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# Development of Gluten Free Muffins Based On Millets

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***Abstract:*** *Millets are a traditional staple food of the dry lands region of the world. The demand of baked items has witnessed an increase in twentieth century. Muffin is a baked dessert that has gained popularity with changes in eating habits of people. The quality of muffin depends on the ingredients used in making it like flours, eggs, flavors, shortening and leavening agents, as well as on conditions prevailing during its preparation. The addition of non-gluten forming products like millet flours, oats or fiber rich products might affect the quality of muffins. Three samples were prepared with three different millet flours; S1 (Amaranth flour), S2 (Proso millet flour), S3 (Barnyard millet flour), and other ingredients like sorghum flour, ragi flour, oats, brown sugar, milk, sunflower oil were added in same amount in all three samples (S1/S2/S3). The result showed that among all the developed products S1 showed the highest weight (gm) (401.77 ± 9.94). Sensory evaluation of the product was done by 9-point hedonic scale. Sample was evaluated by 100 panel members. In the sensory attributes product S2 (proso millet muffins) was highly acceptable by all the members. The nutritional analysis showed that the Moisture content - 23.2, fat/oil content - 20.4 gm% and calcium content – 166 mg% were higher in S1 (amaranth millet muffins). Ash content - 2.66 gm% and crude fiber content - 3.33 % were higher in S3 (barnyard millet muffin). Iron content - 4.06 mg% was higher in S2 (proso millet flour) which was more liked by panel members. This Millet muffins are gluten-free product, that can be consumed by people with gluten intolerance or celiac disease.*
***Keywords: Muffins, Amaranth, Proso millet, Barnyard millet, Sensory evaluation, Nutrient analysis.***

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## I. INTRODUCTION

During recent times there has been a slow and steady increase in consumer interest for wheat (Triticum aestivum) free foods for minimizing the threat of fairly strange condition known as celiac disease (CD). Celiac disease is a life-long dogmatism to the gliadin bit of wheat and the prolamins of rye(secalins), barley(hordeins) and conceivably oats(avidins). As per rule the "Gluten free" is a voluntary term and defined as food containing lower than 20 ppm of gluten. Gluten is the main structure- forming protein in flour, and is responsible for the elastic characteristics of dough, and contributes to the appearance and scruple structure of numerous baked products (Man et al., 2014)

Gluten-free products, especially bakery products, have many technological problems similar as poor appearance, texture, sensitive parcels and reduced shelf life. Gluten-free products also have poor nutritive value. So carrying gluten free products with health factors (fiber, protein, antioxidants, etc.) and bettered sensitive acceptance has gained interest in the once many times.

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)

Millets are traditional staple food of the dry land regions of the world. Millets contribute about 10 % of the total handbasket by growing 17 million ha with periodic product of 18 million tones in India. They're Nutri cereals which are largely nutritional and are known to have high nutrient content which includes protein, essential adipose acids, salutary fiber, B- Vitamins, minerals similar as calcium, iron, zinc, potassium and magnesium. They help in rendering health benefits like reduction in blood sugar position diabetes, blood pressure regulation, thyroid, cardiovascular and celiac conditions, Still the direct consumption millets as food has significantly declined over the formerly three decades (Rao et al., 2016).

There are some bakery products like biscuits, muffins and chuck which are prepared by Millets and available in the request (Miranda et al., 2014). Although millet flours are gluten-free which isn't favorable for use of entirely pure millet constituents for medication of bakery and pate products. Use of millet flour in medication of bakery products enriches them in fibre and micronutrients which enhance the

overall quality and value of products. The millets are known for their superior nutritive values along with several health benefits (Kumar et al., 2021a). Millets are also proved for their salutary health goods like antioxidant exertion, anti-diabetic, anti-tumorigenic, atherosclerogenic goods, and antimicrobial parcels (Kumar et al., 2021b).

The millet grains are the hustler of nutrition that help in perfecting heart health and effectively trim down the coronary blockage. They're amended with magnesium, potassium, and factory lignin, which effectively reduce blood pressure by acting as a vasodilator and drop heart attacks and other cardiovascular pitfalls. The high fiber content of millets lowers the cholesterol position therefore barring LDL (Low viscosity Lipoprotein) from the system and increases the positive goods of HDL (High viscosity Lipoprotein) in the body (Kumar etal., 2021c).

