

Effect of blending ratio on nutritional composition and sensory acceptability of injera produced from teff, cassava and orange-fleshed sweet potato composite flour

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Abstract

Injera is consumed as national, and usually prepared from cereal crops like teff, barley, sorghum and maize or blending cereals with root crops in Ethiopia. Commonly, it is made from teff and cassava composite flour which are poor source of vitamin A. Hence, this study was aimed to produce vitamin A rich injera by blending with vitamin A rich root crops like orange fleshed sweet potato with teff and cassava composite flour. Raw materials were collected from Arba Minch Agricultural Research Center. Teff, cassava, and orange-fleshed sweet potato flour samples were prepared based on scientific procedures and packed with polyethylene bags for further laboratory analysis. The injera samples were evaluated nutritional and beta carotene based procedures and sensory acceptability by using 50 untrained panelists. The conversion factor of 6 µg Trans β-carotene per one micro gram (1µg) retinol equivalent (1µg β-carotene = 0.167µg RE) was used to determine vitamin A. The data for beta-carotene content, nutritional and sensory acceptability of injera samples were analyzed by using one way analysis of variance. The result had showed significance difference for injera made from blending ratio of teff, cassava and orange flashed sweet potato at $p < 0.05$ for its nutritional composition, but had not showed significance difference in sensory acceptability of injera samples. Moreover, beta-carotene content was below detection limit for teff alone injera sample while highest (198µg/g) was measured from 60% teff, 20% cassava and 20% orange-fleshed sweet potato composite flour injera sample which shows orange fleshed sweet potato has great role in enhancing vitamin A content of teff and cassava composite flour injera in study area.

Keywords: Blending ratio; Injera; Nutritional composition; Sensory acceptability and Vitamin A

1. Introduction

Injera is majorly prepared from teff and put to ferment for two to three days in order to have attractive and eyeful injera for consumers (Abraha *et al.*, 2013). It is usually made from teff alone and sometimes blending it with other cereals such as barley, sorghum or maize and root crop in different ratios. In present time, cassava incorporation with teff to produce injera became common practice among low income families of southern Ethiopia (Ashenafi, 2006). In respective of its nutritional importance there is great cultural reliance on teff injera as favorite food in both rural and urban areas of Ethiopia (Ashenafi, 2006).

Due to increased consumption of injera among different communities in Ethiopia, the demand for teff is higher than supply and teff price was alarmingly increased from time to time due to its nutritional and health benefit such as higher fiber and being free of gluten. As teff prices increased, households even with better socio-economic status also tend to blend teff grain with other low cost cereals and root crops in order to sustain their injera consumption (Abraha *et al.*, 2013). This and other associated factors enforced to shift the preparation of injera from white teff to mixing it with other root crops like cassava is common in South Ethiopia Region, Ethiopia. Cassava is root which provides

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carbohydrate and energy for human body. The need to concern during blending of chopped and dried cassava root flour with other cereals is source for carbohydrates as many cereals do (Bradbury and Holloway, 1988). In addition, cassava root flour has very low beta carotene content and it is highly perishable with high amount of hydrogen cyanides (Nweke *et al.*, 2002).

However, injera prepared from blending ratio of tef and cassava composite flour is lack vitamin which can cause vitamin A deficiency (VAD). Vitamin A deficiency (VAD) plays great role in affecting different groups of communities throughout the global and more serious among developing countries like Ethiopia (Demissie *et al.*, 2010). Lack of vitamin A in our daily diet exposes to different health problems like increased maternal and child mortality, immune system weakness, increased risk of diseases and night blindness in common (Harjes *et al.*, 2008) and (Tanumihardjo *et al.*, 2016).

