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Formulation and Quality Evaluation of Multi-Millet Buns

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Abstract

Millets are one of the cheapest and most nutritious option for bakery products due to their low glycaemic index and higher nutritive value in terms of micronutrients, fibre and phytochemicals. Finger millet, barnyard millet and little millet were taken in different proportions separately with wheat flour like T_0 (00:100), T_1 (10:90), T_2 (20:80), T_3 (30:70), T_4 (40:60) and a mixture of all three millets and wheat flour were prepared in the ratio like B_1 (5:5:5:85), B_2 (10:10:10:70), B_3 (15:15:15:55), B_4 (20:20:20:40). Organoleptic evaluation was done in all the products by using nine-point hedonic rating scale. The most accepted multi-millet buns and control (T_0) were kept in poly propylene packaging and sugar cane pulp plate-wrap separately for shelf-life study. Standard AOAC methods were followed to analyze the proximate and mineral composition of the treatments. T_2, T_3 varieties of finger millet buns and barnyard millet buns; $T_{1,}$ T_2 varieties of little millet buns and mixed millet buns were found to have higher nutritional composition in terms of total total ash, crude fibre, crude fat, calcium, iron and phosphorous as compared to control. The most accepted multi-millet buns and control (T_0) varieties had a shelf life of three days within an acceptable range in both poly propylene packaging and sugar cane pulp plate-wrap with a better organoleptic value in poly propylene packaging. Incorporation of millets and carrot in bun enhanced its overall nutritional value.

Keywords: Bun, Millet, Nutritional composition, Organoleptic evaluation, Shelf-life

1. Introduction

Buns are soft, puffed baked items widely consumed worldwide in its own form, especially in low- and middle-income countries and used to make culinary dishes (Vijayendra and Sreedhar, 2023). Buns are made from refined wheat flour which is high in energy, carbohydrate, protein and fat but low in minerals and vitamins etc. Being of high glycaemic index, buns prepared from refined wheat flour can pose threat of various life style diseases (heart diseases, diabetes, obesity, hypertension etc.). Nowadays, as people are more focused on practising healthy diet, there is a need to supplement the bakery items with nutritious raw ingredients other than refined wheat flour. The ingredients and methods are the same as for bread, except buns are molded into various shapes and sizes and are rounded. On the verge of international millet year in 2024, millets are regarded as a multifaceted solution to these challenges owing to their substantial vitamin, mineral, fibre, phytochemical, antioxidant contents and low glycaemic index. The abundant amounts of flavonoids and essential amino acids in millets augment their nutritive potential. The antioxidant content found in millets facilitates the scavenging action of free radicals and reactive oxygen species preventing oxidative stress. The bioactive compounds present in millets help in management of cardiovascular diseases, diabetes, aging and cancer (Mishra *et al*., 2021).

Finger millet (*Eleusine coracana*), also called as ragi is a wholesome crop having health-promoting qualities. Finger millet contains carbohydrates 81.5%, dietary fibre 18-20%, starch 65-75%, protein 9.8%, fat 1-1.7%, minerals 2.7% and crude fibre 4.3% (Saleh *et al.*, 2013). 100 g of ragi provides 305 kcal of energy, 72 g carbohydrates, 11.5 g dietary fibre, 7.3 g protein, 1.3 g fat, 344 mg of calcium, 3.9 mg of iron, 137 mg magnesium, 283 mg of phosphorous, 408 mg potassium, 14 mg sodium and 2.3 mg zinc and 13.1% moisture (Gopalan *et al.*, 1989). It possesses antioxidant, antibacterial, anti-inflammatory and diabetic prevention properties (Devi *et al*., 2014). The phytates, tannins and other antinutritional factors can be well managed by utilizing various pretreatments such as germination, malting, fermentation [Verma and Patel, (2013); Sahoo *et al*., (2024) a; Sahoo *et al*., (2025)].

Barnyard millet (*Echinochloa esculenta*) is the first domesticated tiny millet plant which self-pollinates. It is mostly grown in India's Orissa, Mahartotal ashtra and Madhya Pradesh region. When compared to rice and other millets, barnyard millet exhibited higher capacity of reducing levels of serum cholesterol, triglycerides and blood glucose owing to its higher fibre contents (Kaur *et al*., 2020; Vandana, 2018). It contains 51.5-62% carbohydrate, 11.2-12.7% protein, 8.1-16.3% dietary fibre and 15.6-18.6% iron (Singh *et al.*, 2010). It contains high amount of zinc, essential amino acids and vitamins (Saleh *et al.*, 2013). The polyphenol and carotenoid contents of barnyard millet is twice that of finger millet (Panwar *et al.*, 2016).

The ancient grain little millet (*P. sumantranse*) is gaining popularity because of its excellent nutritious content. 100 g little millet provides 10.16, 6.26, 2.04, 13.08, 20.51, 47.85, 0.116, 0.05, 0.11, 0.01, 0.048 and 0.05 g moisture, protein, fat, fibre, total total ash, carbohydrate, iron, calcium, phosphorous, nickel, zinc and copper, respectively (Dangeti *et al*., 2013). Little millet helps in blood sugar regulation, lower cholesterol and increased immunity. Additionally, it contains fair amounts of prebiotics, which support intestinal health thus, considered as a wholesome grain with many health advantages (Dangeti *et al*., 2013).

Methi leaves, generally referred to as fenugreek leaves, have a long history of use as a culinary and medicinal herb. They provide a multitude of possible health benefits and are an excellent source of nutrients such as calcium, iron, potassium, folic acid, dietary fibre etc. (Chadha, 1985). It has anti-inflammatory, antibacterial, hypocholesterolaemia, antioxidant, anti-carcinogenic, gastro-protective, anti-diabetic, hepatoprotective and autoimmune properties as well as beneficial in management of obesity (Srinivasan, 2006).

Carrot is a nutrient-dense and adaptable root vegetable with several health advantages. They are a great source of beta-carotene, ascorbic acid and tocopherol, which is an antioxidant that the body uses to make vitamin A. 100 g carrots contain 86% moisture, 0.9% protein, 0.2% fat, 10.6% carbohydrate, 1.2% fibre, 1.1% total total ash, 80 mg calcium, 2.2 mg iron, 53 mg phosphorous (Gopalan *et al*., 1989).

