Injera Making Quality Evaluation of Tef and Cassava Composite Flour

[1]Food Science and Nutrition Research, Jimma Agricultural Research Center, Ethiopian Institute of Agricultural Research, Ethiopia ; [2]Food Science and Nutrition Research, Ethiopian Institute of Agricultural Research, P.O.Box. 2003, Addis Ababa, Ethiopia;
*Corresponsing author's e-mail: misganabanti2013@gmail.com

Abstract

Tef is an indigenous Ethiopian cereal crop while cassava is a high carbohydrate-containing crop recently introduced to Ethiopia. Injera is the staple food to Ethiopians mostly prepared from tef as the main ingredient. This was a research done by partially substituting tef, relatively expensive flour, by cassava flour and evaluated its injera making quality. Tef and cassava flours were mixed in all possible ratios at 10% intervals. Functional properties, sensory evaluations and proximate compositions were estimated using standard methods. Except water absorption capacity, all other functional properties were significantly varied with changing proportion of tef and cassava flours. The sensory acceptability of tef-cassava injera was significantly decreased in all parameters with increasing proportion of cassava flour. Tef-cassava injera contained 7.59 to 9.41% moisture, 0.65 to 1.87% ash, 0.40 to 1.02% fat, 3.79 to 11.89% protein, 1.10 to 3.05% fiber, 75.73 to 83.54% carbohydrate and 349.45 to 364.45 energy/100g. As cassava flour substitution levels increase, most flour functional properties increased, whereas sensory characteristics and proximate composition parameters (protein, fat, ash and energy) decreased. It was concluded that up to 40% cassava could be incorporated with tef to make injera with slightly acceptable sensory quality and fair nutritional value.

Keywords: Tef, cassava, injera, sensory quality, functional property, proximate composition

Introduction

Injera, a fermented flatbread common in Ethiopian culture is mainly made from flour of grain tef (*Eragrostis tef* (Zucc.) This food product is popular in almost whole regions of Ethiopia though the level of consumption may differ to some extent from place to place. It is said to be a staple food in the central, western and northern parts of Ethiopia as well as among the urban community (Yassin and Getu, 2019). Though tef is the mainly preferred cereals for injera making, there are other possible sources like wheat, barley, sorghum, millet, maize, and rice to be used just based on the availability. These types of flour sources for injera making can either be tef alone or the combination of the above-listed cereals in addition. From the recent research trends roots and tuber flour can also possibly to be used in the development of this product by partially substituting the above cereals flour (Yassin and Getu, 2019). Cassava, among these roots and tuber crops, is a flour source with good potential to be evaluated for this partial substitution.

Tef considered superior due to its nutritional merits and the crop is rich in carbohydrate, fiber (NRC, 1996), and contains more iron, calcium and zinc than other cereal grains, including wheat, barley and sorghum (Agza *et al*., 2018). Tef has physico-chemical properties with great potential to be used in a broad range of food applications. Tef's flour has a high water absorption capacity, which relates to the higher degree of swelling of its starches, which have a small and uniform granule size, hence, providing larger surface area (Bultosa *et al.,* 2002; Bultosa 2007). Tef starch has a slow retro gradation tendency (Bultosa *et al.,* 2002); hence, it could have a potentially positive impact on the shelf life of baked products. In addition, tef is preferred for making *injera* in terms of flavor quality, texture and softness (Zegeye 1997; Bultosa *et al.*, 2003).

On the other hand, Cassava (*Manihotesculenta*) also known as yucca or manioc is originated in South America. It is now widely grown in many parts of Asia and Africa, mainly for its starchy tuberous roots, which may grow to an enormous size. Readily established from cuttings, it is grown in poor soil, requires relatively little attention, and withstands adverse weather conditions. Cassava is a less expensive source of carbohydrate and the energy yield from cassava is often very high, even higher than energy from cereals. It should be encouraged in non-arid areas where nutrition and the main food problems arise from a shortage of total food and deficient energy intake, because of its high yields and other agricultural advantages.

