Effect of Blending Ratio and Fermentation Time on the Quality of Injera Prepared from Quality Protein Maize and Teff Flours

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Abstract
Injera is a fermented, and pancake-like bread consumed as a staple food in Ethiopia and made from cereals like teff, sorghum, wheat, maize, or a combination of some of these cereals. The study was conducted to investigate the effect of blending ratio and fermentation time on injera quality prepared from quality protein maize and teff flours. The moisture, crude protein, crude fat, crude fiber, and total ash contents of injera samples ranged from 60.63 – 62.08%, 11.86 – 13.30%, 2.80 – 3.53%, 2.19 – 3.19% and 1.46 – 1.70% due to the blending ratio, and from 61.12 – 61.37%, 11.93 – 13.03%, 3.03 – 3.20%, 2.74 – 2.81% and 1.55 – 1.61% due to fermentation time, respectively. Mineral contents of injera samples also ranged from 4.61 – 8.99 mg/100g (iron), 3.03 – 3.23 mg/100g (zinc) and 70.19 – 90.82 mg/100g (calcium) due to the blending ratio and from 6.81 to 7.32 mg/100g (iron), 3.03 to 3.20 mg/100g (zinc) and 78.44 to 82.83 mg/100g (calcium) due to fermentation time respectively. Increasing the blending proportions of teff flour in the composites and 60h fermentation time was found to improve the sensory acceptability of quality protein maize-teff composite injera.
Keywords: injera, quality protein maize, blending ratio, fermentation time
DOI: 10.7176/FSQM/116-02
Publication date: June 30th 2022

1. Introduction

Injera, a fermented thin, flat pancake-like bread with evenly distributed honeycomb eyes, is a major national dish widely consumed daily by many Ethiopians. Teff is commonly used to prepare injera, however, other major cereals in Ethiopia have increasingly been used either entirely or in a mixture with teff to prepare injera, probably driven by the rising price of teff (Senayit *et al*., 2004). Good injera is soft with uniformly distributed gas holes on its top surface and non-sticky top and bottom surfaces, elastic (rolls-easily), and slightly sour taste (Senayit *et al*., 2005). Preparing injera from quality protein maize (QPM) has considerable advantages both nutritionally and economically over teff (Umer, 2021). Quality protein maize is a nutritionally enhanced maize type and contains nearly twice the amount of lysine (>4.0%) and tryptophan (>0.8%) present in common maize (Krivanek *et al*., 2007; Nuss and Tanumihardjo, 2011).

The higher lysine and tryptophan contents of QPM varieties compared to conventional maize, provide a more balanced protein for humans and other monogastric animals (Sofi *et al*., 2009; Adefris *et al.*, 2015). Injera prepared from quality protein maize is only preferred in their fresh state and softness does not last as long as teff injera. Because of this, the use of quality protein maize for injera making received little attention (Umer, 2021). Fermentation time is also an important factor that affects the quality and acceptabilities of injera. Injera made from dough that has not been sufficiently fermented has a sweetish taste and it is considered not good injera (Bemihiretu *et al*., 2013). The present study was conducted to improve injera quality prepared from the quality protein maize flour through compositing with teff flour and determining the required fermentation time to maximize utilization by the communities.

2. Materials and Methods

2.1. Flour preparation

The grains of quality protein maize (Melkassa-6Q) and teff (Magna/DZ-01-196) were collected from Melkassa Agricultural Research Center and Debre Zeit Agricultural Research Center. Quality protein maize grains were soaked and decorticated using traditional wooden mortar and pestle to remove the husk (tip-cap). The teff grains were cleaned through winnowing and sieving. Then, the grains were separately milled (UDY3010019, USA) and sieved with a size of 0.50 mm (Umer, 2021).

