A recent study on the grain revealed that its higher dietary fiber content also contributes to its hypoglycaemic effect [12]. The consumption of little millet has been associated with several health benefits such as enhanced digestion, and lesser risk of chronic diseases such as diabetes, hypertension, and cardiovascular disease.

They also help in maintaining a healthy body weight and reducing the risk of obesity. The high fiber content in little millets helps to regulate blood sugar levels and prevent constipation. Moreover, little millets have antioxidant and anti-inflammatory properties that have lessened the risk of cancer and other severe diseases [10].

As per the available literature, muffins have not been prepared by combining the flour of pearl millet, finger millet and little millet to date, which can be a good option for increasing the crude fiber and mineral content of the optimized product. The current study reported estimating the effect of incorporating various levels of pearl millet, finger millet, and little millet flour on the physicochemical microbial quality of muffins.

Methodology

Procurement of raw materials

Pearl millet, finger millet and little millet were purchased from the local market of Prayagraj. Whole milk and butter (Amul brand) were purchased from the local market outlet. Maltodextrine was purchased online from Bioven ingredients, Noida, stevia was procured from the local store of prayagraj of Herboveda India, Noida and lecithin powder was procured online from Urban Platter, Noida. These all products were visually inspected and were kept in a cool dry place.

Preparation of samples

In this study, for the preparation of muffins, millets were malted and then formed into flour. The Pearl millet, Finger Millet and Little Millet grains were rinsed with 1% solution of salt and further with potable water. For 15 hours, the grains were steeped in potable water and then it was left to form sprouts in the dark for 3- 4 days at the temperature 25°C and relative humidity 80-90%, respectively. The whole sprouted grains were processed in an oven at 40°C for 24 hrs. to stop sprouting and these grains were further milled separately and sieved separately to acquire malted grains, which were milled and sieved further through 250 µm mesh to get fine flour and then it was stored at refrigerated temperature for further analysis.

For the preparation of 100 g muffin batter, 20 g of millet flour, 40ml whole milk, 0.9gm stevia, 1 g lecithin powder, 14.1 g maltodextrin and 4 g baking powder were used. Further, millet flour comprises of varying different ratios of Pearl millet, Finger millet and Little millet, wherein, in treatment M0 no millet flour was used instead wheat flour was used for the preparation of the sample and this sample was considered as the control sample. In treatment M1, samples were prepared to vary the ratio of 10:20:10 pearl millet flour, finger millet flour and little millet flour. For the M2 treatment 10:15:15 ratio of millet flours was taken and for M3 sample 10:10:20 ratio of three different millets was used.

Physicochemical analysis of samples

Determination of moisture

The moisture content of the millet muffin samples was reported as assisted by the standard protocol [13]. The millet muffins were taken 5gms and were put in the petri plate which was already weighed and then again placed inside a hot air oven at 110 ± 1°C for 1hr. The content of moisture was calculated from the average of triplicate sample readings using the formula mentioned below:

$$\text{Moisture content (\%)} = (W_1 - W_2) \text{ X } 100 \ (W_1\text{-}W)$$

(Where, W= Weight of Petri dish, W_1= Weight of Petri dish with sample, W_2= Weight of sample after moisture removal)

Determination of fat

Fat percentage was determined by the Soxhlet extractor by following the standard protocol as mentioned in the method [13]. Millet muffin samples were taken 5 g and was placed in a thimble and fat extraction tube of the Soxhlet assembly. Almost 250 ml of hexane was moved through

the sample in a Soxhlet apparatus and flowed for about 10 hrs. After the accomplishment of the extraction time, the thimble was taken out from the apparatus and a large amount of the ether was distilled off by collecting it in the Soxhlet apparatus. The crude fat content was calculated by using the equation:

Crude fat (%) = Weight of ether soluble material (g) X 100 Weight of sample taken (g)

