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Evaluation of Nutritional Content of Teff Varieties Grown in Oromia, Ethiopia

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Abstract

Teff is among the staple cereal crops mostly produced and the daily consumption of Ethiopians is majorly dependent on Injera. Teff has the lion's share of injera preparation, which might be due to nutritional qualities, shelf life merit and consumers' preference for the product. This study aimed to evaluate the proximate and minerals content of fifteen teff varieties which were new and currently used in production in Oromia Region, Ethiopia. The proximate and mineral content of these varieties were analyzed by using AOAC Official methods. The result showed that the mean content of moisture, ash, crude protein, crude fat, carbohydrate and energy was 9.28%, 2.92%, 9.34%, 3.06%, 75.39% and 366.56kCal respectively. While, iron, calcium, sodium, potassium, manganese and zinc mean contents were determined 548.79ppm, 1552.64ppm, 539.45ppm, 4614.08ppm, 122.79ppm and 31.67ppm respectively. The study revealed that there were significant differences ($p \leq 0.05$) among proximate and minerals content in fifteen teff varieties which could be attributed to differences in varieties. Felagot teff variety had superior protein, fat, calcium, iron and zinc contents. Teff could be a good source of protein, calcium, iron and zinc which are limited in other cereals. Proximate and mineral contents could be affected by variety and environment. Therefore, further research needs to be conducted on the effect of the environment on proximate and mineral compositions.

Keywords: Teff; Variety; Proximate; Minerals;

Introduction

Teff (Eragrostis tef) is among the staple cereal crops mostly produced and consumed in Ethiopia. It is also used as animal feed in other countries. During the 2019/2020 cropping season, cereals were produced on about 10,478,218.0 hectares of land and 296,726,476.9 quintals of yield were obtained in the country. From these, tef had 30% and 19% share for production area and yield, respectively (CSA, 2020). The daily consumption of Ethiopians is solely dependent on Injera and the lion's share of injera preparation might be due to nutritional qualities, shelf life merit and consumers' custom of the product.

There have been many reports that teff is a good source of protein, energy, fiber and minerals. Teff has an attractive nutritional profile, being high in dietary fiber, iron, calcium and carbohydrate and also has high levels of phosphorus, copper, aluminum, barium, and thiamine and excellent content of amino acids essential for humans [1,2]. Teff is a valuable source of minerals; in particular, Ca, Fe, Mn and Zn are present in larger amounts [3]. It is free of gluten [4] and can provide an alternative food source for people with celiac disease. The global use of teff for human consumption has been restrained partly due to limited knowledge about its nutritional values and the processing challenges faced in making teff-based food products [5].

The overall quality may be defined as the sum (or product) of individual properties that enable a plant or plant product to meet the requirements of a user or consumer. The overall quality depends on both physical and chemical plant properties. Plant quality is predominately controlled by genetic and physiological factors. This becomes obvious in a comparison of species, cultivars, plant organs and tissues. In Ethiopia; Regional and National Agricultural Research Institute are adopting/adapting and verifying national and international varieties as to their significance to agro-ecology basis. Accordingly, more than 40 teff varieties were in Ethiopia of which 4 varieties such as Dursi, Guduru, Jitu and Kena were by Oromia Agricultural Research Institute (Bako Agricultural Research Center). However, the physico-chemical food quality characteristics of these teff varieties are not well studied yet. Therefore, this study was initiated to evaluate the nutritional content of teff varieties grown in Oromia, Ethiopia.

Materials and Methods

Samples Collection and Study Sites

Fifteen (15) teff varieties (Figure 1) were collected from Bako Agricultural Research Center and Debra Zeit Agricultural Research Center during the 2019/2020 cropping season. All proximate and mineral analyses were conducted at Food Science Laboratory of Oromia Agricultural Research Institute.

Figure 1: List of teff varieties used in this study.

Sample Preparations for Analysis

All samples were sorted, cleaned, milled and stored at room temperature until analysis.