2.2. Dough processing and fermentation

About 200g of flour was mixed with 180 mL of water and kneaded for about 2 min. Then, 10 mL of (5% on a flour weight basis) pre-prepared starter yeast (*irsho*) was poured on the dough and left to ferment for 48h, 60h, and 72h at room temperature. After the primary fermentation, about 10% of the fermented dough was taken and mixed with three parts of boiling water and then mixed thoroughly for 1 min (*absit*). The mixture was left at room temperature until the temperature dropped and then the mixture was added back to the fermenting dough and mixed well. To this, 100 mL of water was added and the mixture was left to ferment for about 3 – 4h at room temperature until a foamy slurry was formed. Then, the slurry was poured onto an electric clay stove in a circular motion, covered with the lid, and cooked for 2 min (Weerasooriya *et al*., 2018).

2.3. Proximate analysis

The proximate compositions of injera samples were determined according to AOAC (2000) standard procedures. The moisture content was determined by the oven-drying method (method 925.09). The crude protein content was determined by the Kjeldahl method (method 979.09). The crude fat content was determined by continuous extraction in a Soxhlet apparatus using hexane as solvent (official method 4.5.01). Crude fiber content was determined by digesting the samples with diluted 1.25% sulphuric acid solution for 30 min at a boiling point followed by digestion with 1.25% sodium hydroxide solution for the same duration (method 962.09). The total ash content was determined by incinerating the sample in a muffle furnace at 550°C for 5h (official method 923.03).

2.4. Mineral analysis

The mineral contents of injera samples were determined by Atomic Absorption Spectrophotometer following the AOAC (2000) procedure. The absorbance of iron was measured at 248.3nm and the iron content was estimated from a standard calibration curve (10µg Fe/mL) prepared from analytical grade iron wire (Official Method 999.11). For zinc determination, absorbance was measured at 213.8nm and zinc level was estimated from a standard calibration curve (0.1–1.0µg Zn/mL) prepared from zinc oxide (Official Method 999.11). The absorbance of calcium was measured at 422.7nm after the addition of 10% lanthanum chloride to the sample and standard to suppress interference. Calcium content was then estimated from a standard solution (0.1–1.0µg Ca/mL) prepared from calcium carbonate (Official Method 984.27).

2.5. Sensory evaluation

The sensory evaluation of injera samples was carried out by 30 semi-trained panelists composed of males and females. The samples were tested for color, taste, texture, rollability, eye distribution, underneath, and overall acceptability using a seven-point hedonic scale (1=dislike extremely, 2=dislike moderately, 3=dislike slightly, 4=neither like nor a dislike, 5=like slightly, 6=like moderately, and 7=like extremely) (Zewdu *et al*., 2018).

2.6. Experimental design and analysis

A factorial design of two factors in CRD (proximate and mineral) and RCBD (sensory) arrangement was used. The factors were the blending ratio of teff flour (20%, 30%, and 40%) and fermentation time (48h, 60h, and 72h). The experimental data were statistically analyzed using SAS software (version 9.4) following the PROC ANOVA procedure. Means were separated by Fisher's least significant difference (LSD) test at a $p<0.05$ level of significance.

3. Results and Discussion

3.1. Proximate compositions of injera

Results of the proximate compositions of QPM-teff composite injera are listed in Table 1. The blending ratio had a significant effect ($p<0.05$) on the moisture contents. The highest value (62.08%) was recorded the for injera sample prepared from QPM-teff composite flour having 40% teff and the lowest value (60.63%) was recorded the for injera sample prepared from 100% QPM flour. A significant difference ($p<0.05$) was also observed in the moisture contents of injera as the fermentation time varied, and values of 61.12%, 61.23%, and 61.37% were recorded from injera samples fermented for 48h, 60h, and 72h respectively. The crude protein contents of QPM-teff composite injera ranged between 11.86 – 13.30% and significant variation ($p<0.05$) was observed due to the blending ratio. Fermentation time also significantly increased ($p<0.05$) the protein contents of injera, and as it increased from 48h to 60h, and 72h, crude protein contents of 11.93%, 12.80%, and 13.03% were recorded, respectively. The increase might be due to the increase in microbial mass during fermentation, causing extensive hydrolysis of protein molecules to amino acids and other simple peptides (Igbabul *et al*., 2014).