Among sweet potato varieties, orange-fleshed sweet potatoes are particularly rich in pro-vitamin A, which plays a crucial role in combating vitamin A deficiency (VAD) in over 43 million children, especially in many African nations (Itodo *et al.*, 2022). Consuming orange-fleshed sweet potato is considered an effective strategy in reducing vitamin A deficiency, a condition responsible for the premature blindness and death of over 250,000 children annually in Africa (Neela *et al.*, 2019). OFSP contains incredible amount of bio-available β -carotene which could easily be converted to vitamin A in our body (Haskell *et al.*, 2004). In addition to its nutritional importance as the source of beta-carotene, farmers in drought areas can easily cultivate orange-fleshed sweet potato within three to five months and feed their household members with different food options for healthy life (Jenkins *et al.*, 2015). However, orange fleshed-sweet potato plays key role in tackling vitamin A deficiency, the attention given to the crop is very poor among producers and consumers in South Ethiopia. In addition, processing orange-fleshed sweet potato (OFSP) into flour and blending with teff and cassava composite flour which are poor in vitamin A, is less practice among injera consumers in South Ethiopia. Hence, the present study was aimed to evaluate nutritional content and sensory properties of injera prepared from blending ratio of tef, cassava and orange fleshed sweet potato composite flour.

2. Materials and Methods

2.1. Collection of Raw Materials

Teff, cassava and orange-fleshed sweet potato were collected from Arba Minch Agricultural Research Center, South Ethiopia Agricultural Research Institute. Teff, cassava and orange fleshed-sweet potato samples were processed into flour based on scientific procedure, and stored individual in polyethylene bag until use for blending.

2.2. Teff Flour Preparation

Five kilograms (5Kg) of best quality teff grain manually cleaned from unwanted foreign materials in order to separate teff from foreign materials and other debris locally. The cleaned teff grain was milled by disk attrition mill to fineness (750 μm) level. The flour was kept in air tight sealed plastic bag at room temperature until laboratory analysis.

2.3. Preparation of Orange-fleshed Sweet Potato Flour

Orange-fleshed sweet potato flour was prepared as previously described by (Fana *et al.*, 2015). About 25 kilograms of freshly harvested orange fleshed-sweet potato (kulfo variety) was sorted, washed, peeled and sliced. The sliced OFSP was pre-treated with citric acid solution based on the method described by Bechoff *et al.*, (2011) for better retention of beta-carotene and other nutrients, and solar dried. The dried OFSP was milled and sieved through 0.2 mm. Finally, OFSP flour was packed using polyethylene bag packing material, and was stored at ambient temperature until used for laboratory analysis.

2.4. Preparation of Cassava Flour

The collected cassava root was cleaned from soil and other debris before peeling and washing. The cleaned cassava root was immediately peeled manually with kitchen knife and washed with tap water carefully. The cleaned cassava root was uniformly chopped into small slices. In order to minimize its cyanide content, the small slices of cassava were soaked in water for 24hrs and direct sun dried for three days. Eventually, dried cassava slices were milled with commercial grain miller and the flour was sieved with 250 μm sieves according to Girma *et al.*, (2015). Then, the sifted flour was packed with polyethylene bags and stored at dry place until it is used in next steps of dough preparation.

2.5. Experimental Design and Treatment Arrangement

Completely randomized design (CRD) was used for determination of beta carotene and proximate composition of injera samples with triplication. Randomized complete block design (RCBD) was used for evaluation of sensory acceptability

of injera samples with three replications by using 50 un-trend panelists. Blocking principle was followed to remove the variation come from panelists. The clean water was provided to the judges to rinse the mouth in between testing of injera sample to avoid residual effects. The treatment arrangements were described in table 1 as shown below.