Cassava is recently introduced to Ethiopia, its utilization as a portion of food is not well known and limited to local tradition, cooking the root similar to other roots and tuber crops. Despite this, cassava is among food security crops due to its high yield per unit land which could be as high as 36.5t/ha as reported in literatures (Belay and Yared, 2015). Thus, cassava is a crop with high potential to improve food security issues in developing country like Ethiopia. On the contrary to that, tef is of high demand both in domestic and international market due to its high quality including nutritional and health benefit. Therefore, its price is escalating from time to time. Traditional products like injera are almost solely prepared from the crop (Beruk and Fasil, 2017). Minimizing the price of injera by partially substituting highly expensive tef by less expensive flour sources like cassava is very important. This study was therefore initiated and conducted to evaluate injera making quality of cassava through partially substituting tef flour.

Materials and Methods

Sample collection and preparation

Cassava flour preparation

Fresh cassava roots (Kello variety) were collected from the horticulture research program of Jimma Agricultural Research center (JARC). The root was washed and the outer layers of the root were peeled by using a sharp stainless steel knife and chopped and soaked in pure water for 48 hours. After the water was drained off, the tuber was sun-dried on mesh for five days till brittle enough for grinding. The dried cassava was then milled into flour and sieved in order to obtain flour with uniform particle size. Finally, the flour was packaged in polypropylene bags until processing and analysis (Emmanuel *et al*., 2012).

Tef flour preparation

Tef (Kuncho variety) was collected from the cereal crop research program of JARC. Tef grain sample was cleaned for any foreign materials (dust, stone, earth tags, chuff, etc) and milled by disk attrition mill to whole flour to the fineness level used traditionally for injera making at the cottage tef grain-milling house (Jimma, Ethiopia). The milled powder was sieved, collected, and packed in dry polyethylene bags until blending.

Formulation of Blends

Tef and cassava flours were mixed in all possible ratios at 10% intervals as shown in table 1.

Table 5. Blending ratios of tef and cassava composite flour

Treatment	Component 1 A: Tef flour (%)	Component 2 B: Cassava flour (%)
1	100	0
2	90	10
3	80	20
4	70	30
5	60	40
6	50	50
7	40	60
8	30	70
9	20	80
10	10	90

Flours characterization

Water absorption capacity (WAC)

Water absorption capacity was computed as described by Iwe et al. (2017). A gram of the blended flour was added into 10ml distilled water in a weighed centrifuge tube and stir six times by 10-minute intervals. The sample was centrifuged at 3000rpm for 25 minutes and the clear supernatant was decanted and re-weight. Change in weight was expressed as a percent of water absorption.

$$WAC = \frac{W3 - (W1 + W2)}{W1} * 100|$$

Where W1=weight of the sample, W2=weight of the empty centrifuge tube, W3=Weight of residue after decanting supernatant in centrifuge tube

Swelling power

The swelling power of flour was determined based on the modified method of Falade *et al.* (2015). A gram of flour sample was transferred to a weighed centrifuge tube and 10ml of distilled water was added. The sample in the centrifuge tube was stirred gently for 10minutes by a stirrer and then heated at 90^0C for 30 minutes. After cooling to room temperature, the samples were centrifuged at 5000rpm for 10minutes and weighed after decanting all supernatant from the tube.

$$Swellingpower = \frac{\text{weight of sediment paste}}{\text{Weight of sample}} w/w$$

Oil Absorption capacity (OAC)

To determine the OAC, 1g of samples was added to 10ml of soybean oil in 25ml of the centrifuge tube. The sample in the tube was stirred for two minutes and then centrifuged at 4000rpm for 20 minutes. The oil formed as the supernatant was separated in a 10ml cylinder and recorded.

$$OAC\% = V1(\text{initial volume of oil added}) - V2(\text{volume separated as supernatant} * 100)$$

Dispersibility

In order to determine the dispersibility, 10g of flour sample was added into a 100ml measuring cylinder and filled by distilled water up to 100ml. the sample in the measuring cylinder was stirred vigorously and allowed to settle for 3hrs. The Dispersibility was calculated by subtracting the volume of the settled particle from 100ml.