Determination of protein

Crude protein was calculated through the Kjeldahl method by the Kjeldahl apparatus. Almost 1g of muffin sample was kept in a macro digestion tube and K_2SO_4: $CuSO_4.5H_2O$ of 1g mixture and concentrated sulphuric acid of 20 ml was poured in it. The tubes in the digestion unit were further kept at 389°C till the light green color solution started occurring. A blank sample was also run only with sulphuric acid and K_2SO_4: $CuSO_4$ mixture. After the digestion process, tubes were kept to cool and afterward, distillation was done by a semi-automatic distillation unit. After adding up 40% NaOH (90 ml), distillation was done for 3 minutes. The distillate having 4% boric acid solution (50 ml) with two drops of the indicator was recovered inside the flask. It was titrated against 0.1 N H_2SO_4, and the percent nitrogen was calculated using the formula mentioned below:

%Nitrogen =14.01 X (ml titer-ml blank) X N X 100/ Sample weight (g) X 1000

Determination of ash

The ash percentage was determined by the given standard protocol [13]. The muffin samples (3 g) were measured and kept in a weighed silica crucible. The muffin samples kept in the crucible were burned using a gas flame till the time when smoke ceased. Later the crucible was kept in the muffle furnace at 550°C and was reduced to ashes for 4-5 h in the muffle furnace only overnight. The percentage ash content was calculated according to the formula mentioned below:

$$\text{Ash \%} = (W_3 - W_1) \text{ X } 100\% \ (W_2 - W_1)$$

(Where, W1 = Empty crucible weight, W2 = Weight of crucible with sample, W3 = Weight of sample after ashing)

Physical parameters

Texture profile analysis

The texture profile analysis (TPA) of the millet muffins was done using the Texture analyzer (Stable Micro System Ltd, Model TA-XT2i). The millet muffin samples were to the height of the mold and the lower half up to 2.5 cm was horizontally cut to examine the texture measurements and the upper half of the sample was discarded. A double compression test was performed by using a 75 mm diameter flat-ended cylindrical probe (P/75), where the height of 1.25 cm was considered (50% compression), at a speed of 1 mm/s with a 5 s waiting time between the two cycles. During the first compression cycle, the peak force was required where it was noted and expressed as hardness (N). The resilience, cohesiveness, springiness and chewiness (= hardness × cohesiveness × springiness, N) of the millet muffin samples were determined as per the discussion [14].

Determination of specific gravity, specific volume and height

The determination of specific gravity, specific volume and height of millet muffins samples was determined as per the discussion given [15].

Microbial analysis

The analysis of the microbial count of the millet muffin samples, in terms of feasible total plate count and yeast & mold count, was under defensible limit under ambient by standard pour plate method. The samples were analyzed by following the method suggested by Beegum et al., [1]. The results

were reported in terms of colony-forming unit (cfu) per g of millet muffin sample.

Statistical analysis

The data obtained was further moved for statistical analysis using MS Excel 2007 version. The data was presented as mean ± SD values and the values were collected in triplicates. The type of ANOVA used was One-way analysis of variance (ANOVA), which was produced with the use of the Web Agri Stat Package.

Results and Discussion

The results obtained for the proximate composition of muffins prepared from the flour of wheat were considered as controlled samples and multi millets i.e., pearl millet, finger millet and little millet from three different levels of flour is reported in Table 1.

Effect of different levels of finger millet and little millet flour on compositional parameters of low-calorie muffins

Millets flour exhibited significantly ($P < 0.05$) higher fat, ash, protein and fiber contents as compared to wheat flour. The sample of control flour which was 100 % wheat flour showed the content of moisture, fat, protein, carbohydrate and ash 23.43. 18.67, 8.05, 48.83 and 1.02 respectively and in substitution with different levels of pearl millet, finger millet and little millet composition shows the results which are highly acceptable by the consumer. The contribution of moisture, fat, protein, carbohydrate and ash content of muffins were significantly different in M1, M2 and M3. As reported by Mallasiy et al., [5] the study on bound cake prepared by pearl millet flour by replacing wheat flour found that millet is considered to be a good source of protein and fat therefore, the bound cake had increased nutritive values prepared from millet flour than wheat flour. The moisture content of M2 was found to be lesser than other samples while the fat content was found to be lesser in M1 sample with 17.4 content. As compared with the studies of [3] it was mentioned that on barnyard millet based muffins the moisture content was lesser than the muffins developed from wheat flour therefore, the muffins which are millet-based are the reason behind the crumbly texture and dryness feeling in the mouth of the sample.