Table 1 Blending ratio of teff, cassava and OFSP for production of injera

Ingredients	Treatments						
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇
Teff (%)	100	95	95	90	80	70	60
Cassava (%)	0	5	0	5	10	15	20
OFSP (%)	0	0	5	5	10	15	20

2.6. Proximate Composition of Injera

2.6.1. Moisture Content

The moisture content of injera sample was determined according to the standard analytical method (AOAC, 2006). Pre-washed, cleaned and dried crucible was weighed. About 2 gram of sample was weighed, and added the weighed injera sample into a pre-weighed cleaned crucible. The crucible was uncovered and placed in oven and maintained at 103±2°C. After 16 hours, the crucible was replaced and transferred to desiccator at room temperature to cool for 5 minutes and quickly weighed the dried sample with crucible. The loss in weight represented percent of moisture as follow:

$$\text{Moisture}(\%) = \frac{(W_1 + W_2) - (W_3)}{W_2} \times 100\%$$

Where; W_1 = Weight of crucible, W_2 = weight of sample before drying, W_3 = weight of sample with crucible after drying

2.6.2. Ash Content

The ash content of injera sample was determined according to the standard analytical methods (AOAC, 2006). Crucible was washed and dried in an air-hot oven, cooled in a desiccator and weighed (W_1). About 2 g of dried sample was weighed (W_2) and added into crucible to char organic matter. The crucible was placed in a muffle furnace maintained at a temperature of 550°C for 6 hours, and transferred to a desiccator, cool and reweigh immediately (W_3).

$$\text{Ash}(\%) = \frac{(W_3 - W_1)}{W_2} \times 100\%$$

Where, W_1 = Weight of crucible, W_2 = Weight of sample, and W_3 = Weight of crucible + Ash

2.6.3. Fat Content

Fat content of injera sample was determined according to the standard analytical method (AOAC, 2006). Soxhlet system HT2 method was followed. 2 g of sample was weighed (W_1) and loaded in thimble and plugged with cotton wool, and thimble was inserted into the Soxhlet. Extraction beaker was dried and weighed (W_2) and 25 ml of the solvent was added into each beaker. The beaker was inserted into the Soxhlet HT. The extraction beaker was dried and weighed with boiling chips. 25 ml of the solvent was added to the solvent in each beaker. The breaker was inserted into the Soxhlet HT and extracted for 15 minutes in boiling position and for 30 minutes in rinsing position. The solvent was evaporated; the breaker was released and dried at 100°C for 30 minutes. The beaker with fat was cooled in a desiccator and reweighed (W_3).

$$\text{Crude Fat}(\%) = \frac{(W_3 - W_2)}{W_1} \times 100\%$$

W_3 = weight of beaker + weight of fat, W_1 = weight of sample, and W_2 = weight of beaker

2.6.4. Protein Content

The protein content of injera sample formulated from blending ratio of teff, cassava and orange fleshed sweet potato flour was determined using micro Kjeldahl method (AOAC, 2006).

Digestion: About 1 g of injera sample was weighed into a 100 ml micro-Kjeldahl digestion flask. About 1 g of copper sulphate and 10 g sodium sulphate were added to the flask and thoroughly shaken and placed on the digestion rack in an inclined position. The injera sample in the flask was digested by heating in a flame chamber until frothing ceased. The temperature was increased and allowed boiling for about one hour until the color change to bluish green. The clear digested injera sample was allowed to cool.

Distillation: Some distilled water was added to the digested sample with a wash bottle to 100 ml in a 100 ml volume metric flask. A 10 ml of the digest pipette was transferred into a micro-Kjeldahl distillation flask follow by the addition of 60 ml of 60% sodium hydroxide (NaOH) solution. The flask was immediately fixed to the splash head of the distillation apparatus. A 4% boric acid was added into a 100 ml receiving conical flask, 2 drops of methyl red indicator was added, in such a way that the outlet of the adapter of the delivery tube was extended under the surface of the boric acid solution. The mixture was heated to liberate ammonia into the receiving conical flask containing 100 ml boric acid and the indicator until yellowish green color distillate was obtained.