$$Dispersibility = 100\text{ml} - \text{Volume of settled particle}$$

Injera making procedure

The injera was made as described by the modified method of Beruk and Fasil (2017). To make injera, 200g of composite flour from each treatment was mixed with 180 ml of water and kneaded for about 5 min. A starter culture (*Irsho*, 5 % dough saved from previous works) was added and fermented for 48 hrs at room temperature. Part of the dough named *Absit* (80 g or 10%) was mixed with 30 ml of water and cooked in 200 ml boiled water for 1 min, cooled to 45^oC and added back to the fermenting dough and mixed well. A 100 ml of water was added and the batter fermented for 3-4 hours at room temperature until foam and bubbles formed (second fermentation). About 500 ml of the batter was poured in a circular manner; on 50cm diameter hot clay griddle (*Metad*) and baked covered for about 2-3 min. the hot fresh injera was drawn from *metad*. The fresh baked injera was cooled and presented for sensory evaluation. Injera samples were dried for 105 °C in an oven for proximate analysis.

Sensory evaluation

A semi-trained panel (a panel briefed about the scoring of degree of linking for sensory attribute) of 50 peoples from JARC, who have experienced consuming injera has participated. Injera prepared from each treatment were evaluated using a 9 points hedonic scale (1-

with Beruk and Fasil (2017). WAC of the tef-cassava composite flour generally was high and flours with high water absorption capacity have more hydrophilic constituents such as polysaccharides. The high WAC of the composite flour helps the processors to add more water during processing, and might be important to maintain freshness of the product (Kumar *et al*., 2015).

Swelling power in the current study was in the range of 3.60% - 6.10% (table 1). According to Eriksson (2014), swelling power expressed as the weight of sediment per gram of starch; the maximum increase in volume and weight the starch undergoes when heating in excess water. This property of flour is reported to be related with the eating quality of food and hence the higher the swelling power the better will be eating quality of food (Falade *et al*., 2015).

Oil absorption capacity is the indication of the emulsifying capacity and amount of oil uptake by a sample during food processing like frying (Falade *et al*., 2015). It is the property mostly related with sensory property of a product like flavor, taste and aroma. The oil absorption capacity reported in this study varied from 111.0% to 160.0%. The oil absorption capacity of tef flour alone was score lowest value (115.0) and the highest oil absorption capacity was recorded for 70% cassava flour in the blended ratio. Sharma et al. (2016) reported that high oil absorption capacities of flour could improve the property of other flour during formulation development.

Dispersibility is a measure of the reconstitution of flour or starch in water. The higher the dispersibility, the better the sample reconstitutes in water (Adebowale *et al*., 2011). The lower the dispersibility of flour samples is probably the indication of lump formation tendency during preparation (Oluwole et al., 2016). The dispersibility of blend flour in this study ranged between 68.5 and 76.5. Tef flour without cassava had the highest dispersibility (76.50) and blending ratio of 30% tef and 70% cassava flour had the lowest dispersibility (68.50). Tef flour had the best reconstitution ability than all-composite flour proportions with cassava flour.

Table 6. Functional property results of tef-cassava composite flour

Treatment	Water absorption capacity	Swelling power	Oil absorption capacity	Dispersibility
1	123.40^{a}	3.60^{b}	115.00^{d}	76.50^{a}
2	127.80^{a}	6.10^{a}	145.00^{ab}	75.00^{ab}
3	124.40^{a}	5.00^{ab}	145.00^{ab}	72.50^{bc}
4	127.70^{a}	4.00^{b}	135.00^{bc}	74.00^{abc}
5	132.65^{a}	3.70^{b}	115.00^{d}	72.50^{bc}
6	126.30^{a}	3.80^{b}	145.00^{ab}	72.00^{bcd}
7	125.35^{a}	3.80^{b}	120.00^{cd}	71.50^{bcd}
8	140.40^{a}	4.20^{b}	160.00^{a}	68.50^{d}
9	156.90^{a}	4.50^{b}	135.00^{bc}	75.00^{ab}
10	137.00^{a}	4.00^{b}	150.00^{ab}	71.00^{cd}
Mean	125.19	4.27	136.50	72.85
CV (%)	13.76	14.7	5.70	2.24