Proximate and Minerals Analysis

Moisture, crude ash and crude protein were determined by Using AOAC Official Methods 2000 while, fat and minerals contents were analyzed by using AOAC Official Method 2003.05 and 975.03 respectively. Carbohydrate was determined by difference and Energy was calculated using the Atwater factor. All determinations were done in triplicate.

Data Analysis

Means and standard deviations were calculated for all proximate and minerals data. ANOVA subjected to SAS software version 9.00.

Results and Discussions

Proximate content

The results of proximate (moisture, ash, protein, fat and carbohydrate) and energy content determined for fifteen teff varieties were listed in terms of mean value and standard deviation on the dry weight as shown in Table 1. The grand mean of moisture, crude ash, crude protein, crude fat, carbohydrate and energy quantified were 9.28±0.14 %, 2.92±0.05%, 9.34±0.41%, 3.06±0.05%, 75.39±0.46% and 366.56±0.71kcal, respectively and the result revealed that there was a significant difference ($P<0.05$) among the teff varieties. The obtained value of carbohydrate, fat, ash, protein and moisture were acceptable with Ethiopia's standard requirements as teff quality which were 63%, 2% - 6%, 3% - 4%, 8% and max 12.5% respectively [6]. The proximate and energy value of this study compared with some cereals generated by the United States Department of Agriculture [7] as illustrated in Figures 2-4.

Crude Protein Content

The mean crude protein content of teff varieties ranged from 6.48% to 11.35%. The last and highest crude protein was obtained from Guduru and Tseday varieties, respectively. There was no significant difference among Boset, Felagot, Jiru, Simada and Tseday teff varieties. Kamila(2018), Bekabil (2011) and Yılmaz

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[5] reported that teff protein content ranges from 8.9% - 10.5%, 8 - 11%, and 10.5 -11.1%, respectively. USDA reported up to 13.3 % with typical value of 11 % protein content. Bultosa [8] also reported the protein content of 13 teff varieties that ranged from 8.7% - 11.1% with a mean of 10.4%. Even though the maximum protein value was in agreement with these scholars; the lower value of protein was obtained in this study (6.48 %).

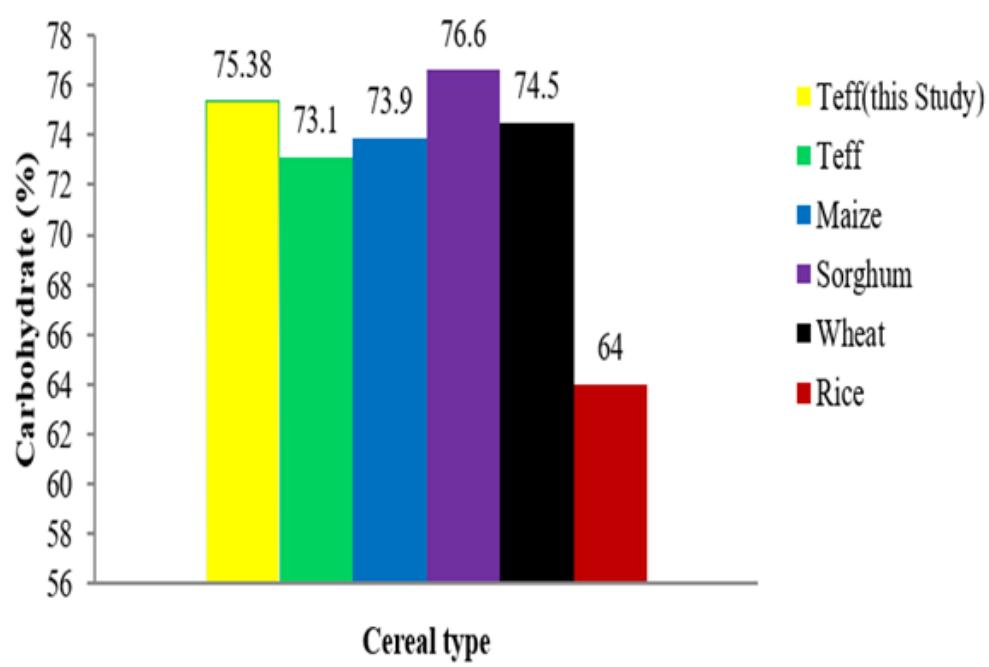

Figure 2: Comparison of carbohydrate content of some cereal with teff.