Titration: The distillate was titrated with 0.1N hydrochloric acid (HCl) until the end point of pink coloration was obtained. The percentage (%) protein was calculated as:

$$\text{Protein(\%)} = \frac{T \times 0.0014 \times 6.25}{\text{Weight of sample}} \times 100$$

Where;

6.25 = protein conversion factor, 0.0014 = correction factor of the acid, and

T = titreable value of the sample

2.6.5. Crud Fiber Content

Crud fiber content of injera sample was determined according to the standard method (AOAC, 2006). 2g of the sample was defatted with petroleum ether, boiled under reflux for 30 minutes with 200 ml of a solution containing 1.25g of H₂SO₄ per 100 ml of solution. It was then filtered with whatman number 1 filter paper, washed with boiled water until the washing was no longer acid. The residue was transferred to a beaker and boiled for 30 minutes with 200ml of a solution containing 1.25g of carbonate free sodium hydroxide per 100ml. It was then filtered and transferred into a crucible and weighed (W₂). The residue was dried in the oven at 600°C in a muffle furnace and the dried weight recorded (W₃).

$$\text{Crude fiber (\%)} = \frac{(W_2 - W_1) - (W_3 - W_1)}{\text{Weight of sample}} \times 100\%$$

Where;

W₁ = Weight of crucible, W₂ = Weight of crucible and residue, W₃ = Weight crucible and ash

2.6.6. Beta Carotene (Vitamin A) Content

Beta carotene extraction was done according to the method reported by (Barba *et al.*, 2006) with some modifications. Beta carotene was extracted by soaking 0.5g of samples in 25mL of different solvents (acetone) at room temperature under dark conditions in order to get a complete extraction. The mixture was magnetically stirred for 30 min. The extracts were centrifuged to separate the supernatant, and these operations were repeated until the injera sample was completely colorless. Volume was made up to 50mL with the extracting solvents. Finally, the absorbance of the extracts was measured using UV-VIS methods by wave length of 440nm. The conversion factor of 6 µg Trans β-carotene per 1 µg retinol equivalent (RE) (1µg β-carotene = 0.167µg RE) was used (Dwyer *et al.*, 2020).

2.6.7. Sensory Evaluation of Injera

Sensory acceptability of injera sample was conducted by using a total of 50 untrained panelists who were consuming injera. Formulated injera samples were coded by using three digit numbers, and given randomly to the panelists to evaluate sensory attributes of injera such as color, taste, texture, rolling, injera eyes and overall acceptability. A five point hedonic scale (5-like very much, 4-like moderately, 3-neither like nor dislike, 2-dislike moderately and 1- dislike very much) was used to rate acceptability of injera as described previously Meilgaard *et al.* (2006). The clean water was provided to the judges to rinse the mouth in between testing of injera sample to avoid residual effects. There had a washout period of three minute before assigned another injera sample for the sensory evaluation.

2.7. Statistical Analysis

The proximate, beta carotene and sensory acceptability data were analyzed by one-way analysis of variance (ANOVA). The statistical analyses of proximate, beta carotene and sensory acceptability dates were performed using SAS system and a significant difference was considered at ($p < 0.05$). Mean separations were evaluated by Turkey's honestly significant difference (HSD) ($p < 0.05$), and the results were expressed as mean.

3. Results and Discussions

3.1. Nutritional Composition of Injera

As shown in table (2), blending ratio of teff, cassava and orange-fleshed sweet potato composite flour injera samples had showed significance ($p < 0.05$) difference for all proximate composition. The moisture content of injera samples were significantly ($p < 0.05$) increased from (8.3-13.8%) as the ratio of orange-fleshed sweet potato and cassava flour increased. This might be due to increased moisture content of orange fleshed sweet potato in its wet basis, and also the high water absorption capacity of cassava flour (Misgana *et al.*, 2020). This is contrary to reports from (Desalegn and Desta, 2017) in which moisture content of injera decreased as the proportion of cassava is increased. However, the increased result of moisture content of injera as increased cassava and orange-fleshed sweet potato flour in proportion was agreed with (Misgana *et al.*, 2020), who reported increased result of moisture content of injera as increased cassava flour in proportion.