## II. MATERIALS AND METHODS

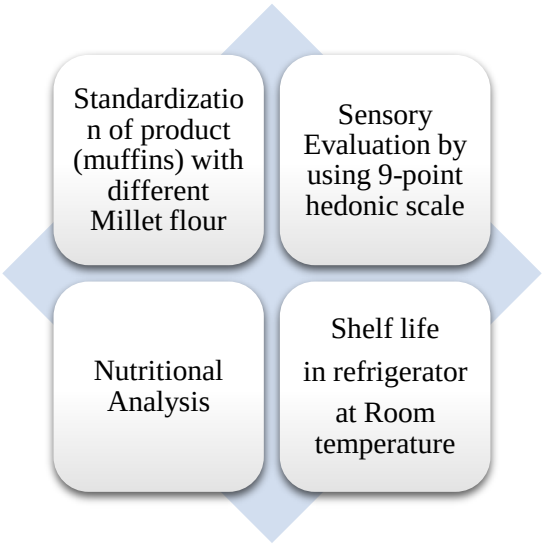


Figure 2.1 : Methods for developed Muffins

### 2.1 Raw Materials

All the ingredients like Finger millet flour, Amaranth flour, Sorghum flour, Proso millet flour, Barnyard millet flour, Oats, Cocoa Powder, Brown Sugar, Baking powder, Baking soda, Flaxseeds, Yogurt, Sunflower oil, Milk, Vanilla essence were used in this study and purchased from the local market, Surat city.

### 2.2 Muffin Preparation

There were total 3 sample of muffins prepared, which is shown in (Table 3.1). First of all, Flaxseed made into a powder by grinding it. Dry flour mixture (Ragi flour, Amaranth flour/ Proso flour /Barnyard flour, cocoa powder, powdered brown sugar, baking soda, baking powder) was sifted thrice.

1.Oats were dry roasted and added in the flour mixture. The oven was preheated at 180° C for 10 minutes.

1.Water was boiled and taken in a mixing bowl. Add sunflower oil to it and whisk it until emulsified.

1.Add milk, yogurt and vanilla essence and whisk well. All the dry ingredients added into the wet ingredients and mix well.

Batter was poured into the muffin mold.

1.Baked in a pre-heated oven at 180° C for 30-35 minutes.


Figure 2.2 : Developed Muffins

Table : 2.1 Muffins Formation

| Amount | Sample 1 | Sample 2 | Sample 3 |
|---|---|---|---|
| 25 gm | Ragi flour | Ragi flour | Ragi flour |
| 25 gm | Sorghum flour | Sorghum flour | Sorghum flour |
| 25 gm | **Amaranth flour** | **Proso millet flour** | **Barnyard millet flour** |
| 25 gm | Oats | Oats | Oats |
| 20 gm | Cocoa powder | Cocoa powder | Cocoa powder |
| 100 gm | Brown sugar | Brown sugar | Brown sugar |
| 4 gm | Baking powder | Baking powder | Baking powder |
| 3 gm | Baking soda | Baking soda | Baking soda |
| 15 gm | Yogurt | Yogurt | Yogurt |
| 15 gm | Flaxseeds | Flaxseeds | Flaxseeds |
| 1 gm | Salt | Salt | Salt |
| 50 ml | Sunflower oil | Sunflower oil | Sunflower oil |
| 50 ml | Water | Water | Water |
| 70 ml | Milk | Milk | Milk |
| 2.5 ml | Vanilla Essence | Vanilla Essence | Vanilla Essence |

## 2.3 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 shown in table 2.2. To evaluate the product attributes (appearance, texture, taste, color, flavor, overall acceptability). All untrained members were given training to evaluate muffins.