The crude fat contents of QPM-teff composite injera were significantly influenced ($p<0.05$) by blending ratio and fermentation time. Injera's prepared from 100% QPM flour had the highest (3.53%) value whereas injera prepared from the composite flour ratio of 60% QPM and 40% teff had the lowest (2.80%) value. A significant difference ($p<0.05$) was also observed in the crude fat contents of injera samples as the fermentation time varied from 48h (3.20%) to 72h (3.03%). It was reported that increased activity of the lipolytic enzymes during fermentation hydrolyze fat components into fatty acids and glycerol (Chinma *et al*., 2009). Crude fiber contents of QPM-teff composite injera samples varied from 2.19 – 3.19% and were significantly affected ($p<0.05$) by the change in teff flour proportion. Injera prepared from the composite flours of 60% QPM and 40% teff had the highest crude fiber value, whereas injera prepared from 100% QPM flour had the lowest crude fiber value. The work of Zewdu *et al*. (2018) also reported that the crude fiber content of teff injera (100%) was

5.21% compared to injera prepared from teff-maize-rice composite flour (3.91%).

Fermentation time significantly decreased (p<0.05) the crude fiber contents of injera, and values of 2.81%, 2.78%, and 2.74% were recorded for injera samples fermented for 48h, 60h, and 72h, respectively. This decrease might be related to the partial solubilization of cellulose and hemicellulosic type of material by microbial enzymes (Afify *et al*., 2011). The total ash contents also varied from 1.46 to 1.70% and from 1.55 to 1.61% due to blending ratio and fermentation time, respectively, and a significant difference (p<0.05) was observed among the samples.

Table 1. Effect of blending ratio and fermentation time on the proximate compositions of quality protein maize-teff composite injera.

Blending ratio (%)	**Moisture content (%)**	**Crude protein (%)**	**Crude fat (%)**	**Crude fiber (%)**	**Total ash (%)**
100:0	60.63±0.53^{d}	11.86±0.53^{d}	3.53±0.09^{a}	2.19±0.04^{d}	1.46±0.03^{d}
80:20	60.79±0.52^{c}	12.18±0.31^{c}	3.22±0.07^{b}	2.70±0.03^{c}	1.55±0.04^{c}
70:30	61.46±0.51^{b}	13.00±0.64^{b}	2.92±0.06^{c}	3.03±0.03^{b}	1.60±0.02^{b}
60:40	62.08±0.55^{a}	13.30±0.54^{a}	2.80±0.07^{d}	3.19±0.03^{a}	1.70±0.03^{a}
CV (%)	0.13	0.35	0.53	0.68	1.14
LSD	0.08	0.04	0.02	0.02	0.02
Fermentation time (h)	**Moisture content (%)**	**Crude protein (%)**	**Crude fat (%)**	**Crude fiber (%)**	**Total ash (%)**
48	61.12±0.78^{c}	11.93±0.55^{c}	3.20±0.31^{a}	2.81±0.39^{a}	1.61±0.09^{a}
60	61.23±0.80^{b}	12.80±0.66^{b}	3.12±0.30^{b}	2.78±0.40^{b}	1.58±0.08^{b}
72	61.37±0.79^{a}	13.03±0.65^{a}	3.03±0.28^{c}	2.74±0.41^{c}	1.55±0.09^{c}
CV (%)	0.13	0.35	0.53	0.68	1.14
LSD	0.07	0.04	0.01	0.02	0.02

QPM flour= 60%, 70%, 80%, and 100%, teff flour= 20%, 30%, and 40%

3.2. Interaction effect of blending ratio and fermentation time

Table 2 summarizes the interaction effects of blending ratio and fermentation time on the proximate compositions of QPM-teff composite injera and significant differences (p<0.05) were observed. The moisture, crude protein, crude fat, crude fiber, and total ash contents of injera samples ranged from 60.53 – 62.24%, 11.17 – 13.75%, 2.72 – 3.64%, 2.23 – 3.22%, and 1.42 – 1.73%, respectively. The moisture and crude protein contents of injera samples were found significantly increase, but the crude fat contents decreased with the increase in the proportion of teff flour in the blends and fermentation time as well. The crude fiber and total ash values were found to increase with the addition of teff flour in the mix but inversely decreased with the increase in the fermentation period.