The ash content of injera increased from (2.3-4.9%) as level of cassava and orange-fleshed sweet potato flour increased, implying that the inorganic nutrient in the composite injera is better than whole teff injera (Abebe *et al.*, 2017). Ash content indicates the presence of minerals in food samples (Laryea *et al.*, 2018), and this shows that the ingredients used for the formulation of injera are potential sources of minerals. This is contrary to results from Mekelle, Northern Ethiopia by which cassava and teff blended injera products showed lower ash content than that of white teff injera (Gebrekidan, 2016). The variation of ash content of injera sample from other studies is due to types of ingredient used and processing methods of flour.

Table 2 Mean value of nutritional composition (%) and beta carotene ($\mu\text{g/g}$) content of injera

Treatments	Nutritional composition of injera (%)					
	Moisture	Ash	Protein	Fat	Fiber	Vitamin A ($\mu\text{g/g}$)
T1	8.3 ^g	2.3 ^g	8.1 ^a	7.2 ^f	2.16 ^g	BDL
T2	9.1 ^f	3.1 ^f	7.1 ^b	8.1 ^e	2.55 ^f	94.3 ^e
T3	10.2 ^e	3.3 ^e	6.9 ^c	8.3 ^d	3.02 ^e	105.0 ^e
T4	11.3 ^d	3.8 ^d	6.5 ^d	8.5 ^c	3.47 ^d	126.9 ^d
T5	12.6 ^c	3.9 ^c	6.3 ^e	8.7 ^b	3.63 ^c	149.4 ^c
T6	13.1 ^b	4.5 ^b	5.6 ^f	8.9 ^a	3.77 ^b	178.8 ^b
T7	13.8 ^a	4.9 ^a	5.1 ^g	9.1 ^a	3.96 ^a	198.3 ^a
HSD ($p < 0.05$)	0.14	0.09	0.19	0.12	0.11	0.79

The result of the crude protein content of teff, cassava, and orange-fleshed sweet potato composite flour (5.1- 8.1%) as described in table 2. The protein content of injera was significantly ($p < 0.05$) decreased as the proportion of cassava and orange-fleshed sweet potato increased, because of blending cassava and orange-fleshed sweet potato, which are poor sources of protein (Kebede *et al.*, 2012). Other authors identified that as poor source of protein, cassava contains only 1-3% protein on dry matter basis (Montagnac *et al.*, 2009). In addition, the decreased result of protein content of injera as increased the level of cassava and orange-fleshed sweet potato in the proportion may be attributed to the general low protein content of roots and tuber crops including cassava and orange-fleshed sweet potato. This result is also in line with reports from (Bultosa and Taylor, 2004) and (Charles *et al.*, 2004), and in line with reports of (Aniedu & Agugo, 2010). The protein content in this study was somewhat lower than findings from (Desalegn and Desta, 2017). This may be due to variation of ingredient used in blending ratio.

The highest crude fat content was obtained from 60:20:20 ratios of teff, cassava and orange-fleshed sweet potato composite injera. As the supplementation of cassava and OFSP increased, the fat content of injera was significantly ($p < 0.05$) increased. The lower value for injera fat content was from teff alone and higher was recorded from 20% of both cassava and orange-fleshed sweet potato. Studies done on the effect blending cassava with teff to produce injera reported lower fat content as proportion of cassava increased, which is contrary to findings from current study (Shiferaw *et al.*, 2021). Inconsistency might be due to addition of orange-fleshed sweet potato and cassava flour to whole teff flour which is more practiced by consumers.

Across all treatments, the highest value (3.96%) fiber was determined from 60% teff, 20% cassava and 20% orange-fleshed sweet potato in current study. As indicated from this result, increasing orange-fleshed sweet potato and cassava significantly ($p < 0.05$) improved fiber content of injera. This is in accordance with findings from (Desalegn and Desta, 2017) who reported contrary result in which the amount of crude fiber was decreased while the amount of tef contained in the composite injera was decreased. The reason could be due to blending of orange-fleshed sweet potato which has relatively better fiber content than teff and cassava.