Several studies involving value addition of buns, bread, momos and other bakery products with incorporation of millets were conducted by Sahoo *et al*., (2024) b, Vijayendra *et al*., (2023), Pushpakumara *et al*., (2023), Sahin *et al*., (2017) and Adubofuor *et al*., (2012). The current study has been designed with following objectives such as

- To develop bun by using millets, fenugreek leaves and carrot
- To evaluate proximate composition, organoleptic characteristics and the shelf life of millet incorporated buns

2. Materials and Methods

2.1. Procurement of raw materials

Whole wheat flour, finger millet, barnyard millet and little millet were purchased from the local market in Siripur, Bhubaneswar, Odisha.

2.2. Preparation of millet flour

All the millets were washed, dried and ground to obtain the fine millet flours.

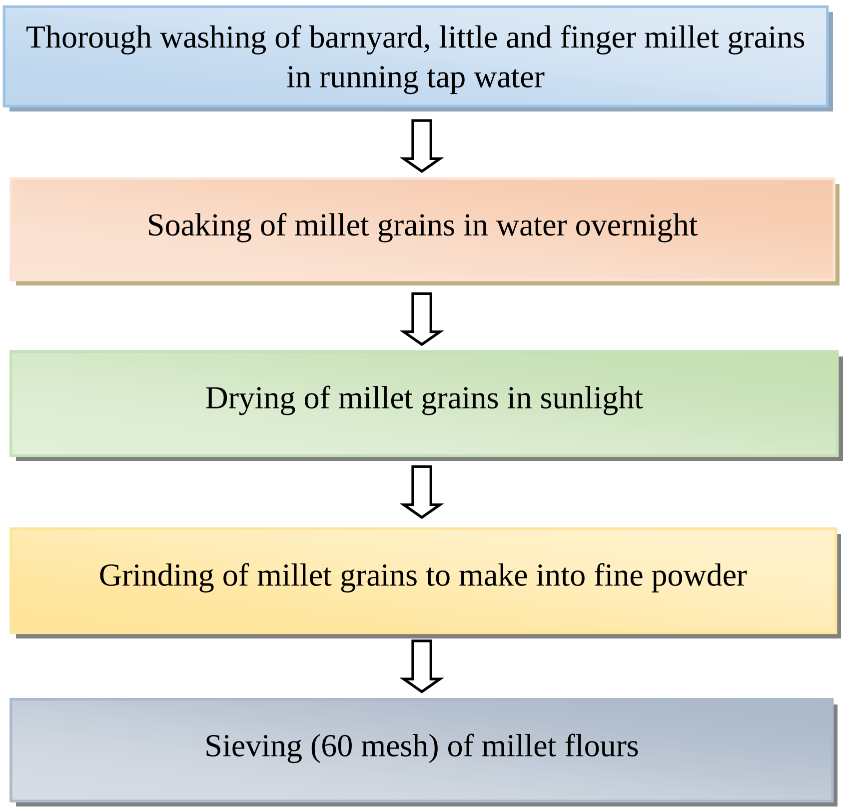

Figure 1. Flow chart for preparation of millet flour

2.3. Standardization of recipe for buns

Composite flour was developed using whole wheat flour (WWF), finger millet flour (FMF), barnyard millet flour (BMF), little millet flour (LMF) for the development of 17 varieties of buns (Table 1).

Table 1: Formulation of flours for preparation of bun

Treatment	Whole wheat flour	Finger millet flour	Barnyard millet flour	Little millet flour	Carrot	Fenugreek leaves
T_0	100 g	-	-	-	10 g	4 g
FT_1	90 g	10 g	-	-	10 g	4 g

FT_2	80 g	20 g	-	-	10 g	4 g
FT_3	70 g	30 g	-	-	10 g	4 g
FT_4	60 g	40 g	-	-	10 g	4 g
BT_1	90 g	-	10 g	-	10 g	4 g
BT_2	80 g	-	20 g	-	10 g	4 g
BT_3	70 g	-	30 g	-	10 g	4 g
BT_4	60 g	-	40 g	-	10 g	4 g
LT_1	90 g	-	-	10 g	10 g	4 g
LT_2	80 g	-	-	20 g	10 g	4 g
LT_3	70 g	-	-	30 g	10 g	4 g
LT_4	60 g	-	-	40 g	10 g	4 g
MT_1	85 g	5 g	5 g	5 g	10 g	4 g
MT_2	70 g	10 g	10 g	10 g	10 g	4 g
MT_3	55 g	15 g	15 g	15 g	10 g	4 g
MT_4	40 g	20 g	20 g	20 g	10 g	4 g

2.4. Procedure for development of nutrient rich Bun

The lukewarm water was mixed with yeast and sugar and left for 10 min to make it fluffy. The whole wheat flour along with sun flower oil was taken in a bowl into which the bubble yeast water was added and mixed well to prepare the dough. The dough was kneaded for at least 5-10 min for the proper development of gluten and covered with a clean cloth and left for proofing for at least 1.5 h in a warm place. Then the uncover dough was punched down and given proper round bun shape. The second proofing was done by leaving the bun to be double in size for 60-90 min. The bun was baked at 200-250ºC for 15-20 min until it became light golden brown.

a. Control (WWF:100%)

b. WWF and FMF were used to develop finger millet bun. 1. WWF:FMF (90:10) 2. WWF:FMF (80:20) 3. WWF:FMF (70:30) 4. WWF:FMF (60:40).

c. WWF and BMF were used to develop barnyard millet bun. 1. WWF:BMF (90:10) 2. WWF:BMF (80:20) 3. WWF:BMF (70:30) 4. WWF:BMF (60:40).

d. WWF and LMF were used to develop little millet bun. 1. WWF:LMF (90:10) 2. WWF:LMF (80:20) 3. WWF:LMF (70:30) 4. WWF:LMF (60:40).

e. WWF, FMF, BMF, LMF were used to develop mixed millet bun. 1. WWF:FMF:BMF:LMF (85:5:5:5) 2. WWF:FMF:BMF:LMF (70:10:10:10) 3. WWF:FMF:BMF:LMF (55:15:15:15) 4. WWF:FMF:BMF:LMF (40:20:20:20).

Figure 2: Different formulations of bun

2.5. Organoleptic evaluation of the developed bun

All the treatments of bun were evaluated by thirty semi-trained panel members for their organoleptic parameters such as colour, texture, flavour, taste and overall acceptability by using nine-point Hedonic rating scale (Peryam and Girardot, 1952).

