Food Science and Quality Management www.iiste.org
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.68, 2017

Effect of Blending Ratio on Proximate Composition, Physico-Chemical Property, and Sensory Acceptability of Injera Produced from Red Tef (Eragrostis tef) and Cassava (Manihot esculenta)

Beruk Berhanu Desalegn[1*] Fasil Tarekegn Desta[1,2]
1. School of Nutrition, Food Science and Technology, Hawassa University, Ethiopia
2. Quality Manager, Global Inspection Survey Agency, Addis Ababa, Ethiopia

Abstract
Injera is a staple food for Ethiopian communities. It is fermented, sour leavened pancake-like bread made from crops like teff (Eragrostis tef), wheat, barley, sorghum or maize or a combination of some of these cereals. Since a few years, injera has been made from teff and cassava blends in low income families and prepared for commercial purpose in southern Ethiopia. The crops which have been used for producing injera depend on availability on the farm or market, abundance of the crops and the prices. Injera produced from teff alone is believed to be superior, especially from white one by most of Ethiopian people due to its white color. The productivity of teff per hectare is lower than other cereals like wheat, barley, sorghum or maize and the increasing in domestic and foreign market demand related with ever inflating price due to its higher fiber content and free of gluten which is related with treatment of diabetes and assisting with blood sugar control and alternative grain for persons with gluten sensitivity problem. Due to increasing price of injera from white has shifted families with low income and those who are home based injera producers to using red teff which is the lowest in terms of price. This shift emerges the blending of red teff with crops which give white color for the injera that is considered as superior and has lower price. The objective of this study was to see the effect of blending ratio on physico-chemical, functional properties, sensory acceptability and proximate composition of injera produced from red teff and cassava flours. Data for physico-chemical and sensory evaluation were analyzed using one way analysis of variance (ANOVA)to see the effects of the blending proportions. Data were analyzed by SAS (version 9.1) and chemical analyses were done using standard methods. Incorporating cassava on teff up to 30% significantly reduced the amount of all macro/nutrients except total carbohydrate. Except color, all the other sensory attributes were significantly ($p<0.05$) affected due to increased cassava flour on the composite injera flour. all the injera prepared from the cassava: teff up to 70:30 were above the average score (3.5) in all acceptability test. Increasing the amount of cassava on the teff: cassava composite flour improved the water absorption capacity. As conclusion, injera can be produced by mixing with up to 30% cassava were found acceptable by consumers.
Keywords: Injera, red teff, cassava, blending

1. Introduction

Injera is a national food of Ethiopians (Chavan and kadam, 1999). It is fermented, soft porous, sour leavened thin pancake-like bread and, honey comb like appearance made from crops like *teff* (*Eragrostis tef*), wheat, barley, sorghum or maize or a combination of some of these cereals (Ashenafi, 2006). Injera from Ethiopia and Eritrea is a large (approx. 50cm diameter) made from flour, water and starter *ersho* (Yigzaw Y*, et.al*, 2001). People who are living on the highlands prepare injera from barley, and wheat, whereas those on the lowlands prepare it from maize, sorghum or finger millet. Even though, *teff* injera is the main staple food in much of the central and northern highlands of Ethiopia, it is the most common staple and considered superior both in urban and rural communities throughout the country (Ashenafi, 2006). *Teff* is a cereal crop widely cultivated in Ethiopia while the agricultural productivity of *teff* per hectare is lower than other cereals like wheat, barley, sorghum. According to CSA (2008), *teff* is third (after maize and wheat) in terms of grain production (18.57%, 29.9 million quintals) in Ethiopia. Beside this, white injera prepared from white *teff* is considered the most nutritious and quality, which mainly prepared from white teff. According to Belay et al., (2006), Ethiopian farmers indicated white teff was more preferred than darker colored varieties.

Currently, domestic and foreign market demand for teff are increasing in price due to its nutritional and health benefit due to higher fiber and free of gluten content for its ability to prevent non-infectious diseases like cardiovascular diseases and an alternative grain for persons with gluten sensitivity problem (celiac disease). As a result, the low income families shifted their preparation of injera from white *teff* to red *teff* which is the lower in terms of price. This shift emerges increasing in blending ratio of red *teff* with other crops like cassava which gives a white color to injera and the product also low in price which is reasonable. Cassava (Manihot esculenta) is a staple food for an estimated 500 million people in the tropics. It is widely grown in tropical regions of Africa, Latin America and Asia. Cassava is grown over a range of climates, altitudes and on a wide variety of soils.