Incorporation of orange-fleshed sweet potato (OFSP) in teff and cassava composite flour was enhanced the β -carotene content of injera. The highest record for β -carotene was obtained from the 6th treatment which is 20% orange-fleshed sweet potato flour supplementation. The higher result of beta carotene content of formulated injera was due to the effect of orange-fleshed sweet potato. Orange-fleshed sweet potato is rich in beta carotene because 90% of total carotenoid is beta carotene, which is the precursor of vitamin A (Achir *et al.*, 2014). Similar study conducted on nutritional value and consumer preferences of tef injera incorporated with OFSP showed significantly higher β -carotene content as the ratio of orange-fleshed sweet potato increased (Mengesha *et al.*, 2023). Therefore, one approach for tackling vitamin A deficiency could be to incorporate orange-fleshed sweet potato flour in the predominantly consumed diets (Gebretsadikan *et al.*, 2015).

3.2. Sensory Acceptability of Injera

In this study there was no significant difference ($p < 0.05$) among treatments for sensory attributes of injera as shown on table 3. Teff alone injera scored highest record for sensory value than other treatments blend with cassava and orange-fleshed sweet potato. This is in agreement with similar research findings from (Gebrekidan, 2016) whose result showed higher overall acceptance of whole teff injera when compared with 20%-30% cassava flour supplementation. This could be due to familiar of panelists' on teff injera and less practice of blending orange-fleshed sweet potato and teff composite flour to bake injera.

Table 3 Mean value of sensory acceptability of injera

Treatments	Sensory acceptability of injera					
	Color	Taste	Rolling	Injera eye	Texture	Over all acceptability
T1	5.0	4.80	4.85	4.80	4.67	5.0
T2	4.82	4.85	4.83	4.82	4.65	5.0
T3	4.84	4.81	4.84	4.61	4.67	4.85
T4	4.81	4.68	4.69	4.63	4.83	4.82
T5	4.23	4.45	4.67	4.47	4.29	4.69
T6	4.26	4.29	4.28	4.24	4.47	4.67
T7	4.01	4.09	4.26	4.29	4.28	4.41
HSD ($p < 0.05$)	NG	NG	NG	NG	NG	NG

Where, NG is no significant difference in mean value of treatments

Color is one of the important sensory attributes for injera to attract the interest of consumers. The mean value of color of injera prepared from blending ratio of teff, cassava and orange fleshed sweet potato composite flour were ranged from 4.01-5.0. In current study, the color of injera was decreased as increased the amount of cassava, and orange fleshed sweet potato in composite flour. According to Beruk and Fasil (2017), it is indicated that due to its whitish color, incorporation of cassava with teff improved color of injera which disagree with current study due to yellowish color of orange-fleshed sweet potato which approves it is rich in β -carotene.

The taste of injera samples prepared from blending ratio of teff, cassava and orange-fleshed sweet potato was ranged from 4.09-4.85 which had not significant difference among treatments. As Cassava and orange-fleshed sweet potato content increased, the taste of injera was decreased when compared with control treatment (teff alone injera). This is contrary to results from Wasihun and Ermias (2021) in which the taste of injera sample was increased with addition of orange-fleshed sweet potato flour. When considering overall acceptability of teff, cassava and orange-fleshed sweet potato injera, it is ranged from 4.4-5 scores. As cassava and orange-fleshed sweet potato flour samples were increased, the overall acceptances of injera samples were decreased in present study. This is consistent with reports of (Gebrekidan, 2016), in which increasing cassava proportion lowered the overall acceptability of the injeras. Still the reason of panelists to judge cassava and orange-fleshed sweet potato injera with less acceptability score could lack practice on orange-fleshed sweet potato blended injera. Other injera quality parameters such as rolling, texture and injera eyes were also similarly affected as the ratio of cassava and OFSP flour supplementation enhanced.