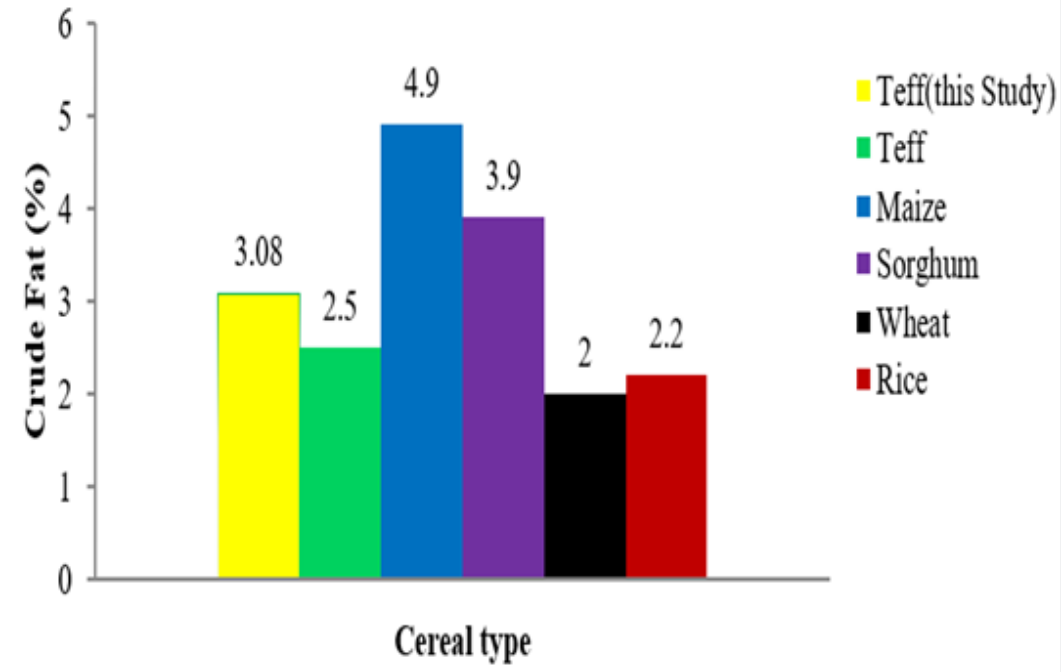

Figure 3: Comparison of crude fat content of some cereal with teff.