Cassava is tolerant to drought and is productive in poor soil where other staple crops cannot grow (Bradbury and Holloway, 1988). The crop is an important source of carbohydrate for humans and animals, having higher energy than other root crops, 610 kJ/100 g fresh weight. Dried cassava root has energy similar to the cereals (Bradbury and Holloway, 1988). However, cassava has low protein content, highly perishable after it is harvested; contain higher amount of cyanogenic glucosides and other toxins (Nweke *et al*., 2002). Additionally, the small scale producers of injera has been started producing injera from teff and cassava for maximizing their profit getting from the conventional teff injera. In this case, it is important to address the optimal level of blending ratio of cassava and *teff* for preparation of quality injera. Therefore, the objective of this study was to see the effect blending ratio on proximate composition, physico-chemical properties, functional properties and sensory acceptability of injera produced from *teff* and cassava flours.

2. Materials and Methods

2.1. Sample collection and preparation

Both of the raw materials, red *teff* (*Eragrostis teff*) and cassava (Manihot esculenta Crantz), were obtained from Hawassa Agricultural Research Center (HARC), Sothern Ethiopia, and transported to School of Nutrition, Food Science and Technology laboratory, Hawassa University using tighten sack. *Teff* was separately dry cleaned from foreign materials (stones, dusts, broken and under sized immature kernels). *Teff* grains was screened through *wonfit* (weaven grass basket with mesh at the underneath), sun dried, milled into flour, sieved with mesh size of 1mm (Endecotts Ltd., London, England) and packed in airtight polythene bags and stored at dry place until the flour was required for *injera* making. Cassava was also processed into cassava flour using the standard method reported by IITA/UNICEF (1990) with minor modifications. After harvesting, it was processed immediately within a day on arrival at laboratory. The roots were sorted and washed with tap water to remove soil and then peeled manually with knife, sliced into chips by slicer machine. The sliced cassava chips were soaked in water for 24 hours to detoxify. The chips were dried by sun for 72 hours and oven at $60^{o}{}_{C}$ for 24 hours respectively. The dried chips were finely milled into flour using commercial mill and the resulting flour was sieved to pass through 250 µm aperture (Girma, et., al 2015) then packed in polyethylene plastic bags and finally stored at room temperature until required for the experiment.

2.2. Injera preparation

Injera prepared from different proportions of red teff: cassava blended were prepared following the procedures described by Bultosa and Taylor (2004) with minor modifications. The flours of *teff* and cassava were mixed uniformly with the proportions of 100:0, 90:10, 80:20 and 70:30, respectively. Then composite flours (200g) were again mixed with water (180ml) or (111%w/v) and thoroughly kneaded. Then ersho (starter culture) was also added and the batter was left to be fermented for about 72hrs. After fermentation, the surface supernatant formed on the top of the dough was discarded and 10% of the sediment was mixed with water (1:3) and cooked for 2-3 minutes for the purpose of gelatinization (cooking) primarily to improve the cohesiveness of the batter and to provide readily fermentable carbohydrates for the microbes. This batter enhancer (also called *absit*) was cooled to room temperature and it was added back to the fermenting batter. After fermentation for 0.5–1 hour, bubbles were formed which was an indicator of endpoint. Then, more water was added to the fermented batter to get uniform consistency. Approximately, 500g of the fermented batter was poured on a circular manner on a 50cm diameter hot clay griddle, covered, and baked for 3-4 minutes.

2.3. Laboratory analysis

The pH, TTA, bulk density and water absorption capacity were conducted at School of Nutrition, Food Science and Technology laboratory of Hawassa University; whereas the proximate composition analyses were carried out at Ethiopian Conformity Assessment Agency. The pH of the batter samples was determined by mixing 10g of the samples with 25 ml of distilled water, stirring thoroughly and measured with a pH meter at 20°C (AOAC, 2000). Titreable acid of the samples was determined by taking 10gm of each batter sample and diluting with 50 ml distilled water separately for three times at 12 hrs interval. From each treatment dilution 25ml sample was taken and titrated with 0.1 M NaOH standard solution by using phenolphthalein as an indicator. The result was obtained by percentage of the lactic acid produced (AOAC, 2000). For water absorption capacity, about 1 g of the flour was mixed with 10 ml of distilled water (density of 1 g/cm^3) in a centrifuge tube and allowed to stand at room temperature for 1 hr and centrifuged at 200 rpm for 30 min and the supernatant then noted in a 10 ml graduated cylinder. Water absorption capacity was then calculated as ml of water absorbed per gram of the flour (Beruk et al., 2015). Proximate compositions like moisture content, crude protein, crude fat and total ash were analyzed using standard method (AOAC, 2000).