4. Conclusion and Recommendation

Current study out looked that incorporation of 20% cassava and 20% orange fleshed-sweet potato on 60% teff had significantly improved the nutritional composition of composite injera except crude protein. All sensory attributes of injera prepared from blending ratio teff, cassava and orange fleshed-sweet potato flour were not significantly ($p < 0.05$) affected up to 20% cassava and orange fleshed-sweet potato supplementation. The mean scores for sensory properties of injera from all treatments were like very much and like moderately by untrained panelists. Considering the higher β -carotene content and sensory properties of injera made from 60% teff, 20% cassava and 20% orange-fleshed sweet potato composite flour is recommended for commercial production and consumption among urban and rural consumers, including the most vulnerable groups to decrease vitamin A deficiency.

Compliance with Ethical Standards

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Disclosure of conflict of interest

We confirm that there is no competing of interest on this research work that could affect the collection, analysis and publishing of our paper.

References

- [1] Abebe H., Negussie R., Chernet A. (2017). Sensory and Nutrient Composition Evaluations of Ethiopian Staple Meal (Injera) Prepared From Quality Protein Maize, Teff and Cassava Composite Flours. *BIRJSH* (2017) 1: 60-7
- [2] Abraha, A.K. Uhlen, F. Abay, S. Sahlstrom, A. Bjornstad (2013). Genetic variation in barley enables a high quality, the Ethiopian staple flat bread, comparable to Teff *Crop Sci.*, 53 (5) (2013), pp. 2040-2050. doi: 10.2135/cropsci2012.11.0623
- [3] Achir, N., Pénicaud, C., Bechoff, A. (2014). Use of Multi-response Modeling to Investigate Mechanisms of β -Carotene Degradation in Dried Orange-Fleshed Sweet Potato During Storage: from Carotenoids to Aroma Compounds. *Food Bioprocess Technol* 7, 1656–1669. <https://doi.org/10.1007/s11947-013-1229-y>
- [4] AOAC International (Eds.). (2006). Official methods of analysis of AOAC International (18. ed., current through rev. 1, 2006). AOAC International.
- [5] Aniedu, C., & Agugo, U. A. (2010). Acceptability of bread produced from hausa-potato and sweet potato composite flours. *Journal of Agriculture and Social Research*, 10(2), 162-166. <https://doi.org/10.4314/jasr.v10i2.67586>
- [6] Ashenafi M. (2006). A review on the microbiology of indigenous fermented foods and beverages of Ethiopia, *Ethiop. J Biol. Sci.*, 5: 189-245. <https://doi.org/10.4236/ojas.2018.81005>
- [7] Barba, A. I. O., Hurtado, M. C., Mata, M. C. S., Ruiz, V. F., & Tejada, M. L. S. de. (2006). Application of a UV-vis detection-HPLC method for a rapid determination of lycopene and β -carotene in vegetables. *Food Chemistry*, 95(2), 328–336. <https://doi.org/10.1016/j.foodchem.2005.02.028>