Means with the same letter in a column are not significantly different (p>0.05), T_1=100%tef, T_2=90% tef & 10% cassava, T_3=80% tef & 20% cassava,T_4=70% tef & 30% cassava, T_5=60% tef & 40% cassava, T_6=50% tef & 50% cassava, T_7=40% tef & 60% cassava,T_8=30% tef & 70% cassava, T_9=20% tef & 80% cassava,T_{10}=10% tef &90% cassava

Sensory properties of tef-cassava injera

The sensory acceptability of tef-cassava injera was significantly decreased in all parameters with increasing proportion of cassava flour. A similar report by Desalegn and Desta (2017) also indicated that the sensory quality of injera declined with an increasing proportion of cassava flour. Even though the difference in sensory acceptance is significantly declining with addition of cassava, incorporation of cassava flour as high as 30% was moderately acceptable.

Table 7. Sensory properties of tef-cassava composite injera

Treatments	Top and bottom surface color	Eye description	Texture	Test and after the test	Overall acceptability
1	1.35^{f}	1.50^{f}	1.76^{d}	2.18^{e}	1.86^{f}
2	2.21^{ef}	1.88^{f}	2.36^{d}	2.49^{de}	2.35^{f}
3	3.16^{ed}	3.81^{e}	3.89^{c}	3.29^{d}	4.28^{e}
4	4.22^{cd}	4.29^{de}	4.62^{bc}	4.85^{c}	4.93^{cde}
5	4.68^{bc}	4.96^{cd}	4.77^{b}	5.06^{bc}	4.54^{de}
6	5.27^{bc}	5.35^{c}	5.00^{b}	5.15^{bc}	5.39^{bcd}
7	5.75^{b}	5.52^{c}	5.27^{b}	5.21^{bc}	5.54^{bc}
8	7.03^{a}	6.34^{b}	6.47^{a}	6.40^{a}	6.56^{a}
9	7.40^{a}	7.07^{ab}	6.15^{a}	5.89^{ab}	6.56^{a}
10	7.97^{a}	7.47^{a}	6.62^{a}	6.53^{a}	6.24^{ab}
CV	10.57	6.92	8.12	9.32	8.28
LSD	1.17	0.75	0.86	0.99	0.90

Means with the same letter in a column are not significantly different (p>0.05), nine hedonic scale was used for sensory evaluation (1-like extremely, 9extremely dislike). T_1=100% teff, T_2=90% teff& 10% cassava, T_3=80% teff& 20% cassava, T_4=70% teff & 30% cassava, T_5=60% teff& 40% cassava, T_6=50% teff& 50% cassava, T_7=40% teff& 60% cassava, T_8=30% teff & 70% cassava, T_9=20% teff& 80% cassava, T10=10% teff &90 casssava.

Even the 40% inclusion level is slightly liked in color and eye description, but neither liked nor disliked in taste, texture and overall acceptability. These indicate that it is possible to prepare injera by incorporation of up to 40% cassava flour with tef flour with acceptable sensory quality.

Proximate composition of Tef-Cassava Injera

The proximate composition of tef-cassava injera is presented in table 4. Moisture content of tef-cassava injera was in the range of 7.59-9.41% and had shown a slight increment as the proportion of cassava increased. However, the increment was not significant statistically. Ash content of injera prepared from 100% tef flour was 1.87% and the same parameter reduced to 1.04% at 10% cassava substitution. This result was in line with Beruk and Fasil (2017) where the author reported tef flour had higher ash content than cassava flour. The fat content estimated in this study is generally low (0.23-1.54%), and the value had shown a decreasing trend with increasing level of cassava flour which might be due to higher fat content of tef than cassava. The blending of cassava flour had a significant ($p<0.05$) effect on the protein content of blended injera. The addition of more cassava flour had reduced the protein content of injera. The protein content of injera had decreased from 11.89 for 100% tef to 3.79% for 90% cassava containing injera that might be due to the higher protein content of tef than cassava. The fiber content of tef-cassava injera was in the range between 1.10-3.05%. There was also a decreasing trend in fiber content as level of cassava increase in the proportions.