2.6. Nutrient analysis of the developed bun

The proximate analysis of moisture, fat, protein, mineral and crude fibre was estimated by AOAC method (2007). Moisture content of the developed products was determined by using hot air oven drying methods of (AOAC, 2007). The carbohydrate content was calculated by using the difference method. Kjeldahl method was used to determine the crude protein content of the developed bun in KELPLUS Automatic Nitrogen estimator system by following the digestion, distillation and titration processes (AOAC, 2007). The fat content of the developed products was estimated by the Soxhlet method of (AOAC, 2007). The concentration of minerals such as calcium, iron and phosphorous was determined by using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method.

2.7. Shelf-life evaluation of the developed bun

To evaluate the organoleptic characteristics and shelf life, the most accepted bun varieties were packed in two different packaging materials. One packing material was polypropylene pouch and other one was sugarcane pulp plate and wrap. In polypropylene packaging, the buns were packed and sealed by using hand operated sealing machine and in other one the buns were packed in sugarcane pulp plate and covered by cling wrap. The shelf life of most accepted developed product was analysed by means of organoleptic attributes on each day up to 3 days (0, 1, 2, 3 days).

2.8. Statistical analysis of data

Statistical analysis was carried out for the data collected during organoleptic evaluation of developed product, nutritional composition and shelf-life analysis. Microsoft Excel (2019 version) were used by using analysis of variance (ANOVA) techniques to examine the data.

3. Results and Discussion

3.1. Nutritional composition of developed bun

3.1.1. Proximate composition of finger millet bun

Table 2. Proximate composition of finger millet buns (per 100 g on dry matter basis)

Treatment	Moisture (%)	Total ash (mg)	Crude protein (g)	Crude fat (g)	Crude fibre (g)	Carbohydrate (g)
T_0	$23.74^{a} \pm 0.50$	$1.76^{b} \pm 0.01$	$12.26^{a} \pm 0.43$	$4.76^{a} \pm 0.17$	$2.21^{b} \pm 0.21$	$55.25^{b} \pm 0.08$
FT_1	$23.15^{a} \pm 0.4$	$1.78^{bc} \pm 0.02$	$11.81^{a} \pm 0.44$	$4.58^{a} \pm 0.62$	$2.28^{b} \pm 0.5$	$56.38^{bc} \pm 1.96$
FT_2	$22.90^{a} \pm 0.22$	$1.83^{b} \pm 0.01$	$11.53^{ab} \pm 0.78$	$4.06^{ab} \pm 0.04$	$2.43^{b} \pm 0.06$	$57.24^{ab} \pm 0.53$
FT_3	$22.45^{a} \pm 0.62$	$1.87^{ab} \pm 0.04$	$10.57^{bc} \pm 0.42$	$3.54^{bc} \pm 0.21$	$2.83^{b} \pm 0.17$	$58.56^{a} \pm 1.19$
FT_4	$20.92^{b} \pm 0.23$	$1.93^{a} \pm 0.02$	$10.04^{b} \pm 0.04$	$3.32^{b} \pm 0.23$	$3.78^{a} \pm 0.18$	$60.00^{a} \pm 0.35$
CD@5%	1.34	0.08	1.53	1.03	0.86	3.36
p-value	<0.01	<0.01	0.04	0.04	0.01	0.04
Note**:** Values are mean ± SE of three independent replications. Mean with same superscript (a, b, c, d) in the same column differ significantly ($p<0.05$).						

The data on proximate composition of finger millet buns were described in table 2. It was observed that control (T_0) contained 23.74% moisture, 1.76% total ash, 12.26% crude protein, 4.76% crude fat, 2.21% crude fibre and 55.25% carbohydrate (Table 2).

The moisture content of finger millet buns was ranged from 20.92-23.15% which gradually decreased from FT_1 to FT_4 with increasing finger millet concentration. Control bun contained highest moisture (23.74%) and FT_4 contained lowest moisture. The moisture content of finger millet buns ranged from 20.92-23.15%. Similar results were reported by Pushpakumara *et al.*, (2023) during preparation of tea buns. The gradual decrease in moisture content might be due to less gluten in the finger millet incorporated dough.

The total ash content of finger millet buns ranged from 1.78-1.93% which was gradually increased. Control and FT_4 contained lowest and highest amount of total ash, respectively. Similar results were reported by Sekyere *et al*., (2022), Mudau *et al*., (2021) and Sahoo *et al*., (2024) during preparation of bread and momo with partial substitution of malted finger millet flour.

The protein content of finger millet buns ranged from 10.04-11.81% which is gradually decreases from FT_1 to FT_4. Similar results were reported by Sekyere *et al*., (2022), Ibrahim *et al*., (2021) and Sahoo *et al*., (2024) during preparation of bread and momos with partially substitution of finger millet. There was gradually decrease in the protein content with increasing finger millet proportion which might be due to more protein in wheat flour than that of finger millet.

The fat content of finger millet buns ranged from 3.32-4.58% which is also decreased gradually. Control bun contained highest fat as compared to all treatments of finger millet buns.

The crude fibre content of finger millet buns ranged from 2.28-3.78% which is gradually increases from FT_1 to FT_4. There was increase in the fibre content might be due to high fibre content of carrot, fenugreek leaves and finger millet. Sekyere *et al*., (2022), Sahoo *et al*., (2024) and Sahoo *et al*., (2025) reported similar result during preparation of bread and momos with partially substitution of finger millet.

The carbohydrate content of finger millet buns ranged from 56.38-60%. Control (WWF-100%) bun contained lowest carbohydrate as compared to finger millet buns. Similar result was interpreted by Sekyere *et al*., (2022), Sahoo *et al*., (2024) and Sahoo *et al*., (2025).

The proximate composition of highly accepted finger millet buns (FT_2 and FT_3) had moisture-22.9% and 22.45%, total ash-1.83% and 1.87%, protein-11.53% and 10.57%, fat-4.06% and 3.54%, fibre-2.43% and 2.83%, carbohydrate-57.24% and 58.56%, respectively. It was noticed that control buns (T_0) contained highest moisture, protein, fat and lowest total ash, fibre, carbohydrate. FT_4 contained maximum fibre, carbohydrate and minimum protein. Control and all four varieties of finger millet buns differ significantly (p<0.05) on their proximate value (Table 2).