Table 2.2 : 9- point Hedonic Scale

| Hedonic Scale | |
|---|---|
| Like Extremely | 9 |
| Like Very Much | 8 |
| Like Moderately | 7 |
| Like Slightly | 6 |
| Neither Like Nor Dislike | 5 |
| Dislike Slightly | 4 |
| Dislike Moderately | 3 |
| Dislike Very Much | 2 |
| Dislike Extremely | 1 |

## 2.4 Nutrient Analysis

Estimation of Moisture and Ash content done by AOAC method. Oil/Fat extraction (estimation) doney by Soxhlet Apparatus. Iron and Crude fiber estimated by Dipyridyl method of Ramsay (1954) method. And Calcium content estimated by Titrimetric method of Clarke & Collip.

## 2.5 Shelf-life Estimation

### 2.5.1 At room temperature

Muffins were putted in a air tight container and place in a dry area to observe in every 2 days and marked changes which were seen.

2.5.2 In Refrigerator

The temperature of fridge was 6° C placed in a refrigerator in air tight container and observed in every 5 days and observed changes were marked.

## III. RESULT AND DISCUSSION

### 3.1 Sensory Evaluation of Developed Muffins

Table 3.1 : Sensory Evaluation of Developed Muffins

| Sample | Appearance | Texture | Taste | Color | Flavor | Overall Acceptability |
|---|---|---|---|---|---|---|
| **S1** | 8.25 ± 1.07 | 7.82 ± 1.05 | 7.92 ± 1.36 | 8.41 ± 1.01 | 8.05 ± 1.3 | 8.04 ± 1.19 |
| **S2** | 8.05 ± 0.82 | 8.09 ± 0.91 | 8.12 ± 1.16 | 8.07 ± 0.76 | 8.08 ± 0.98 | 8.08 ± 0.75 |
| **S3** | 8.08 ± 0.94 | 8.09 ± 0.88 | 8.09 ± 1.15 | 8.08 ± 0.85 | 8.08 ± 1.15 | 8.08 ± 1.01 |

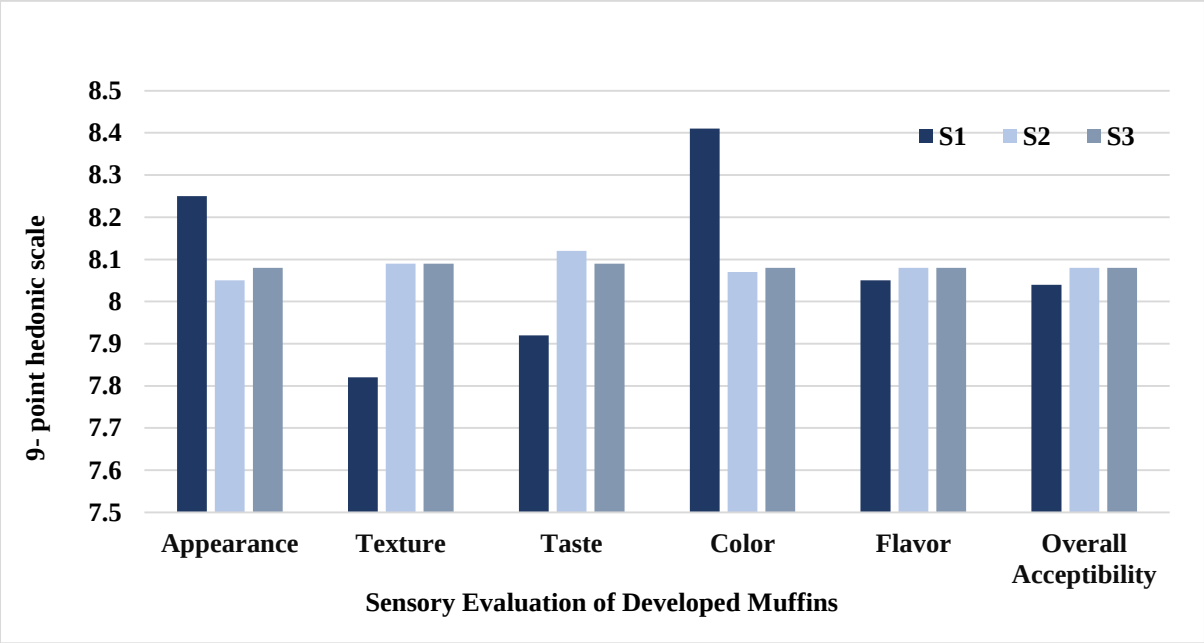


Figure 3.1 : Weight of Developed Muffins

Table no. 3.1 shows the mean value of sensory attributes summarizing control different samples of Muffins made with Sample 1-Amaranth flour, Sample 2-Proso flour and Sample 3-Barnyard flour.