Table 2. Interaction effect of blending ratio and fermentation time on the proximate compositions of quality protein maize-teff composite injera.

Blending ratio (%)	**Fermentation time (h)**	**Moisture content (%)**	**Crude protein (%)**	**Crude fat (%)**	**Crude fiber (%)**	**Total ash (%)**
100:0	48	60.53±0.59^{g}	11.17±0.03^{j}	3.64±0.02^{a}	2.23±0.03^{g}	1.48±0.02^{f}
100:0	60	60.59±0.60^{g}	12.08±0.03^{h}	3.55±0.01^{b}	2.19±0.02^{h}	1.46±0.02^{f}
100:0	72	60.76±0.60^{f}	12.34±0.03^{f}	3.41±0.02^{c}	2.14±0.02^{i}	1.42±0.02^{g}
80:20	48	60.66±0.59^{fg}	11.78±0.03^{i}	3.31±0.02^{d}	2.73±0.03^{e}	1.59±0.03^{d}
80:20	60	60.78±0.59^{f}	12.28±0.03^{f}	3.22±0.03^{e}	2.71±0.01^{e}	1.54±0.02^{e}
80:20	72	60.92±0.61^{e}	12.47±0.04^{e}	3.14±0.01^{f}	2.66±0.02^{f}	1.52±0.03^{e}
70:30	48	61.34±0.58^{d}	12.16±0.06^{g}	2.99±0.02^{g}	3.06±0.03^{c}	1.62±0.02^{c}
70:30	60	61.48±0.57^{c}	13.30±0.03^{c}	2.92±0.02^{h}	3.03±0.03^{cd}	1.61±0.02^{cd}
70:30	72	61.55±0.58^{c}	13.55±0.07^{b}	2.84±0.01^{j}	3.01±0.01^{d}	1.58±0.03^{d}
60:40	48	61.94±0.64^{b}	12.59±0.05^{d}	2.87±0.02^{i}	3.22±0.03^{a}	1.73±0.02^{a}
60:40	60	62.06±0.63^{b}	13.56±0.03^{b}	2.80±0.03^{k}	3.18±0.03^{b}	1.70±0.02^{a}
60:40	72	62.24±0.59^{a}	13.75±0.06^{a}	2.72±0.01^{l}	3.16±0.02^{b}	1.66±0.02^{b}
CV (%)		0.13	0.35	0.53	0.68	1.14
LSD		0.13	0.07	0.03	0.03	0.03

QPM flour= 60%, 70%, 80%, and 100%, teff flour= 20%, 30%, and 40%

3.3. Mineral contents of injera

Table 3 shows the mineral contents of QPM-teff composite injera samples. The blending ratio a had significant effect (p<0.05) on iron, zinc, and calcium contents, and the values ranged from 4.61 – 8.99 mg/100g (Fe), 3.03 –

3.23 mg/100g (Zn), and 70.19 – 90.82 mg/100g (Ca). The highest value was recorded for the injera samples prepared from 60% QPM and 40% teff composite flour, and the lowest value was recorded for the injera samples prepared from 100% QPM flour. A significant increment was also recorded for iron, zinc, and calcium contents as the fermentation time varied from 48 – 72h.

Table 3. Effect of blending ratio and fermentation time on the mineral contents of quality protein maize-teff composite injera.