Table 3. Proximate composition of barnyard millet bun (per 100 g on dry matter basis)

Treatment	Moisture (%)	Total ash (mg)	Crude protein (g)	Crude fat (g)	Crude fibre (g)	Carbohydrate (g)
T_0	$23.74^a \pm 0.50$	$1.76^b \pm 0.01$	$12.26^a \pm 0.43$	$4.76^b \pm 0.17$	$2.21^b \pm 0.21$	$55.25^a \pm 0.08$
BT_1	$22.89^{ab} \pm 0.07$	$1.81^b \pm 0.05$	$12.23^a \pm 0.50$	$4.87^b \pm 0.005$	$2.95^b \pm 0.16$	$55.24^a \pm 0.37$
BT_2	$21.89^b \pm 0.07$	$1.94^{ab} \pm 0.03$	$11.94^a \pm 0.81$	$4.92^{ab} \pm 0.003$	$3.65^b \pm 0.32$	$55.64^a \pm 0.99$
BT_3	$20.89^{bc} \pm 0.50$	$2.07^a \pm 0.13$	$11.85^a \pm 0.11$	$5.07^a \pm 0.005$	$4.62^{ab} \pm 0.31$	$55.48^a \pm 0.90$
BT_4	$20.18^c \pm 0.18$	$2.12^a \pm 0.03$	$11.81^a \pm 0.11$	$5.14^a \pm 0.003$	$5.74^a \pm 0.90$	$54.99^a \pm 1.07$
CD@5%	1.04	0.22	1.49	0.26	1.46	2.48
***p*-value**	<0.01	0.02	<0.01	0.04	<0.01	0.02
Note: Values are mean ± SE of three independent replications. Mean with same superscript (a, b, c, d, e) in the same column differ significantly (p<0.05).						

The data on proximate composition of barnyard millet buns were described in table 3. It was observed that control (T_0) contained 23.74% moisture, 1.76% total ash content, 12.26% crude protein, 4.76% crude fat, 2.21% crude fibre and 55.25% carbohydrate (Table 3).

The moisture content of all four varieties of barnyard millet buns were ranged from 20.18-22.89% which was gradually decreased from BT_1 to BT_4. The moisture content of barnyard millet buns decreased with increasing amount of barnyard millet. The control and BT_4 showed the highest and lowest quantity of moisture, respectively. The barnyard millet buns had a moisture percentage of 20.18–23.74%. The moisture content gradually decreased might be due to barnyard millet contain less gluten by which water holding capacity of buns decreased. Similar results were reported by Salunke *et al.*, (2019), Anju and Sarita (2020) and Devadarshini *et al*., (2024).

The total ash content of barnyard millet buns ranged from 1.81-2.12% which gradually increased with increased concentration of barnyard millet flour. Control and BT_4 contained lowest and highest amount of total ash content. The increased mineral content of carrot, fenugreek leaves and barnyard millet relative to whole wheat flour, which may account for the rise in total ash level. Similar results were reported by Salunke *et al.*, (2019), Anju and Sarita (2020), Veena *et al*., (2020) and Devadarshini *et al*., (2024).

The protein content of barnyard millet buns ranged from 11.81-12.23% which declined from BT_1 to BT_4. The protein content of barnyard millet bun incorporated with fenugreek leaves and carrot ranged from 11.81-12.23%. The protein value significantly decreased as the amount of barnyard millet flour. The protein amount decreased progressively as the quantity of barnyard millet increased; this could be because wheat flour has a higher protein content than barnyard millet. Salunke *et al.*, (2019), Anju and Sarita (2020), Veena *et al*., (2020) and Devadarshini *et al*., (2024) reported similar results during preparation of barnyard millet incorporated pizza base and other bakery products.

The fat content of barnyard millet buns increased gradually ranged from 4.87-5.14%. Control contained the lowest fat as compared to barnyard millet buns.

The crude fibre content of barnyard millet buns ranged from 2.95-5.74% which increased from BT_1 to BT_4. The fibre content of barnyard millet bun incorporated with fenugreek leaves and carrot ranged from 2.95-5.74%. When there was increase in the proportion of barnyard millet flour in the whole wheat flour, the fibre content gradually increased. There was increase in the fibre content might be due to high fibre content of carrot, fenugreek leaves and barnyard millet flour. Salunke *et al.*, (2019), Anju and Sarita (2020), Veena *et al*., (2020) and Devadarshini *et al*., (2024) reported similar result during preparation of cookies and pizza base with partially substitution of barnyard millet.

The carbohydrate content of barnyard millet buns ranged from 54.99-55.64%. BT_1 incorporation bun contained the lowest carbohydrate as compared to other treatments.

The proximate composition of highly accepted two barnyard millet buns (BT_2 and BT_3) had moisture-21.89% and 20.89%, total ash-1.94% and 2.07%, protein-11.94% and 11.85%, fat-4.92% and 5.07%, fibre-3.65%and 4.62%, carbohydrate-55.64% and 55.48%. It was observed that T_0 contained highest moisture, protein, fat and lowest total ash, fibre. BT_4 contained maximum total ash, fibre and minimum protein. BT_2 contained maximum carbohydrate among all five variations. Control and all four varieties of barnyard millet buns differ significantly (p<0.05) on their proximate value (Table 3).

Table 4. Proximate composition of little millet buns (per 100 g on dry matter basis)

Treatment	Moisture (%)	Total ash (mg)	Crude protein (g)	Crude fat (g)	Crude fibre (g)	Carbohydrate (g)
T_0	$23.74^a \pm 0.50$	$1.76^b \pm 0.01$	$12.26^a \pm 0.43$	$4.76^b \pm 0.17$	$2.21^b \pm 0.21$	$55.25^a \pm 0.08$
LT_1	$22.99^a \pm 0.11$	$1.98^b \pm 0.02$	$11.72^a \pm 0.43$	$4.92^b \pm 0.13$	$2.86^b \pm 0.07$	$55.51^a \pm 0.45$
LT_2	$22.19^b \pm 0.23$	$2.15^{ab} \pm 0.07$	$11.48^{ab} \pm 0.08$	$5.26^{ab} \pm 0.30$	$3.66^{ab} \pm 0.66$	$55.23^a \pm 0.57$
LT_3	$21.32^b \pm 0.20$	$2.24^a \pm 0.12$	$10.82^b \pm 0.47$	$5.45^a \pm 0.22$	$4.26^a \pm 0.37$	$55.9^a \pm 0.58$
LT_4	$21.47^b \pm 0.33$	$2.38^a \pm 0.06$	$10.56^b \pm 0.29$	$5.77^a \pm 0.09$	$4.83^a \pm 0.72$	$54.97^a \pm 0.57$
CD@5%	0.96	0.23	1.17	0.64	1.51	1.54
***p*-value**	<0.01	<0.01	0.02	0.03	0.02	0.02

Note: Values are mean ± SE of three independent replications. Mean with same superscript (a, b, c, d) in the same column differ significantly ($p<0.05$).