In Sensory attributes the appearance of samples S1, S2, S3 were 8.25 ± 1.07, 8.05 ± 0.82, and 8.08 ± 0.94 respectively. Sample 3 get high score in appearance as compared to sample 2 & 3 because sample 1 was dark in color.

The score of Texture of samples S1, S2, S3 were 7.82 ± 1.05, 8.09 ± 0.91, and 8.09 ± 0.88 respectively. Texture of the Sample 1 is quite sticky and it has cracks on the surface of muffins. Whereas panel members liked texture of sample 2 & 3 more than sample 1.

In sensory attributes the Taste of samples S1, S2, S3 were 7.92 ± 1.36, 8.12 ± 1.16, and 8.09 ± 1.15 respectively. Sample 1 get low score in taste than sample 2 & 3. Panel members liked taste of sample-3 which is Proso millet Muffin.

Panel members liked color of sample 1 (amaranth flour) because sample 1 was dark in color and looking delicious. The Sensory Attributes the Color of samples S1, S2, S3 were 8.41 ± 1.01, 8.07 ± 0.76, 8.08 ± 0.85 respectively The score of color of sample 2 & 3 were similar.

Flavor was observed with non significant difference between three Samples. The score of samples S1, S2, S3 were 8.05 ± 1.3, 8.08 ± 0.98 and 8.08 ± 1.15 respectively. The score of sample 2 & 3 was similar and sample 1 was low in score than others.

In sensory attributes the overall acceptability of muffin samples S1, S2, S3 were 8.04 ± 1.19, 8.08 ± 0.75 and 8.08 ± 1.01 respectively. Sample 2 & 3 were similarly acceptable by panel members than sample.

Sample 2 (Proso Millet Muffins) was acceptable and got positive comments. Sample 2 (Amaranth flour Muffins) got low score and it was sticky by texture. It was give after taste in mouth. Some cracks was seen on the surface of sample 1 muffin. Sample 2 get high score in every parameters and acceptable from major Panel members. The sponginess and texture of sample 2 was good than sample 1.

In the other study, Muffins made from rice and soy flour sensory score is quite similar this study. Mean score of taste and texture had been decreased, in the case of the sample's taste, while the texture decreased from 7.9 to 6.8. Mean score for flavor of muffins had been decreased (Man et al., 2014).

### 3.2 Nutrition Evaluation

#### 3.2.1 Weight of developed products

Table 3.2 : Weight of different samples of Muffins

| Samples | Weight (gm) |
|---|---|
| S1 | 401.77 ± 9.94 |
| S2 | 321.34 ± 8.66 |
| S3 | 311.03 ± 9.40 |