Blending ratio (%)	**Iron (mg/100g)**	**Zinc (mg/100g)**	**Calcium (mg/100g)**
100:0	4.61±0.14[d]	3.03±0.07[d]	70.19±2.39[d]
80:20	6.34±0.12[c]	3.08±0.08[c]	77.12±2.01[c]
70:30	8.38±0.10[b]	3.15±0.10[b]	84.96±2.11[b]
60:40	8.99±0.09[a]	3.23±0.08[a]	90.82±1.96[a]
CV (%)	0.73	0.62	0.85
LSD	0.05	0.02	0.67
Fermentation time (h)	**Iron content (mg/100g)**	**Zinc content (mg/100g)**	**Calcium content (mg/100g)**
48	6.81±0.84[c]	3.03±0.08[c]	78.44±8.31[c]
60	7.11±0.78[b]	3.14±0.08[b]	81.03±8.28[b]
72	7.32±0.81[a]	3.20±0.09[a]	82.83±8.01[a]
CV (%)	0.73	0.62	0.85
LSD	0.04	0.02	0.58

QPM flour= 60%, 70%, 80%, and 100%, teff flour= 20%, 30%, and 40%

3.4. Interaction effect of blending ratio and fermentation time

The interaction effects of blending ratio and fermentation time on iron, zinc, and calcium contents of injera are indicated in Table 4 and varied significantly (*p*<0.05). The results ranged from 4.32 to 9.30 mg/100g, 2.95 to 3.30 mg/100g, and 67.66 to 92.70 mg/100g for iron, zinc, and calcium, respectively. The two factors showed a synergic effect in their interaction, increasing the mineral contents of injera's as both factors increased. Higher mixing proportions of teff flour and increased fermentation time (48h, 60h, and 72h) resulted in an increment in the mineral contents.

Table 4. Interaction effect of blending ratio and fermentation time on the mineral contents of quality protein maize-teff composite injera.

Blending ratio (%)	**Fermentation time (h)**	**Iron (mg/100g)**	**Zinc (mg/100g)**	**Calcium (mg/100g)**
100:0	48	4.32±0.02[l]	2.95±0.02[g]	67.66±1.24[l]
100:0	60	4.67±0.06[k]	3.05±0.03[e]	70.18±0.84[k]
100:0	72	4.85±0.12[j]	3.09±0.04[d]	72.73±1.16[j]
80:20	48	6.01±0.03[i]	3.00±0.02[f]	74.91±0.83[i]
80:20	60	6.38±0.03[h]	3.10±0.02[d]	77.59±1.48[h]
80:20	72	6.62±0.02[g]	3.16±0.03[c]	78.85±0.99[g]
70:30	48	8.20±0.06[f]	3.04±0.02[e]	82.49±1.15[f]
70:30	60	8.41±0.04[e]	3.17±0.02[c]	85.28±0.89[e]
70:30	72	8.52±0.09[d]	3.26±0.02[b]	87.11±0.77[d]
60:40	48	8.72±0.02[c]	3.14±0.03[c]	88.70±1.23[c]
60:40	60	8.97±0.03[b]	3.25±0.03[b]	91.08±1.12[b]
60:40	72	9.30±0.04[a]	3.30±0.04[a]	92.70±0.66[a]
CV (%)		0.73	0.62	0.85
LSD		0.09	0.03	1.16

QPM flour= 60%, 70%, 80%, and 100%, teff flour= 20%, 30%, and 40%

3.5. Sensory acceptability of injera

The sensory acceptability results of QPM-teff composite injera samples are presented in Table 5. The blending ratio had a significant effect (*p*<0.05) on the color mean score but not the fermentation time. The difference in color scores might be due to the difference in color values of QPM and teff flour. Cuevas-Rodríguez *et al.* (2006) reported the lightness of QPM flour was 91.10 and Yoseph (2019) reported the lightness of teff flour ranged from 71.0 – 87.70. Taste, texture, eye distribution, and injera underneath quality mean scores of injera samples were significantly influenced (*p*<0.05) by the blending ratio of teff flour and fermentation time. The sensory scores for the rollability of injera samples varied from 4.61 – 5.69. Panelist's response for rollability acceptance indicated that injera's prepared from QPM flour (100:0) and QPM-teff composite flour (80:20) were rated below

5 which shows a lower degree of liking. The overall acceptability scores of injera samples ranged from 5.03 – 5.38 due to the blending ratio. Injera samples fermented for 60hr also showed better acceptance compared to injera samples fermented for 48h and 72h. The quality of injera is influenced to a large extent by the fermentation process and the length of time for fermentation (Bemihiretu *et al*., 2013; Samuel, 2015).