2.4. Sensory quality evaluation

Injera prepared from blends of *teff* and cassava flours were evaluated for various sensory attributes (visual color, appearance, flavor, crispiness and overall acceptability) and sensory evaluations were conducted after injera were prepared at a temperature between 40^{o}c and 60^{o}c using 7-point hedonic scales. Thirty panelists who previously took sensory evaluation course were selected from the College of Agriculture students at Hawassa University who usually consuming injera and also cassava products before.

2.5. Experimental design and data analysis

The blending ratio had four levels as 90:10, 80:20 and 70:30 of *teff*: cassava flours, respectively and 100% teff as a control. All the blending ratio were prepared in duplicate and injera were prepared accordingly. The data were analyzed using the analysis of variance (ANOVA) at 95% level of confidence with SAS 9.1 version. For the components revealing significant ANOVA, mean separation was carried out using Fischer's least significant difference (LSD).

3. Results and Discussion

Moisture contents of composite flours and injera prepared in this study were significantly (p<0.05) different from each other (table1 and 2). As the amount of cassava incorporated in the composite flour increased, the moisture contents were decreased. This result was supported by previous study conducted on the six cassava varieties, which indicated the amount of moisture content on dried cassava was lower than teff (Emmanuel *et al.*, 2012). However, the amount of moisture in the injera were increasing while the amount of cassava incorporated in the injera increased (table 2). This may be due to high moisture absorption capacity of cassava as compared to *teff* (table 4). The moisture content of 100% teff flour in this study was lower than reported by Sadik *et al*. (2013), but the four composite flours prepared in this study had comparable with the report by Bultosa and Taylor (2004).

Table 1: Effect of blending ratio on proximate composition of teff: cassava composite flour

Treatment	Moisture content (%)	Total Carbohydrate (%)	Crude protein (%)	Crude fat (%)	Total ash (%)	Crude fiber (%)
A	10.5±0.1a	79.95±0.75b	10.76±0.68a	2.47±0.42a	3.11±0.15 a	3.71±0.15a
B	10.25±0.11b	81.0±0.72c	9.82±0.61b	2.373±0.41c	3.06±0.14b	3.59±0.14b
C	10.02±0.13c	82.2±0.65ab	9.05±0.14ab	2.28±0.4b	3.04±0.15ab	3.46±0.13c
D	9.75±0.14bc	83.2±0.6a	8.19±0.48c	2.18±0.38bc	2.99±0.16c	3.35±0.13bc

NB: Results are presented as mean ± SD of duplicate analysis in dry basis, except for moisture which is in wet basis, A= Control sample (100% *teff* flour), B= 90:10 *teff*:cassava composite flour, C= 80:20 *teff*:cassava composite flour, D= 70:30 *teff*:cassava composite flour

The carbohydrate content of the 70:30 *teff*-cassava composite flour and injera exhibited significantly highest (P<0.05) than the rest three composite flours prepared in this study (table 1). This could be due to cassava has higher carbohydrate than teff's. On the contrary, crude protein, ash and fat were decreasing while the amount of teff in the composite flour and injera were decreasing. This could be also due to higher amount of protein, mineral and fat contained in teff flour. This result is in line with findings by Bultosa (2007) and Charles *et al.* (2004). However, the amount of crude fat presented in the composite flours presented in this study was higher than repoted by Koko et al., (2014) on different cassava varieties flour. Similarly, the amount of crude fiber was decreasing while the amount of teff contained in the composite flour and injera were decreasing. This could be due to the less content of fiber in cassava flour (Teka et al., 2013), particle size of teff was smaller than cassava and some fibers left due to inappropriate sieving before milling the teff grains.

Table 2: Effect of blending ratio on proximate composition of teff: cassava composite injera

Treatment	Moisture content (%)	Total Carbohydrate (%)	Crude protein (%)	Crude fat (%)	Total ash (%)	Crude fiber (%)
A	57.7±0.92d	81.5±0.76d	10.49±0.9a	2.2±80.08a	3.07±0.16a	2.66±0.1a
B	61.46±0.87c	83.38±0.41c	9.48±0.26b	1.88±0.03b	2.94±0.06b	2.32±0.06b
C	63.09±0.57b	84.87±0.32b	8.55±0.11bc	1.75±0.01c	2.75±0.15c	2.08±0.06c
D	64.82±0.81a	86.8±0.18a	7.47±0.19c	1.67±0.07d	2.5±0.1d	1.57±0.16d