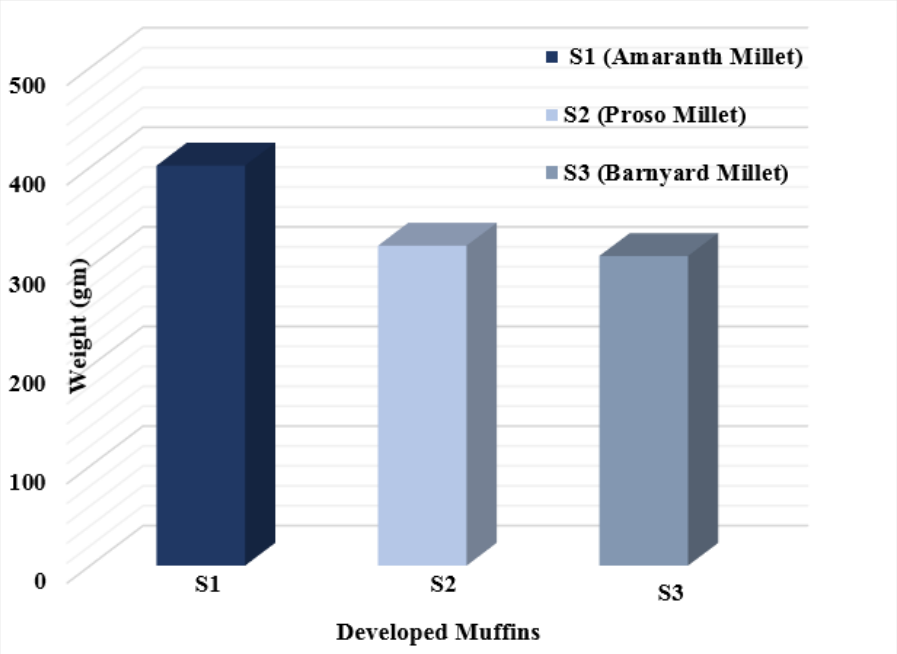


Figure 3.2 : Weight(gm) of Developed Muffins

Table 3.2 shows the mean value of weight of different samples of Muffins made with Amaranth flour, Proso flour and Barnyard flour.
The highest value of weight (gm) was observed in sample 1 (401.77 ± 9.94) as compared to the other samples. Whereas Sample 2 (321.34 ± 8.66) and Sample 3 (311.03 ± 9.40) are low in weight compared to sample 1.
The results of muffins using wheat and coconut flour for physical properties (weight) of muffins. There was a significant increase in the weight of muffins in the sample T1 (41.31g), T2 (40.30g) T3 (39.92g) compared with

T4 (38.12g). When there is increase in volume in the muffins it will gradually decreases the density in all the samples (Ramya & S. Anitha, 2020).

### 3.3 Nutrient Analysis of Developed Muffins

Table 3.3 : Nutrient content in Developed Muffins

| Samples | Moisture (gm%) | Fat/Oil (gm%) | Ash (gm%) | Crude fiber (%) | Iron (mg%) | Calcium (mg%) |
|---|---|---|---|---|---|---|
| S1 | 23.2 | 20.4 | 2 | 3 | 3.95 | 166 |
| S2 | 20.9 | 19.46 | 2.33 | 3 | 4.06 | 109 |
| S3 | 16.5 | 17.33 | 2.66 | 3.33 | 3.85 | 154 |

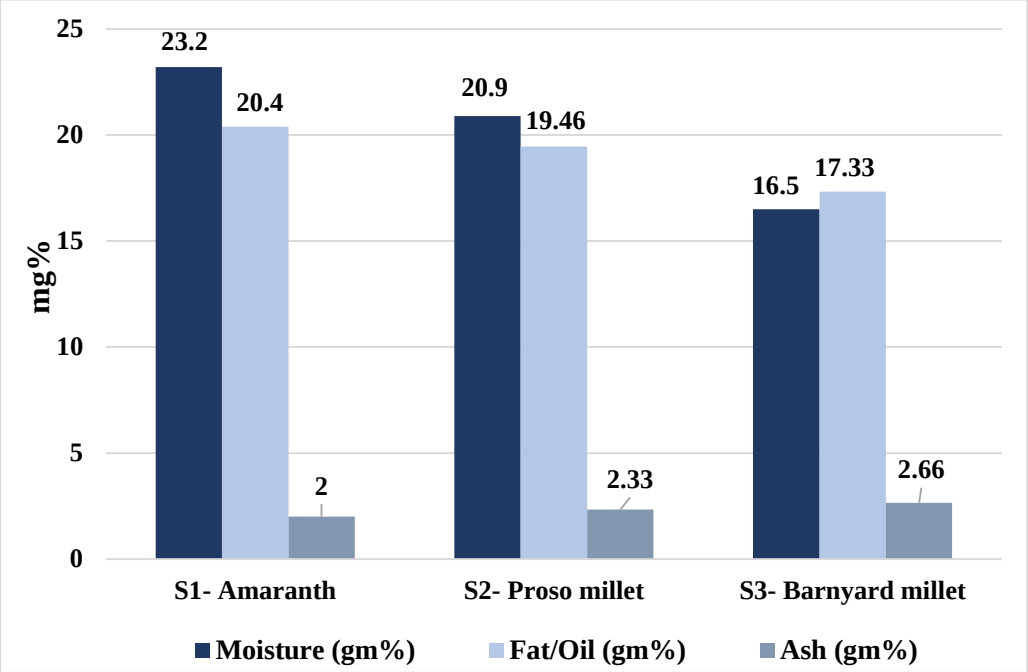


Figure 3.3 : Evaluation of Moisture (gm%), Fat/Oil (gm%) and Ash (gm%) content in different samples of muffins