Table 5: Effect of blending ratio and fermentation time on sensory acceptability of QPM-teff composite injera.

Blending ratio (%)	Color	Taste	Texture	Rollability	Eye distributions	Underneath	Overall acceptability
100:0	5.86±0.70[a]	5.09±0.90[b]	5.01±0.86[d]	4.61±1.17[d]	5.12±0.85[c]	5.08±0.86[b]	5.03±0.80[b]
80:20	5.69±0.83[ab]	5.23±0.81[ab]	5.24±0.64[c]	4.94±0.81[c]	5.27±0.91[bc]	5.18±0.91[ab]	5.23±0.82[ab]
70:30	5.64±0.81[ab]	5.33±0.85[a]	5.46±0.71[b]	5.42±0.76[b]	5.43±0.95[ab]	5.26±0.76[ab]	5.36±0.75[a]
60:40	5.56±0.93[b]	5.38±0.80[a]	5.76±0.72[a]	5.69±0.71[a]	5.52±0.80[a]	5.40±0.93[a]	5.38±0.71[a]
CV (%)	14.41	14.43	12.80	15.11	15.02	16.00	13.75
LSD	0.24	0.22	0.20	0.23	0.24	0.25	0.21
Fermentation time (h)	**Color**	**Taste**	**Texture**	**Rollability**	**Eye distribution**	**Underneath**	**Overall acceptability**
48	5.77±0.67[a]	5.20±0.76[b]	5.28±0.76[b]	5.08±0.82[b]	5.23±0.85[b]	5.10±0.98[b]	5.22±0.78[b]
60	5.68±0.81[a]	5.43±0.87[a]	5.35±0.82[ab]	5.16±1.14[ab]	5.53±0.93[a]	5.21±0.80[ab]	5.41±0.79[a]
72	5.62±0.96[a]	5.13±0.88[b]	5.48±0.77[a]	5.29±0.92[a]	5.26±0.87[b]	5.38±0.81[a]	5.13±0.75[b]
CV (%)	14.41	14.43	12.80	15.11	15.02	16.00	13.75
LSD	0.21	0.19	0.17	0.20	0.20	0.21	0.18

QPM flour= 60%, 70%, 80%, and 100%, teff flour= 20%, 30%, and 40%

3.6. Interaction effect of blending ratio and fermentation time

The interaction effects of blending ratio and fermentation time on the sensory acceptability of QPM-teff composite injera are shown in Table 6. A significant difference ($p<0.05$) in color scores existed only between the control sample with fermentation times of 48h and 60h, and the injera prepared from composite flour of 40% teff fermented for 72h. The rest of the injeras did not have a difference in color acceptability score with values between 5.57 to 5.80. The interaction effects of blending ratio and fermentation time on taste, texture, rollability, eye-distributions, underneath surface, and overall acceptability mean scores were significant. The taste of the injera sample prepared from 100% QPM flour was highly affected by fermentation time and acceptability obtained only for 48h.

The eye distributions were also highly affected and extended fermentation time (60h and 72h) for preparing injera from 100% QPM flour resulted in few and scattered eyes. The absence of eyes or a limited number of eyes in the prepared injera is indicative of very little carbon dioxide being produced during fermentation (Senayit *et al*., 2005). As the blending ratio of teff flour increased in the composites and the fermentation time varied from 48h to 60h and 72h, an improvement in the textural quality and rollability was observed between the treatments. The elastic texture and pores (referred to as eyes) formed on the surface of injera are important quality attributes (Attuquayefio, 2014). Injera's prepared from QPM-teff composite having 20%, 30%, and 40% teff flour blends obtained better acceptability when fermented for 60h compared to 48h and 72h.

Table 6: Interaction effect of blending ratio and fermentation time on sensory acceptability of QPM-teff composite injera.