The data on proximate composition of little millet buns were described in table 4. It was observed that control (T_0) contained 23.74% moisture, 1.76% total ash content, 12.26% crude protein, 4.76% crude fat, 2.21% crude fibre and 55.25% carbohydrate (Table 4).

The moisture content of all four varieties of little millet buns were ranged from 21.32-22.99%. The moisture content of little millet buns incorporated with fenugreek leaves and carrot decreased. Control bun contained highest moisture and LT_4 contained lowest. The moisture content gradually decreased might be due to little millet contain less gluten as compared to whole wheat flour. Similar results were reported by Kumari *et al.*, (2019) during preparation of bun made from quality protein maize.

The total ash content of all four varieties of little millet buns gradually increases and value ranged from 1.98-2.38% which was gradually increased with increased amount of little millet. Control contained lowest total ash proportion and 40% addition of little millet buns contained highest total ash content. The increase in the total ash content which might be due to higher mineral content of little millet, fenugreek leaves and carrot as compared to whole wheat flour. Similar results were reported by Deshmukh *et al.*, (2017) and Mannuramath *et al.*, (2015) during quality evaluation of bread incorporated with little millet.

The protein content of little millet buns ranged from 10.56-11.72% which was gradually decreased from LT_1 to LT_4. When there was increase of little millet flour proportion, there was decrease in protein content gradually. Similar results were reported by Mannuramath *et al.*, (2015) during preparation of bread incorporating with little millet. The gradual decrease in the protein content with increasing little millet proportion might be due to higher protein contents in wheat flour as compared to little millet.

The fat content of little millet buns ranged from 4.92-5.77% which declined in a gradual manner. Control contained lower fat as compared to little millet buns.

The crude fibre content of little millet buns ranged from 2.86-4.83% which gradually increased from LT_1 to LT_4. The fibre content of little millet bun incorporated with fenugreek leaves and carrot ranged from 2.86-4.83%. When there was increase in the proportion of little millet flour in the whole wheat flour, the fibre content gradually increased. There was increase in the fibre content might be due to high fibre content of carrot, fenugreek leaves and little millet as compared to whole wheat flour. Similar results were reported by Mannuramath *et al*., (2015) during preparation of bread by incorporating little millet.
The carbohydrate content of little millet buns ranged from 54.97-55.90%. LT_4 bun contained the lowest carbohydrate content.
The proximate composition of highly accepted two little millet buns (LT_1 and LT_2) had moisture-22.99% and 22.19%, total ash-1.98% and 2.15%, protein-11.72% and 11.48%, fat-4.92% and 5.26%, fibre-2.86%and 3.66%, carbohydrate-55.51% and 55.23%. It was noticed that T_0 contained highest moisture, protein and lowest total ash, fat and fibre. LT_4 contained maximum fat, fibre, total ash and minimum protein. LT_3 contained maximum carbohydrate among all five variations. Control and all four varieties of little millet buns differ significantly (p<0.05) on their proximate value (Table 4).

Table 5. Proximate composition of mixed millet buns (per 100g on dry matter basis)

Treatment	**Moisture (%)**	**Total ash (mg)**	**Crude protein (g)**	**Crude fat (g)**	**Crude fibre (g)**	**Carbohydrate (g)**
T_0	$23.74^{a} \pm 0.50$	$1.76^{c} \pm 0.01$	$12.26^{a} \pm 0.43$	$4.76^{b} \pm 0.17$	$2.21^{c} \pm 0.21$	$55.25^{a} \pm 0.08$
MT_1	$22.69^{b} \pm 0.10$	$1.91^{c} \pm 0.17$	$11.64^{a} \pm 0.18$	$4.85^{b} \pm 0.02$	$2.86^{bc} \pm 0.46$	$56.04^{a} \pm 0.66$
MT_2	$21.82^{b} \pm 0.19$	$2.28^{b} \pm 0.08$	$11.34^{ab} \pm 0.32$	$4.99^{ab} \pm 0.06$	$4.04^{b} \pm 0.57$	$55.52^{a} \pm 0.44$
MT_3	$20.78^{c} \pm 0.13$	$2.45^{ab} \pm 0.02$	$10.6^{b} \pm 0.39$	$5.13^{a} \pm 0.05$	$4.91^{ab} \pm 0.65$	$56.11^{a} \pm 1.09$
MT_4	$20.63^{c} \pm 0.35$	$2.66^{a} \pm 0.07$	$10.35^{b} \pm 0.32$	$5.26^{a} \pm 0.03$	$5.78^{a} \pm 0.53$	$56.82^{a} \pm 1.63$
CD@5%	0.93	0.29	1.08	0.29	1.61	2.99
***p*-value**	<0.01	< 0.01	0.02	0.02	<0.01	0.03

Note: Values are mean ± SE of three independent replications. Mean with same superscript (a, b, c, d) in the same column differ significantly (p <0.05).

The data on proximate composition of mixed millet bun were described in table 5. It was observed that control (T_0) contained 23.74% moisture, 1.76% total ash content, 12.26% crude protein, 2.31% crude fat, 4.76% crude fibre and 55.25% carbohydrate (Table 5).
The moisture content of all four varieties of mixed millet buns were ranged from 20.63-22.69% which gradually decreased from MT_1 to MT_4. This table shows that increased amount of finger millet, barnyard millet and little millet mix flour reduced the moisture content buns. MT_4 had the lowest moisture content compared to the control. The reason for the steady drop in moisture content could be that composite

millet flours have lower gluten content than whole wheat flour. Kumari *et al*. (2019) saw comparable outcomes.

The total ash content of all four varieties of mixed millet buns ranged from 1.91-2.66% which steadily increased. When more composite millet flour was added, the total ash level of mixed millet buns increased steadily. MT_4 added had the largest amount of total ash, while the control had the lowest amount. The higher mineral content of composite millet flour as compared to whole wheat flour may be the cause of the rise in total ash level. Similar results were reported by Sahoo *et al*., (2025).

The protein content of mixed millet buns ranged from 10.35-11.64% which gradually declined from MT_1 to MT_4. The protein content gradually decreased as the amount of composite millet flour in whole wheat flour increased. The protein level decreased progressively as the proportion of composite millet flour increased. This could be because wheat flour has a higher protein content than composite millet flour. The similar results were reported by Mishra *et al*., (2021) during preparation of bread.

The fat content of mixed millet buns increased gradually ranged from 4.85-5.26%. Control contained the lowest amount in comparison to mixed millet buns.