The moisture (gm%) content was higher in S1 (23.2 gm%) as compared to the other muffins products S2 (20.9 gm%) and S3 (16.5 gm%) because its extremely small granules and unique dodecahedral structure of amaranth flour which enhance moisture absorption. Due to the higher content of moisture in S1 it became sticky and quite wet in appearance. The lowest content of moisture was in sample 3 which is barnyard millet muffins. A study of development of high-fruit-dietary fiber muffins by Grigelmo-Miguel *et al*., (2001) has described about moisture content in different samples of muffins, which were (22.5gm%). He also described moisture of the muffins increased with the DF content because of the high water-holding capacity of used ingredient.

The higher value of Fat/Oil (gm%) was in sample 1 (20.4 gm%). While sample 3 was lowest in Fat/Oil content which is (17.33 gm%). The fat/oil content in sample 2 was 19.46 gm%. Thus, Amaranth flour contain more fat/oil than proso and Barnyard millet because amaranth contain approximately 77% unsaturated fatty acids and is high in linoleic acid also contain high amount of dietary fiber.In the study of Development of cookies using wheat four and ragi flour by Rana (2021). The fat content of wheat and ragi flour cookies was ranged from 17.95% to 19.65%.

The Ash content in muffins samples S1, S2, S3 were 2 gm%, 2.33 gm% and 2.66 gm% respectively. The higher level of Ash content is in sample 3 (barnyard millet) because it contain high amount of minerals like calcium, magnesium and potassium. The lowest value of ash was in sample 1 and this ensures the safety of product, ,making sure there are no toxic minerals present. A study of Consumer Acceptability of muffins made with Flaxseed by using Finger millet and Rice flour by Ramcharitar *et al*., (2005) has studied about Ash content of mentioned muffins, the result of samples (30:70, 50:50 & 70:30) were ( 2.55%, 2%, 2.55%). He stated that lower content of ash ensures the safety of product making sure there are no toxic minerals present.

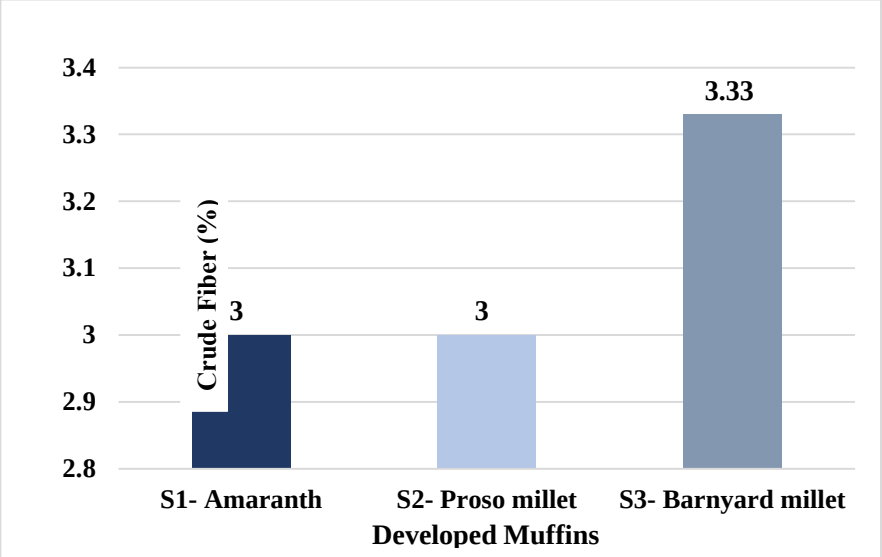


Figure 3.4 Crude fiber (%) content in Developed Muffins

The Crude fiber content in muffins samples S1, S2, S3 were 3 %, 3 % and 3.33 % respectively. The higher level crude fiber content is in sample 3 (barnyard millet). Thus Barnyard millet also known as fasting millet and with a good balance of both soluble and insoluble fractions.A study of Sprouted ragi flour blended cookies by Viswanath *et al*., (2009) estimated crude fibre content in sprouted ragi flour blended cookies. The results of cookies were ranged from 3.17% to 3.66% which was founded close to my study of crude fiber content result in developed muffins.