NB: Results are presented as mean ± SD of duplicate analysis in dry basis, except for moisture which is in wet basis, A= Control sample (100% *teff* injera), B= 90:10 *teff*:cassava composite injera, C= 80:20 *teff*:cassava composite injera, D= 70:30 *teff*:cassava composite injera

According to table 3, all of the sensory attributes considered in the present study had significant difference (p<0.05) values due to differences in the blending proportion of composite flours used for injera evaluated, but all the injera prepared in the present study was accepted on the parameters above average using 7-hedonic scales sensory evaluation. As the amount of cassava flour increased in the composite flour injera prepared, the acceptance of color was increasing. This could be the whitish nature of cassava flour than teff's. Texture is an important parameter often used to measure the quality of *injera*. Acceptable texture of the injera prepared from teff: cassava composite flours in this study were decreasing as the amount of teff in the composite flour was decreasing. This could be related with the gelatinization capacity of the cassava was lower which leads to decreasing the roll ability of injera (table 3). Likewise, the taste, sourness, roll ability, injera eyes and overall acceptability were decreasing while the amount of cassava incorporated increased from 0% to 30% (table 3).

Table 3: Effect of blending ratio on sensory acceptability of *teff*:cassava composite fresh injera

Treatment	Color	Texture	Taste	Sourness	Roll ability	Injera eyes	Over all acceptability
A	4.41±0.02[d]	6.34±0.05[a]	6.13±0.02a	5.67±0.02[b]	6.45±0.04[a]	6.33±0.02[a]	6.22±0.03a
B	5.34±0.02[c]	5.94±0.02[b]	5.61±0.02[b]	5.21+±0.16[d]	6.21±0.02[b]	6.02±0.1[b]	5.55±0.08b
C	5.54±0.02[b]	5.62±0.02[c]	5.54±0.02[c]	5.31±0.12[c]	5.87±0.06[c]	5.81±0.02[c]	5.53±0.04c
D	5.93±0.02[a]	5.13±0.01[d]	4.74±0.01[d]	5.72±0.2[a]	5.81±0.02[d]	4.74±0.02[d]	5.33±0.03d

NB: Results are presented as mean ± SD of acceptability study. A= Control sample (100% *teff* injera), B= 90:10 *teff*:cassava composite injera, C= 80:20 *teff*:cassava composite injera, D= 70:30 *teff*:cassava composite injera

The functional properties determine the application and use of food material for various food products (Beruk et al., 2015). In this study we assessed bulk density and absorption capacity of the composite flours. According to table 4, the bulk density of the composite flour was decreasing while the amount of cassava incorporated increased; however, the decrement was not significant ($p<0.05$). therefore, there is no special container needed for the composite flour with high content of cassava from teff alone. The water absorption of composite flour was increasing while the amount of cassava increased in the composite flour. This indicates the economic importance of producing more injera from the high cassava containing composite flour than the teff flour alone for small scale injera sellers.

Table 4: Effect of blending ratio on the functional properties of *teff*:cassava composite flour

Treatment	Bulk density (BD)	Water absorbing capacity (WAC)
A	0.73±0.01a	1.55±0.01b
B	0.73±0.01a	1.70±0.14b
C	0.72±0.01a	2.00±0.14b
D	0.71±0.01a	2.50±0.28a

Legend: Results are presented as mean ± SD. A= Control sample (100% *teff* flour), B= 90:10 *teff*:cassava composite flour, C= 80:20 *teff*:cassava composite flour, D= 70:30 *teff*:cassava composite flour

The pH and titratable acidity give an indication of the sourness of a food product. In the present study, the titreable acidity and pH of the batter for injera produced from the composite flours at different proportions were not significant ($p<0.05$) from each other. This result is also supported by sensory evaluation result conducted on the same injeras from the batter (table 3).

Table 5: Effect of blending ratio on the physico-chemical properties of *teff*-cassava composite batter

Treatment	pH	TTA (%Lactic acid)
A	4.05±0.01[a]	0.50±0.01[a]
B	4.04±0.00[a]	0.48±0.01[a]
C	4.07±0.01[a]	0.49±0.01[a]
D	4.10±0.01[a]	0.49±0.01[a]

NB: Results are presented as mean ± SD. A= Control sample (100% *teff* batter), B= 90:10 *teff*:cassava composite batter, C= 80:20 *teff*:cassava composite batter, D= 70:30 *teff*:cassava composite batter

4. Conclusions and Recommendations

This study showed that incorporating cassava on teff up to 30% significantly reduced the amount of all macro/nutrients except total carbohydrate. Beside this, it reduced the moisture contents of both the flour and injera and caused stalling injera. Except color, all the other sensory attributes were significantly ($p<0.05$) affected due to increased cassava flour on the composite injera flour. However, all the injera prepared from the cassava: teff up to 70:30 were above the average score (3.5) in all acceptability test. Increasing the amount of cassava on the teff: cassava composite flour improved the water absorption capacity and can increase the number of injera to be produced than teff flour. As recommendation, improving the acceptability of cassava based injera using different processing techniques and studying further on the micro-nutrients and shelf life not included in this research with further improving the macro-nutrients should be the inevitable activity.