Blending ratio (%)	Fermentation time (h)	Color	Taste	Texture	Rollability	Eye-distribution	Underneath	Overall acceptability
100:0	48	5.90±0.55[a]	5.47±0.78[a-d]	4.93±0.74[f]	4.57±0.77[d]	5.40±0.77[bcd]	5.20±0.92[bc]	5.37±0.76[abc]
100:0	60	5.87±0.73[a]	4.97±0.93[ef]	4.97±0.96[f]	4.63±1.69[d]	5.00±0.91[de]	5.03±0.89[bc]	4.97±0.72[de]
100:0	72	5.80±0.81[ab]	4.83±0.87[f]	5.13±0.86[ef]	4.73±0.87[d]	4.97±0.81[e]	5.00±0.79[c]	4.77±0.82[e]
80:20	48	5.73±0.52[ab]	5.20±0.81[b-f]	5.20±0.71[def]	4.93±0.83[cd]	5.10±0.84[cde]	5.03±1.03[bc]	5.23±0.86[bcd]
80:20	60	5.67±0.92[ab]	5.53±0.82[ab]	5.23±0.57[c-f]	4.93±0.74[cd]	5.50±0.97[abc]	5.23±0.90[bc]	5.37±0.81[abc]
80:20	72	5.67±0.99[ab]	4.97±0.72[ef]	5.30±0.65[c-f]	4.97±0.89[cd]	5.20±0.89[cde]	5.27±0.78[bc]	5.10±0.80[cde]
70:30	48	5.77±0.77[ab]	5.10±0.71[c-f]	5.37±0.76[b-e]	5.27±0.74[bc]	5.17±0.91[cde]	5.07±0.91[bc]	5.20±0.76[cd]
70:30	60	5.60±0.86[ab]	5.50±0.78[abc]	5.47±0.73[b-e]	5.47±0.82[b]	5.77±0.86[ab]	5.27±0.64[bc]	5.60±0.77[ab]
70:30	72	5.57±0.82[ab]	5.40±1.00[a-d]	5.53±0.63[bcd]	5.53±0.73[ab]	5.37±1.00[b-e]	5.43±0.68[ab]	5.27±0.69[bcd]
60:40	48	5.67±0.80[ab]	5.07±0.69[def]	5.60±0.67[abc]	5.53±0.63[ab]	5.23±0.86[cde]	5.10±1.09[bc]	5.07±0.74[cde]
60:40	60	5.57±0.73[ab]	5.73±0.78[a]	5.73±0.78[ab]	5.60±0.77[ab]	5.83±0.75[a]	5.30±0.75[bc]	5.70±0.70[a]
60:40	72	5.43±1.19[b]	5.33±0.80[a-e]	5.93±0.69[a]	5.93±0.69[a]	5.50±0.68[abc]	5.80±0.81[a]	5.37±0.56[abc]
CV (%)		14.37	15.15	13.81	17.18	15.68	16.31	14.41
LSD		0.42	0.40	0.38	0.45	0.43	0.43	0.38

QPM flour= 60%, 70%, 80%, and 100%, teff flour= 20%, 30%, and 40%

4. Conclusions

Quality protein maize is a nutritionally enhanced maize type and is important for people who depend on maize for their energy, protein, and other nutrient requirements. The study was conducted to improve injera quality prepared from quality protein maize through blending with teff flour and fermentation time. The study concluded that mixing 30% teff flour and 60hr fermentation time was recommended for preparing acceptable QPM-teff composite injera.

Acknowledgments
The authors are thankful to the staff of Pawe Agricultural Research Center and Melkassa Agricultural Research Center for their kind assistance.