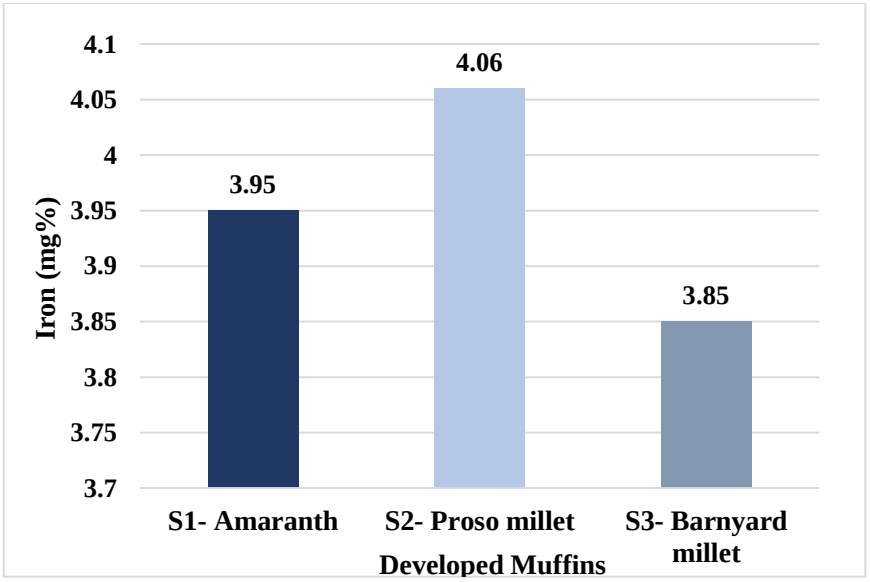


Figure 3.5 Iron (mg%) content in Developed Muffins

The Iron (mg%) content in muffins samples S1, S2, S3 were 3.95 mg%, 4.06 mg% and 33.85 mg% respectively. The higher level Iron content was in sample 2 (Proso millet muffin) than Amaranth and Barnyard millet muffins. A study of Development of standardized cookies using Kodo millet by Nami *et al*.,(2019) described result of Iron content of Kodo millet cookies which was 3.5 mg%. He also stated that millets are also rich in other micronutrients like calcium, zinc, lipids and high-quality proteins.