The crude fibre content of mixed millet buns ranged from 2.86-5.78% which gradually enhanced from MT_1 to MT_4. The fibre content progressively rose as the percentage of composite millet flour (CMF) in wheat flour increased. The higher fibre content of the carrot, fenugreek leaves, and CMF (finger millet, barnyard millet and little millet) in comparison to whole wheat flour may have caused the rise in fibre content. The similar findings were reported by Mounika and Sireesha (2021) during preparation bread.

The carbohydrate content of mixed millet buns ranged from 55.52-56.82%. Mixed millet buns contained highest carbohydrate as compared to control.

The proximate composition of highly accepted two mixed millet buns (MT_1 and MT_2) had moisture-22.69% and 21.82%, total ash-1.91% and 2.28%, protein-11.64% and 11.34%, fat-4.85% and 4.99%, fibre-2.86%and 4.04%, carbohydrate-56.04% and 55.52%. It was observed that T_0 contained highest moisture, protein and lowest total ash, fat, fibre, carbohydrate. MT_4 contained maximum fibre, and minimum moisture, protein. MT_4 contained maximum carbohydrate among all 5 variations. Control and all four varieties of mixed millet buns differ significantly (p<0.05) on their proximate value (Table 5).

3.1.2. Mineral composition of the most accepted treatments of bun

Table 6. Mineral composition of most accepted buns

Treatment	Calcium (mg/100 g)	Iron (mg/100 g)	Phosphorus (mg/100 g)
T_0	$64.16^{e} \pm 1.48$	$5.01^{e} \pm 0.24$	$403.16^{b} \pm 0.76$
FT_2	$126.53^{b} \pm 2.35$	$4.98^{e} \pm 0.21$	$398.2^{ab} \pm 1.45$
FT_3	$159.76^{a} \pm 2.73$	$4.6^{e} \pm 0.20$	$389.76^{d} \pm 2.73$
BT_2	$59.81^{e} \pm 1.49$	$7.25^{c} \pm 0.13$	$395.48^{c} \pm 0.85$
BT_3	$54.36^{f} \pm 1.38$	$8.23^{b} \pm 0.31$	$386.4^{d} \pm 1.79$
LT_1	$61.14^{e} \pm 2.89$	$5.63^{cd} \pm 0.19$	$398.23^{b} \pm 1.26$
LT_2	$58.01^{de} \pm 2.55$	$5.79^{d} \pm 0.28$	$387.01^{d} \pm 0.65$
MT_1	$77.14^{d} \pm 2.04$	$7.23^{c} \pm 0.13$	$419.16^{a} \pm 1.47$
MT_2	$89.78^{c} \pm 1.19$	$9.26^{a} \pm 0.12$	$387.12^{d} \pm 1.52$
CD@5%	7.12	0.69	5.11
***p*-value**	0.04	< 0.01	0.03

Note: Values are mean ±SE of three independent replications. Mean with same superscript (a, b, c, d, e, f) in the same column differ significantly (p<0.05).

The data of mineral composition (calcium, iron and phosphorus) of control and most accepted multi millet buns were described in table 6. It was observed that control (T_0) contained 64.16 mg calcium, 5.01 mg iron, 403.16 mg phosphorus per 100 g sample. Maximum calcium content was found in FT_3 *i.e.*, 159.76 mg 100 g. Maximum iron content was found in MT_2 *i.e.*, 9.26 mg and maximum phosphorus content was found in MT_1 *i.e.*, 419.16 mg per 100 g. All the mineral contents (calcium, iron and phosphorus) of control and most accepted multi millet buns incorporated with fenugreek leaves and carrot differ significantly at p<0.05. The most accepted finger millet bun (FT_3) contained highest calcium *i.e.*, 159.76 mg/100 g as compared to control. This could be because of finger millet contained highest calcium among all the cereals. Similar results were reported by Chhavi and Sarita (2012), Devani *et al*., (2016), Sahoo *et al*., (2024) b and Sahoo *et al*., (2025). The most accepted mixed millet bun MT_2 and MT_1 contained highest iron and phosphorous, respectively as compared to others. This could be because of higher iron content of barnyard millet as well as little millet. Similar results were reported by Devani *et al*., (2016) and Devadarshini *et al*., (2024) (Table 6).

3.2. Organoleptic evaluation of developed bun

Effects of adding finger millet flour on organoleptic parameters of buns are depicted in the figure 3. It was observed that by increasing the level of finger millet flour the organoleptic attributes (colour, texture, flavour, taste, overall acceptability) decreased. The colour, texture, flavour, taste and overall acceptability of finger millet buns incorporated with fenugreek leaves and carrot decreased from 7.8-6.7, 7.9-6.9, 7.8-6.4, 7.9-6.2, 7.6-6.3, respectively. Buns with incorporation of 20% and 30% finger millet flour *i.e.*, FT_2 and FT_3 in whole wheat flour (WWF) were highly acceptable when compared with control bun. Similar results were reported by Devani *et al*., (2016).