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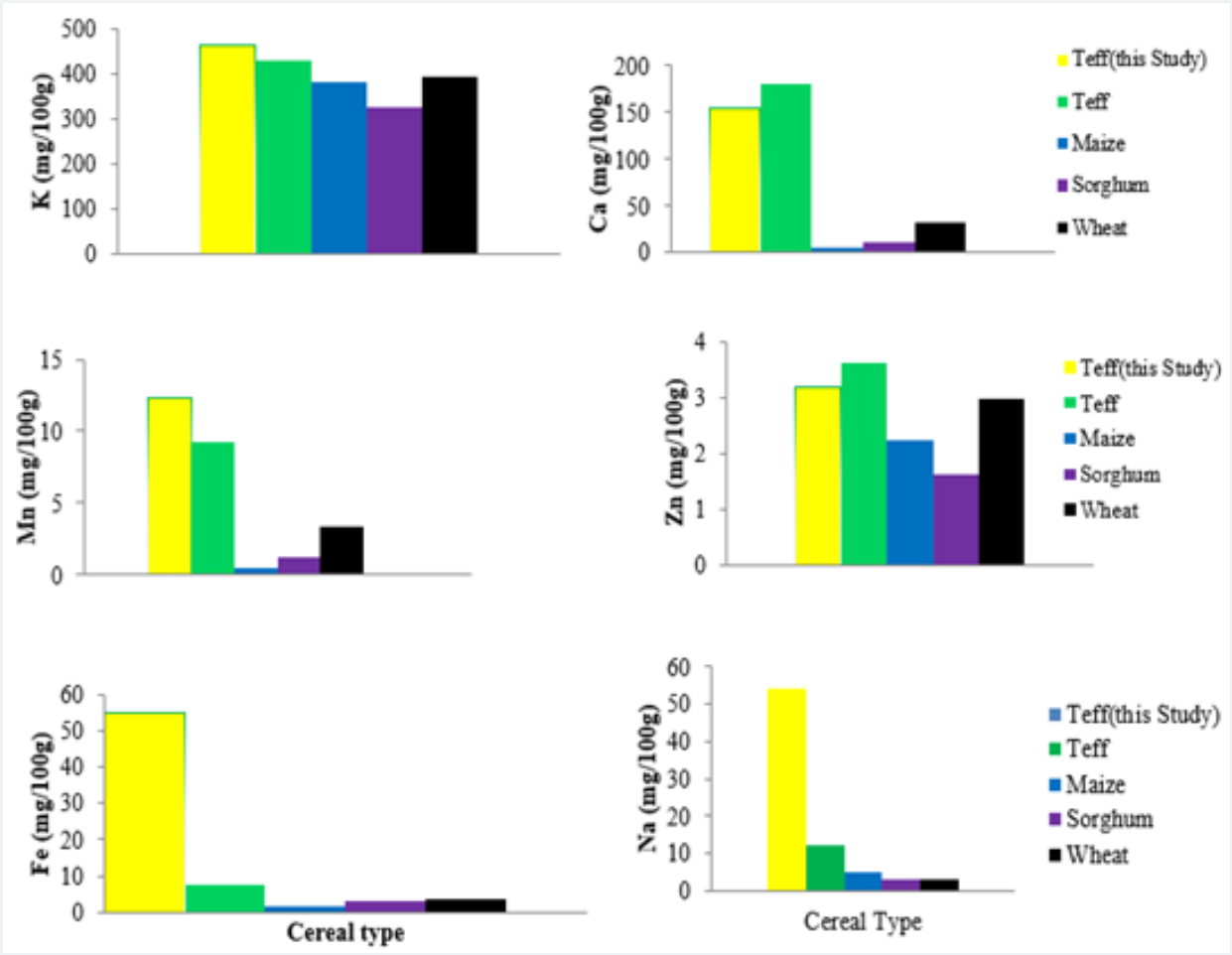

Figure 4: Comparison of K, Ca, Mn, Zn, Fe and Na content of some cereal with teff.

Moisture Content

The moisture content of teff varieties ranged from 7.63±0.12% to 12.17±0.16% with a mean value of 9.28±0.14%, which is in the normal range for field-dried teff grain.

Carbohydrate Content

Teff varieties had a mean value of 75.39% carbohydrate and it ranged from 70.90% to 79.32%. The smallest and highest values were obtained from the Felagot and Dagim varieties respectively. There was no significant difference between Dagim and Tesfa varieties. The total carbohydrate content of teff ranges from 57 to 86g/100g [8]. Various Studies have reported that the content of teff carbohydrates produced in different ecologies can change the values. In this study, the teff had higher carbohydrate content than maize, wheat and rice as shown in Figure 2 & (Table 1) [7].

Crude Fat Content

Tested teff varieties had crude fat content ranging from 2.66±0.00 % to 3.43±0.01% with the minimum and maximum values obtained from Simada and Guduru varieties, respectively. There was no significant difference among Dursi, Felagot, Jitu and Guduru varieties. Thirteen teff varieties had crude fat ranged 2.0-3.0% with a mean of 2.3% and the value is similar to the review report of 2.00 -3.09% of previous works (Bultosa, 2004) [8]. Teff lipid content is higher than wheat and rice, but lower than maize and sorghum as shown on Figure 3 [7].