Table 8: Proximate and energy contents of tef-cassava injera (%)

Treatment	Moisture	Ash	Crude fat	Protein	Crude fiber	Carbohydrate	Energy
1	7.59^{a}	1.87^{a}	1.02^{abc}	11.89^{a}	3.05^{a}	75.26^{d}	357.74^{ab}
2	7.61^{a}	1.41^{bcd}	1.21^{ab}	10.07^{ab}	1.97^{f}	75.72^{d}	362.12^{a}
3	9.41^{a}	1.83^{ab}	1.54^{a}	9.07^{abc}	2.45^{de}	77.75^{cd}	352.98^{bc}
4	7.66^{a}	1.87^{a}	1.38^{a}	8.10^{de}	1.10^{g}	82.45^{ab}	364.45^{a}
5	8.55^{a}	1.55^{abc}	0.90^{abcd}	7.62^{bcd}	2.42^{e}	78.98^{bcd}	354.45^{bc}
6	9.27^{a}	0.65^{e}	0.68^{bcd}	6.07^{cde}	2.75^{b}	80.59^{abc}	352.70^{bc}
7	8.81^{a}	1.27^{cd}	0.53^{cd}	5.43^{de}	2.56^{c}	81.40^{abc}	352.11^{bc}
8	9.07^{a}	1.26^{cd}	0.40^{cd}	4.25^{e}	2.80^{b}	82.24^{ab}	349.45^{c}
9	8.39^{a}	1.29^{cd}	0.46^{cd}	5.56^{bcd}	2.54^{cd}	83.54^{a}	353.46^{bc}
10	8.75^{a}	1.04^{de}	0.23^{d}	3.79^{e}	2.38^{e}	78.84^{bcd}	349.83^{c}
Mean	8.51	1.4	0.83	7.18	2.4	79.68	354.93
CV (%)	11.32	14.19	15.91	19.72	1.96	2.13	0.91

Means with the same letter in a column are not significantly different ($p>0.05$),T_1=100% teff, T_2=90% teff& 10% cassava, T_3=80% teff& 20% cassava,T_4=70% teff& 30% cassava, T_5=60% teff& 40% cassava, T_6=50% teff& 50% cassava, T_7=40% teff& 60% cassava,T_8=30% teff& 70% cassava, T_9=20% teff& 80% cassava,T_{10}=10% teff& 90 cassava. Energy (kcal/100 g) = [9 x fat (%) + 4 x protein (%) + 4 x carbohydrates (%)].

The carbohydrate content of injera had an increasing trend for every 10% addition of cassava flour. However, the increment was not linear, and the lowest carbohydrate (75.26%) was recorded for control injera (100% tef) while the highest (83.54%) was recorded at 80% cassava. This increase in carbohydrate content may be attributed to high carbohydrate composition of cassava as is in other roots and tuber crops. Similarly, there was a decreasing trend in energy value of injera as the proportion of cassava in the blend is increased. This is attributed to the higher fat and protein content of tef as compared with that of cassava. Nevertheless, the energy contents of the blended injeras were high in all proportions because of the high carbohydrate of cassava as it is true in other roots and tuber crops. In general, the effect of cassava flour addition is not as such a concern on fat, fiber, carbohydrate and energy contents of tef injera. Rather, sensory acceptability is more important factor to determine the substitution level of cassava in injera making.

Conclusions and Recommendation

This study showed that cassava flour can be a good ingredient to prepare injera together with tef and diversify Ethiopian diet. As cassava flour substitution levels increase, most flour functional properties including water absorption capacity, swelling power and oil absorption capacity increased, whereas sensory characteristics and some proximate composition parameters (protein, fat, ash and energy) were slightly decreased. From this study, it may be concluded that up to 40% cassava could be incorporated with tef to make injera with slightly acceptable sensory quality and fair nutritional quality. In the current study standard tef injera preparation procedure was used to process the tef-cassava flour blend. However, some process characterization and modification might be required to adjust cassava incorporation. Further investigation is also required to assess the influence of various maturity stages during cassava harvesting and its post-harvest storage on injera quality.

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