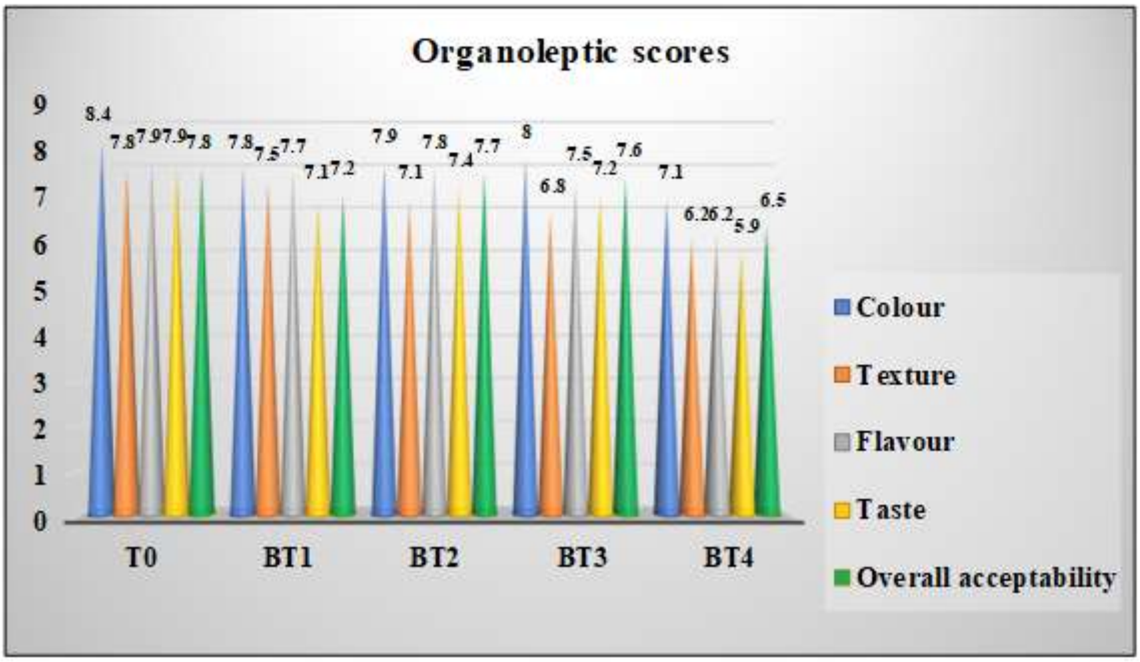

Fig. 3. Organoleptic evaluation of finger millet bun

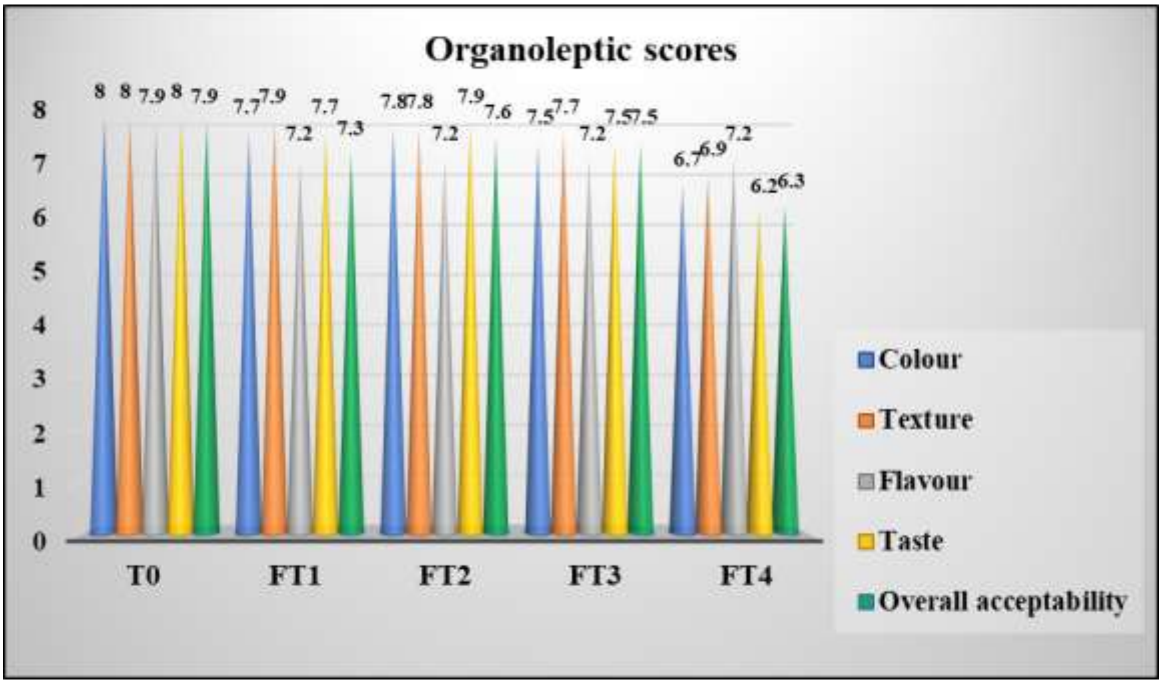

Figure 4. Organoleptic evaluation of barnyard millet bun

In figure 4, organoleptic scores of barnyard millet buns are shown. Control had the highest rating with respect to all the parameters of organoleptic evaluation. There was no major difference in ratings between the barnyard millet buns and the control. Addition of barnyard millet flour decreased colour (8-7.1), texture (7.5-6.2), flavour (7.8-6.2), taste (7.4-5.9) and overall acceptability (7.7-6.5). BT_2 and BT_3 were highly acceptable when compared with control. Nazni *et al*., (2016) and Devadarshini *et al*., (2024) reported similar results on incorporation of barnyard millet flour.