Mineral Content

The concentration of mineral in all studied teff varieties is presented in Table 2 and results are in terms of mean value and standard deviation on dry weight. The result revealed that there were a significant difference ($P<0.05$) among the teff varieties. The difference in mineral content among teff varieties was wide-ranging from the highest and least order of mineral were K > Ca > Fe > Na > Mn >Zn with grand mean values of 4614.08 mg/kg, 1552.64mg/kg, 548.79mg/kg, 539.45mg/kg, 122.79 mg/kg and 31.67mg/kg respectively. The concentration of K was the highest of all the analyzed minerals and ranged from 4190.45-5064.97mg/kg and the least was obtained for Zn that ranged from 17.43 - 48.93 mg/kg.

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Table 1: Proximate and Energy Content of Teff Variety.

SN	Teff Varieties	Proximate and Energy Content of Teff Varieties on the dry weight					
		Moisture (%)	Ash (%)	Crude Protein (%)	Crude Fat (%)	Carbohydrate (%)	Energy (Cal)
1	Bora	10.58±0.05c	1.66±0.81g	9.62±0.23b	2.85±0.04dc	75.79±0.34d	369.58±0.88d
2	Boset	10.30±0.17d	2.84±0.01e	11.07±0.73a	2.94±0.06c	72.85±0.52h	362.11±0.45h
3	Dagim	7.30±0.16k	2.95±0.01ed	7.31±0.75d	3.12±0.02b	79.32±0.81a	374.43±0.76a
4	Dursi	9.48±0.07f	3.67±0.01b	7.27±0.46d	3.35±0.22a	76.15±0.66c	364.14±1.42g
5	Eba	8.05±0.31i	2.49±0.03f	8.92±1.20cb	2.77±0.03de	77.76±0.91bc	371.50±1.33c
6	Felagot	9.89±0.21e	4.57±0.02a	11.22±0.66a	3.42±0.02a	70.90±0.88i	359.23±0.74i
7	Guduru	12.17±0.16a	3.59±0.01b	6.48±0.57d	3.42±0.09a	74.29±0.74gf	354.05±0.97j
8	Jitu	8.53±0.04h	3.24±0.07c	11.17±0.04a	3.32±0.01bc	73.74±0.08g	369.48±0.41d
9	Kena	11.27±0.19b	3.13±0.02c	6.81±0.16d	3.43±0.01a	75.37±0.29dc	359.56±0.74i
10	Kora	8.03±0.20i	2.46±0.02f	8.74±0.21c	3.13±0.01e	77.65±0.35c	372.84±0.68bc
11	Kuncho	9.13±0.17g	3.22±0.02c	11.12±0.28a	3.08±0.03b	73.45±0.29gh	366.01±0.61f
12	Nigus	7.63±0.12j	2.49±0.12f	10.85±0.08a	2.83±0.06dc	76.20±0.22d	373.70±0.76ba
13	Simada	8.34±0.10h	3.00±0.02d	11.19±0.31a	2.66±0.00e	74.81±0.33de	367.92±0.45e
14	Tesfa	8.98±0.06g	2.49±0.11f	6.97±0.36d	2.94±0.07c	78.62±0.35ba	368.83±0.17ed
15	Tseday	9.51±0.02f	2.57±0.03f	11.35±0.15a	2.67±0.03e	73.90±0.17g	365.06±0.28gf
Grand Mean		9.28±0.14	2.92±0.05	9.34±0.41	3.06±0.05	75.39±0.46	366.56±0.71
CV		1.7	2.44	5.49	2.42	0.69	0.22
LSD(α=0.05)		0.26***	0.12***	0.86***	0.12***	0.87***	1.35***

Values within the same column with different letters are significantly different ($p < 0.05$).
Where, CV= Coefficient of variation, LSD: List significant difference, ***: Highly significant and Cal= Calorie.

Felagot variety had the highest Ca composition (1861.80±30.80ppm) while the least value was obtained from Jitu (1328.48±81.57ppm). The concentration of Ca (1206.9 - 1769.5 mg/kg) in this study agrees with the range of the value 124 - 155 mg/100 g, 168.64 ± 11.03 to 180.7 ± 14.65 mg/100 g and 1800 mg/kg reported by Alemtsehay et al. [9], Ma et al. [10] lower USDA [7], respectively.