5. References

AOAC (Association of Official Analytical Chemists), (2000). Official methods of Analysis of AOAC International, 17th edition, Vol. II. Washington, DC, USA.

Ashenafi Mogessie. (2006). A review on the microbiology of indigenous fermented foods and beverages of Ethiopia, *Ethiop. J Biol. Sci.,* 5: 189-245.

Beruk, BD., Abegaz, K. and Kinfe, E. (2015). Effect of Blending Ratio and Processing Technique on

Physicochemical Composition, Functional Properties and Sensory Acceptability of Quality Protein Maize (QPM) Based Complementary Food. International Journal of Food Science and Nutrition Engineering, 5(3): 121-129.

Belay, G. Teffera, H., Tadesse, B., Metaferia, G., Jarra D. and Tadesse, T. (2006). "Participatory Variety Selection in the Ethiopian Cereal *Teff* (*Eragrostis tef*)". *Experimental Agriculture*, 42: 91–101.doi:10.1017/S0014479705003108.

Bradbury, JH. and Holloway, WD. (1988). Chemistry of tropical root crops: significance for nutrition and agriculture in pacific. ACIAR Monograph No 6.

Bultosa, G. And Taylor, JRN. 2004. Teff. In: Encyclopedia of Grain Science, Vol. 3(edited by C. Wrigley, H. Corke & C.E. Walker). Pp. 281–290. Oxford, UK: Elsevier Ltd.

Central Statistical Agency of Ethiopia. Agricultural Sample Survey: Report on Area and Production of Crops. Addis Ababa, Ethiopia. 2008.

Charles, AL., Chang, YH., Wen-Ching, K., Huangn TT. (2004). Some physical and chemical properties of starch isolates of cassava genotypes. Starch starke, 56:413-418.

Chavan, JK., and Kadam, SS. (1989). Critical reviews in food science and nutrition. Food Science, 28:348–400.

Emmanuel, OA., Clement, A., Agnes, SB., Chiwona-Karltun, L. and Drinah, BN. (2012). Chemical composition and cyanogenic potential of traditional and high yielding CMD resistant cassava (Manihot esculenta Crantz) varieties. International Food Research Journal, 19(1): 175-181.

Girma, G., Bultosa, G. and Solomon, A. (2015). Effect of Cassava (*Manihot esculenta* Crantz) variety, drying process and blending ratio on the proximate composition and sensory properties of Cassava- *Wheat composite bread Direct Research Journal of Agriculture and Food Science (DRJAFS), .3(2):38-47*

IITA/UNICEF (1990). Cassava in tropical Africa: A reference manual. p. 176.

Koko, CA., Benjamin KK., Lorougnon, G., Georges NA., Emmanuel Na. and Felix Hb. (2014). Comparative Study On Physicochemical Characteristics Of Cassava Roots From Three Local Cultivars In Côte D'ivoire. European Scientific Journal, 10 (33):418-432.

Nweke, F., Spencer, D., & Lynam, J. (2002). *The Cassava Transformation: Africa's Best-Kept Secret*. Michigan State University Press. Retrieved from http://www.jstor.org/stable/10.14321/j.ctt7ztc0t

Sadik, JA., Demelash, B. and Gizaw, M. (2013). Hydration kinetics of teff grain. Agric Eng Int: CIGR Journal, 15(1):124-130.

Teka, TA., Shimelis, AE., Gulelat, DH. and Tilahun, BG. (2013). Effect of Processing On Physicochemical Composition and Anti-Nutritional Factors of Cassava (Manihot Esculenta Crantz) Grown in Ethiopia. IJSID, 3(2):212-222.

Yigzaw, Y., Gorton, L., Akalu, G. and Solomon, T. (2001). Fermentation of *teff (Eragrostis teff)*,grass-pea (*Lathyrus sativus*), and their mixtures: Aspects of nutrition and food safety. *Lathyrus Lathyrism Newsletter,*2.