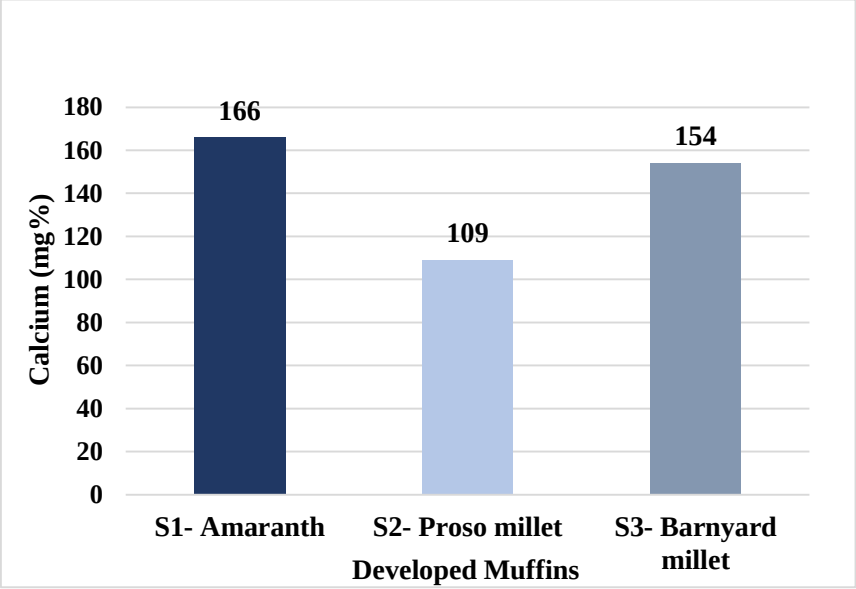


Figure 3.6 Calcium (mg%) content in Developed Muffins

The Calcium (mg%) content in muffins samples S1, S2, S3 were 166 mg%, 109 mg% and 153 mg% respectively. The higher level Calcium content was in sample 1 (Amaranth millet muffins) than Proso and Barnyard millet muffins. Amaranth are loaded with highly absorbable calcium and a host of other healthful nutrients. A study of Development of Muffins from Wheat Flour and Coconut Flour using Honey as a Sweetener by Ramya & Anitha (2020) estimated nutrients in their study. Result of calcium content were (156 mg%, 162mg%, 115 mg%) which was similar to my study result.

### 3.4 Shelf-life Estimation

Table 3.4 Shelf life of a different samples of Muffins made with Amaranth flour, Proso flour and Barnyard flour in room temperature.

| Days | Aroma | | | Taste (Flavor) | | |
|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S1 | S2 | S3 |
| Day-1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Day-3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Day-5 | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ |
| Day-7 | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ |

✓ : Acceptable
✗ : Unacceptable

Table 3.4 shows the Millet muffins' shelf life after 7 days of manufacturing the criteria to evaluate Aroma and flavor. On the Day-7 slight changes in aroma and taste were noticed and after cutting them, they were breaking in the powder after touching.

Table 3.5 Shelf life of a different samples of Muffins made with Amaranth flour, Proso flour and Barnyard flour in refrigerator.

| Days | Aroma | | | Taste (Flavor) | | |
|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S1 | S2 | S3 |
| Day-5 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Day-10 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Day-15 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Day-20 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Day-25 | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ |
| Day-30 | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ |

Temperature of the Refrigerator: 6° C

✓ : Acceptable

✗ : Unacceptable

Table 3.5 shows the Millet muffins' shelf life after 30 days of manufacturing the criteria to evaluate Aroma and flavor in refrigerator. Evaluation has been done every 5 days. After 30 days changes in aroma has been observed in the sample 1 and 2 and taste has changed of the sample 3 on the 20$^{th}$ day. After the 30 days observation product S2 was satisfy in aroma and taste.

## IV. CONCLUSION

It was concluded that development and standardization of baked product like Muffins recipes using millets can be popularized and can replaced instead of using refined flour. Addition of Millet flours has improved the muffins quality attribute nutritionally Fat, fiber, iron, calcium and physically flavor, texture, color and taste. These Muffins are advantageous for people suffering with gluten intolerance. Millets play major role as raw material in commercial products. Product S2 (Proso millet muffin) is highly acceptable from panel members and can consumed by population. Millets in bakery products improved nutritional quality. Muffin is one of the relished and palatable produce made by baking batter. Muffin is major baked product in the fast food industry and highlight of many celebrations. The addition of millet flour in the muffin has risen the demand of its power to scale back the risk of chronic disease beyond nutritional function.

## V. RECOMMENDATIONS

1. Inclusion of preservatives in the recipe can increase the shelf life.
2. Natural sweeteners like Honey and Jaggery can be used in future study.
3. In-depth Study is possible to gain more nutritional information and make it better.
4. In the physical properties except from weight diameter, sponginess, height can also be measured.
5. Addition of different flavours can be used in recipe of muffins.
6. Future study should develop millet muffins without visible fat sunflower oil and milk.

## VI. LIMITATIONS

1. Access to readily available millet flours was challenging in Surat.
2. Laboratory equipment was not fully automated and may have caused errors in the accuracy of the findings.
3. Due to lack of access to equipment like Kjeldahl Apparatus, protein estimation along with other necessary test were not possible.
4. Result can be improved by statistical analysis between Control and standardized product.
5. Used only chocolate flavor in recipes because off taste of millets.

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