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Figure 1. QPM-teff composite injera samples fermented for 4h

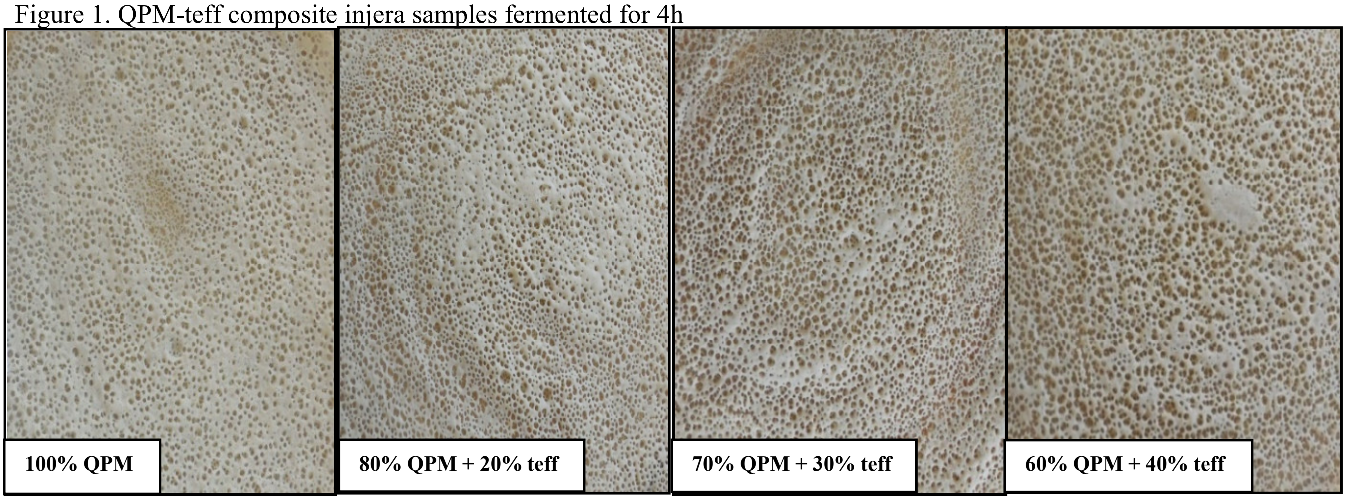

Figure 2. QPM-teff composite injera samples for 60h

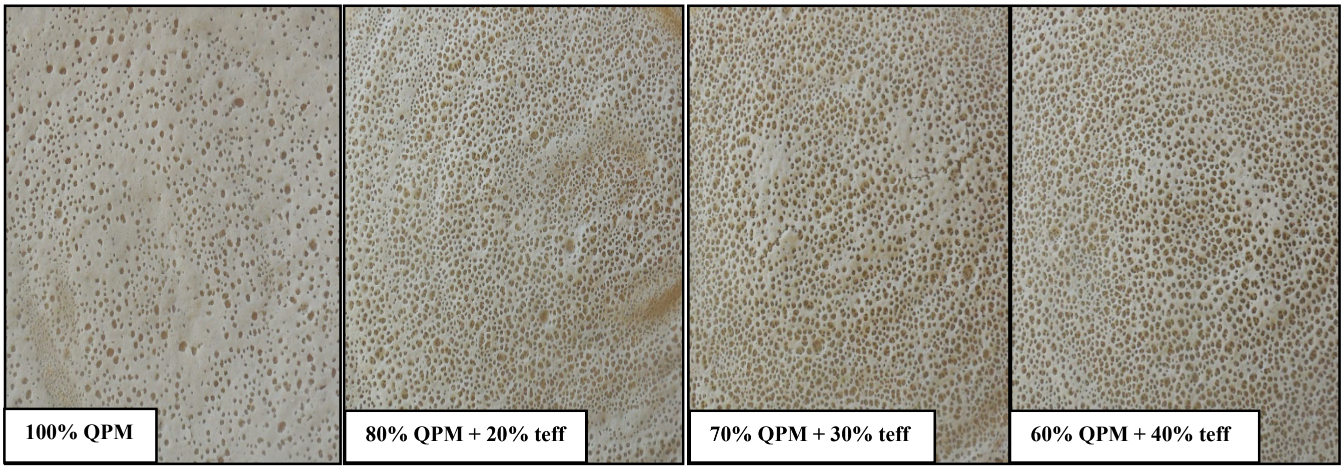

Figure 3. QPM-teff composite injera samples for 72h