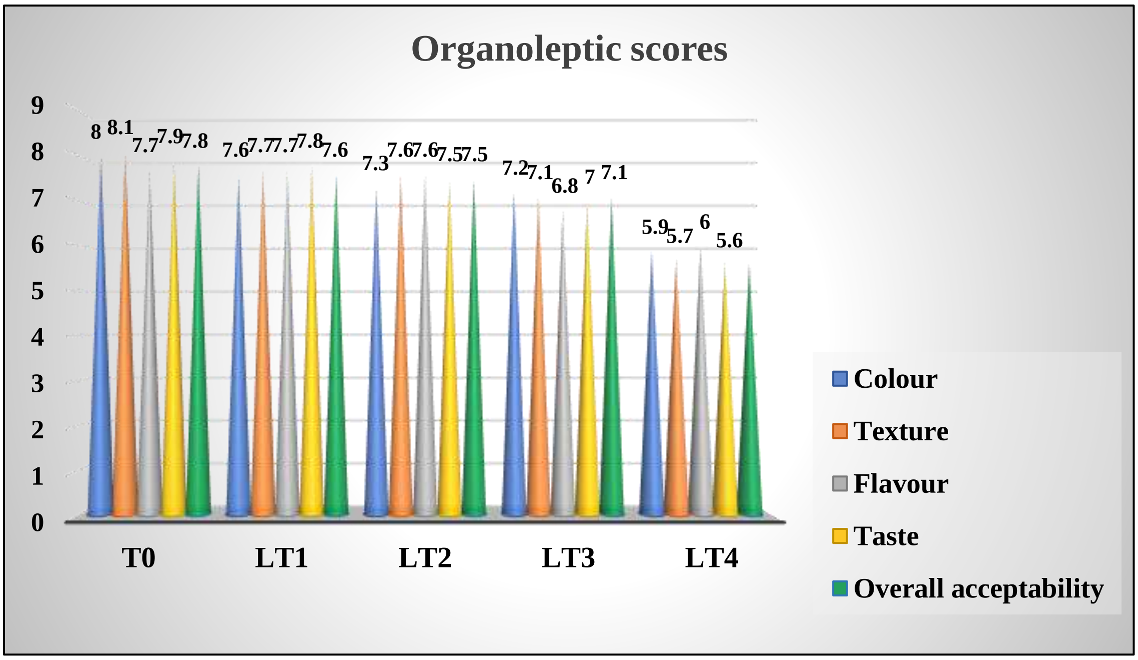

Figure 5. Organoleptic evaluation of little millet bun

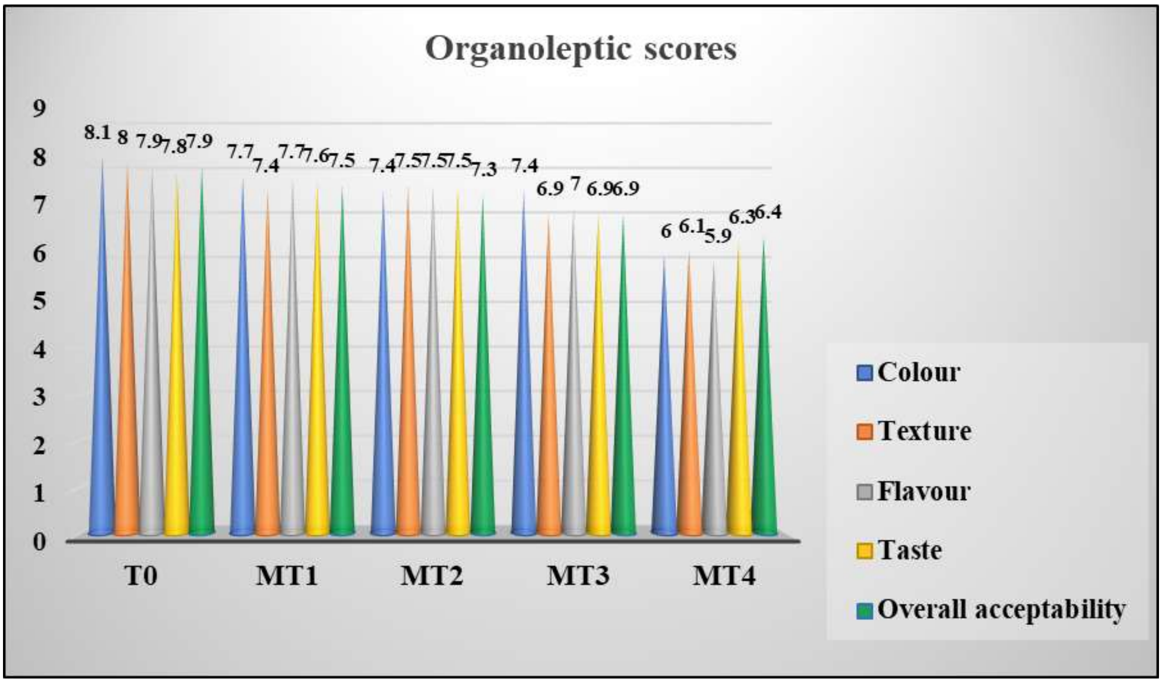

Figure 6. Organoleptic evaluation of mixed millet bun

The results from figure 5 described that by addition of little millet flour decreased colour from 7.6-5.9, texture from 7.7 to 5.7, flavour from 7.7 to 6.0, taste from 7.8 to 5.6, overall acceptability from 7.6 to 5.6. LT_1 and LT_2 buns were highly acceptable when compared with control. There was no major difference of organoleptic parameters of the most accepted two variety buns when compared with control. Similar findings were suggested by Pradhan *et al*., (2022) and Mannuramath *et al*., (2015).
The data from figure 6 described that by addition of composite finger, little and barnyard millet flour in buns decreased colour from 7.7 to 6.0, texture from 7.5 to 6.1, flavour from 7.7 to 5.9, taste from 7.6 to 6.3 and overall acceptability from 7.5 to 6.4. MT_1 and MT_2 were highly acceptable when compared with control. There was no major difference observed in organoleptic parameters of the most accepted two treatments of multi-millet buns when compared with control. Devadarshini *et al*., (2024), Nehra *et al*., (2021) and Chhavi *et al*., (2012) suggested 30% addition of composite millet flour in refined wheat flour in bread was highly acceptable.

3.3. Shelf-life analysis of developed bun

Results showed the colour of the most accepted multi-millet buns and control decreased as the storage time increased. There were no significant changes occurred in colour in both the sugarcane pulp plate-wrap and polypropylene packaging material up to 3rd day. In poly propylene packaging the colour score was good as compared to sugarcane pulp plate-wrap after the 4th day of storage. The organoleptic score of texture of most accepted multi-millet buns and control incorporated with fenugreek leaves and carrot declined periodically. The sugarcane pulp plate-wrap and polypropylene packaging used to store the multi-millet buns did not exhibit any notable alterations. The organoleptic score of flavour of most accepted multi-millet buns and control declined periodically. There were no significant changes occurred in flavour score of buns in both the packaging material up to 3rd day. But after the 4th day of stored buns, flavour slightly degraded in sugarcane pulp plate-wrap as compared to poly propylene packaging. The taste of most accepted multi millet buns and control incorporating with fenugreek leaves and carrot decreased as the storage time increased. There were no significant changes in the taste occurred up to 2nd day in both the packaging, after 2nd day the taste decreased gradually. The mean score of taste of buns packaged in sugarcane pulp plate wrap degraded little bit as compared to poly propylene packaging after 4th day of storage. The organoleptic score of overall acceptability of most accepted multi-millet buns and control incorporated with fenugreek leaves and carrot were decreased gradually during storage period. There was very small difference of overall acceptability in both the packaging material. But buns packed in poly propylene packaging material underwent less changes as compared to sugarcane pulp plate-wrap. Control and most accepted multi millet buns are acceptable up to 3rd day after that there is decrease in the quality of the buns. Similar findings were obtained by Chang *et al*. (2023) during shelf-life analysis of bread.

4. Conclusion

It can be concluded that with incorporation of different millets, fenugreek leaves and carrots in buns, the proximal value as well as mineral content can be increased. The organoleptic score of the various millet buns—finger millet buns, barnyard millet buns, little millet buns, and mixed millet buns showed a substantial variation. During preparation of bun, millets can be incorporated up to 30% without affecting the organoleptic parameters. The mineral (calcium, iron and phosphorus) content of highly accepted mixed millet buns increased by increasing the millet formulation. By increasing the storage time there was significant changes in the organoleptic score obtained. The organoleptic score of most accepted multi millet buns were good up to 3rd days in both the packaging material (poly propylene and sugarcane pulp plate-wrap). The poly propylene packaging showed little bit of better result of organoleptic evaluation as compared to sugarcane pulp plate-wrap packaging.

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