Table 1. Proximate analysis of multi millet muffin

PARAMETERS	M0	M1	M2	M3
Moisture (%)	23.43 ± 0.00^{a}	22.63 ± 0.02^{b}	22.19 ± 0.06^{c}	22.41 ± 0.12^{d}
Fat (%)	18.67 ± 0.01^{a}	17.4 ± 0.05^{b}	17.53 ± 0.10^{c}	17.59 ± 0.05^{d}
Protein (%)	8.05 ± 0.04^{a}	12.39 ± 0.05^{b}	12.65 ± 0.03^{c}	12.47 ± 0.07^{d}
Carbohydrate (%)	48.83 ± 0.05^{a}	45.26 ± 0.05^{b}	45.60 ± 0.06^{c}	45.39 ± 0.06^{d}
Ash (%)	1.02 ± 0.00^{a}	1.96 ± 0.01^{b}	1.93 ± 0.03^{c}	1.93 ± 0.01^{d}

N= 3, values followed by different alphabets in superscript column wise are significantly different ($P<0.05$), Data represented as mean ± SD

Effect of different levels of finger millet and little millet flour on physical parameters of low-calorie muffins

The influence of varying concentrations of Pearl millet flour, Finger millet flour and little millet flour on the physical qualities of muffins is discussed below. The textural analysis of muffin samples prepared during the investigation is graphically represented. The substitution of wheat flour with multi millet flour gave the millet muffin samples a smother texture as compared with the controlled muffin sample and the same is observed from the significant ($P < 0.05$) decrease in hardness, springiness, cohesiveness, and chewiness of muffins with the increase in the level of little millet in the formulation of multi millet flour. As mentioned, in Figure 1 (A-D), the hardness of millet muffin samples decreased significantly from 90.32 in the control sample to 85.21 in the M2 (10:10:20) ratio of multi millet flour. The springiness of the millet muffin samples were also affected highly by the

multi millet flour as compared with wheat flour. As mentioned by Goswami et al., [3] the chewiness