The mean mineral content of teff varieties was compared with some cereals that was generated by United States Department of Agriculture [7] as illustrated in Figure 4. As a result of this study; teff has a higher iron, calcium, manganese, zinc, potassium and sodium content than maize, wheat, sorghum and rice (Table 2).

Table 2: Minerals Content of Teff Varieties.

SN	Teff variety	Teff minerals content on the dry weight(mg/kg)					
		Fe	Ca	Na	K	Mn	Zn
1	Bora	174.50±2.27j	1551.15±42.17c	355.84±30.43g	5064.97±8.36a	92.53±2.94e	31.95±0.11cbd
2	Boset	448.36±21.55g	1824.01±57.08a	469.19±19.28f	4344.53±44.94hi	40.22±6.30i	31.02±5.75cd
3	Dagim	498.64±27.95f	1346.25±5.39hg	539.84±11.28ed	4836.46±19.57c	62.80±2.80h	28.40±1.38cd
4	Dursi	793.85±21.97b	1432.46±49.99fge	613.88±39.44b	4886.67±17.86c	257.86±9.02b	30.58±0.97cd
5	Eba	407.57±22.49h	1466.55±42.39dfce	676.58±30.61a	4759.60±23.56d	86.93±4.26fe	27.98±3.26cd
6	Felagot	1128.98±20.91a	1861.80±30.80a	586.13±3.66bcd	4308.79±40.59i	91.02±4.21e	48.93±2.01a
7	Guduru	745.42±34.05c	1381.35±0.34hfg	632.30±39.88a	4574.77±47.56e	307.93±5.57a	28.79±0.86cd
8	Jitu	1140.49±14.18a	1328.48±81.57h	593.19±41.69bc	4190.45±54.37j	207.55±6.50c	34.59±2.30cb
9	Kena	625.19±39.82e	1460.63±4786def	359.11±61.63g	4713.68±45.82d	263.02±4.06b	26.32±0.42d
10	Kora	182.63±17.80j	1510.31±38.93dce	585.25±8.38bcd	4981.92±28.47b	74.16±3.18g	29.90±6.56cd
11	Kuncho	644.05±8.92d	1672.41±7142b	561.26±4.83ecd	4510.96±19.53f	82.83±4.56f	32.86±0.95cbd

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12	Nigus	432.13±23.98hg	1528.61±65.56dc	633.72±47.47a	4389.34±59.43hg	89.82±2.72fe	39.26±13.84b
13	Simada	516.19±14.94f	1826.37±37.97a	534.99±37.75e	4404.02±13.86g	15.98±0.75j	31.42±1.83cd
14	Tesfa	157.99±25.55j	1682.43±86.05b	523.88±16.92e	4880.92±11.61c	157.55±1.38d	17.43±2.77e
15	Tseday	294.74±26.74i	1416.82±4.01fg	426.51±11.38f	4364.22±18.53hgi	4.19±4.70k	35.66±1.41cb
Grand Mean		548.79±21.54	1552.64±44.13	539.45±24.98	4614.08±30.27	122.79±4.20	31.67±2.96
CV		4.32	3.34	5.45	0.76	3.73	14.56
LSD		39.67***	86.73***	49.13***	58.65***	7.65***	7.71***

Values within the same column with different letters are significantly different ($p < 0.05$).
Where; CV= Coefficient of variation, LSD: List significant difference, ***: Highly significant and Cal= Calorie.

Conclusion and Recommendations

In this study, 15 teff varieties were collected and their nutrient contents were evaluated. Significant differences were observed in proximate and mineral content among the teff varieties. From the evaluated teff varieties; Felagot teff variety had superior protein, fat, calcium, and iron and zinc contents`. Teff could be good source of protein, calcium, iron and zinc which are limited in other cereals. Proximate and mineral contents could be affected by variety and environment [11-16]. Therefore, further research on the effect of environment on proximate and mineral composition needs to be conducted.

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