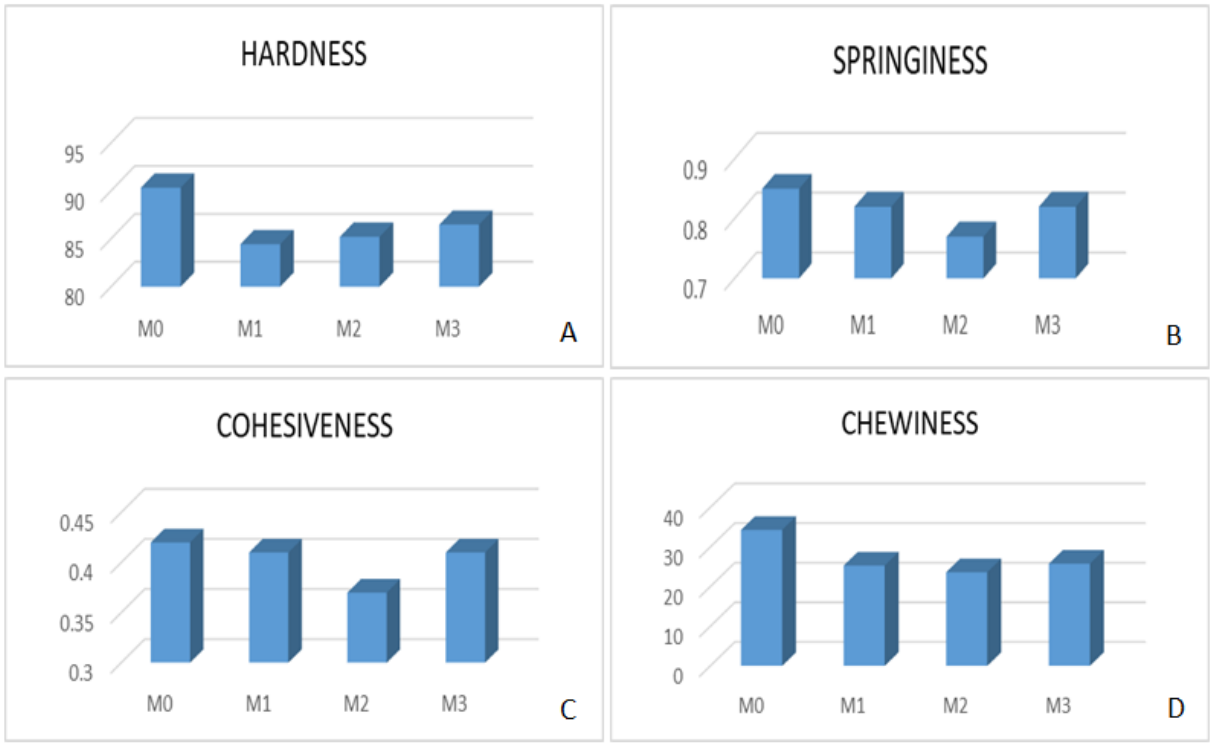

Figure 1. (A) Graph depicting the hardness of muffins (B) depicting the springiness of muffins (C) depicting the cohesiveness of muffins (D) depicting the chewiness of muffins

of the sample, is the parameter that is related to the chewing difficulty in the food and bolus formation before swallowing. According to its studies, done on barnyard millet flour (BMF) based muffins showed the results that the chewiness of the muffins was also highly affected by the barnyard millet flour level even at 10 g/100 g of barnyard millet flour level in the flour blend. In correlation with the above study, the present study also indicated adverse differences between wheat flour and multi millet flour. Studies given by Rajiv et al., [9] also observed a decrease in cohesiveness, chewiness, and springiness values of the millet muffin sample with increasing levels of finger millet flour in the flour blend. The data regarding specific gravity, specific volume and height of the control sample and multi millet muffins is shown in Table 2.

Table 2. Physical parameters of multi millet muffins

PARAMETERS	M0	M1	M	M3
Specific gravity	1.18±0.02	1.24±0.01	1.44±0.02	1.27±0.01
Specific volume (cc/g)	2.32±0.01	1.63±0.01	2.01±0.00	1.43±0.01
Height (cm)	4.63±0.02	3.42±0.01	4.32±0.00	3.2±0.00

N= 3, values followed by different alphabets in superscript column wise are significantly different (P<0.05), Data represented as mean ± SD

The results depicted that the incorporation of pearl millet flour, finger millet flour and little millet flour had a significant ($P < 0.05$) influence on the muffins specific gravity. The results depicted that the highest mean specific gravity of control and multi millet muffin samples was found to be 1.18 of W0 followed by 1.24 for M1, 1.44 for M2 and 1.27 for M3. The highest mean of specific volume for

the control sample was 2.32 in M0, 1.63 in M1, 2.01 in M2 and 1.43 in M3. And the results for the highest mean of muffin height were 4.65 in M0, 3.42 in M1, 4.32 in M2 and 3.22 in M3. As compared with the studies of [2] similar studies were reported regarding specific gravity, specific volume and height.

Effect of different levels of finger millet and little millet flour on microbial parameters of low-calorie millet muffins

The microbial analysis of the millet muffin samples M0, M1, M2, M3 and M4 in concern of total plate count, yeast & mold count and coliform count was evaluated and was acceptable for consumption. According to the studies, total plate count was 3.21, 3.19, 3.17 and 3.20 (cfu/g) for M0, M1, M2 and M3 respectively, and no coliform and yeast and mold count was found in the respective muffin samples.

Conclusion

Different types of millet based flour was used as feasible alternative to wheat based flour for muffin development. The data obtained from the proximate, physical and microbial analysis confirmed that millet based muffins were more acceptable. As the millet based flour was better than 100% wheat flour, pearl millet, finger millet and little millet composite flour (10:10:20) had excellent results as compared with wheat flour. The data of proximate analysis reported that pearl millet, finger millet and little millet is highly nutritious because of the high protein, fat and crude fiber. The multimillet muffin adversely affected the hardness, cohesiveness, springiness and chewiness as compared to the control sample which was (100%) wheat based. Muffins developed by three different millets observed no major microbial growth at ambient temperature which made it acceptable for the consumers for the consumption of product.

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