- [8] Bechoff, A., Westby, A., Menya, G., & Tomlins, K. I. (2011). Effect Of Pretreatments For Retaining Total Carotenoids In Dried And Stored Orange-Fleshed-Sweet Potato Chips: Pretreatment Effect On Carotenoids In OFSP. *Journal of Food Quality*, 34(4), 259–267. <https://doi.org/10.1111/j.1745-4557.2011.00391.x>
- [9] Beruk B. D. and Fasil T.D. (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*),” *Food Sci Qual Man agement*, vol. 68, pp. 6-10, 2017.
- [10] Bradbury, JH and Holloway, WD. (1988). Chemistry of tropical root crops: significance for nutrition and agriculture in pacific. *ACIAR Monograph No 6*.
- [11] Bultosa, G. And Taylor, JRN. (2004). Tef. In: *Encyclopedia of Grain Science*, Vol. 3 (edited by C. Wrigley, H. Corke & C.E. Walker). Pp. 281–290. Oxford, UK: Elsevier Ltd. doi: 10.12691/jfmr-6-2-2
- [12] Demissie, T., Ali, A., Mekonen, Y., Haider, J., & Umata, M. (2010). Magnitude and distribution of vitamin A deficiency in Ethiopia. *Food and Nutrition Bulletin*, 31(2), 234-241. <https://doi.org/10.1177/156482651003100206>
- [13] Desalegn B. B., Desta F. T. (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*). *Food Science and Quality Management*. <https://doi.org/10.12688/F1000RESEARCH.52634.1>
- [14] Dwyer J, Saldanha L, Haggans C, Potischman N, Gahche J, Thomas P, Bailen R, Costello R, Betz JM, Andrews K, Gusev P, Pehrsson P, Savarala S, Tey P, Harnly J.(2020). Conversions of β -Carotene as Vitamin A in IU to Vitamin A in RAE. *J Nutr*. 1;150(5):1337. doi: 10.1093/jn/nxz334. PMID: 32367133; PMCID: PMC7373782.
- [15] 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. <https://doi.org/10.1002/star.200300226>
- [16] Fana Haile, Shimelis Admassu, Abrehet Fisseha. Effects of Pre-treatments and Drying Methods on Chemical Composition, Microbial and Sensory Quality of Orange-Fleshed Sweet Potato Flour and Porridge. *American Journal of Food Science and Technology*. 2015; 3(3):82-88. doi: 10.12691/ajfst-3-3-5.
- [17] Gebretsadikan, T. M., Bultosa, G., Forsido, S. F., & Astatkie, T. (2015). Nutritional quality and acceptability of sweet potato–soybean–moringa composite porridge. *Nutrition & Food Science*, 45(6), 845–858. <https://doi.org/10.1108/NFS-05-2015-0048>
- [18] 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
- [19] Harjes, C. E., Rocheford, T. R., Bai, L., Brutnell, T. P., Kandianis, C. B., Sowinski, S. G., Stapleton, A. E., Vallabhaneni, R., Williams, M., Wurtzel, E. T., & Buckler, E. S. (2008). Natural genetic variation in lycopene epsilon cyclase tapped for maize biofortification. *Science*, 319(5861), 330-333. <https://doi.org/10.1126/science.1150255>
- [20] Haskell, M. J., Jamil, K. M., Hassan, F., Peerson, J. M., Hossain, M. I., Fuchs, G. J., & Brown, K. H. (2004). Daily consumption of Indian spinach (*Basella alba*) or sweet potatoes has a positive effect on total-body vitamin A stores in Bangladeshi men. *The American Journal of Clinical Nutrition*, 80(3), 705–714. <https://doi.org/10.1093/ajcn/80.3.705>
- [21] Itodo, A. U., Okporie, P. J., Asemave, K., Obasi, S. C., & Ukpabi, U. J. (2022). Postharvest proximate and mineral compositions of orange-fleshed sweet potato treated with different concentrations chloride. of calcium *Chemistry Research Search Journal*, 13(1), 81-93.
- [22] Jenkins, M., Byker Shanks, C., & Houghtaling, B. (2015). Orange-fleshed sweet potato: Successes and remaining challenges of the introduction of a nutritionally superior staple crop in Mozambique. *Food and Nutrition Bulletin*, 36(3), 327–353. <https://doi.org/10.1177/0379572115597397>
- [23] Kebede, A., Beka, T., Asrat, W. Adamu, B., Birhanu, W., Aynalem, L. (2012). Detoxification and Consumption of Cassava Based Foods in South West Ethiopia. *Pakistan Journal of Nutrition* 11(3): 237-242. <https://doi.org/10.3923/pjn.2012.237.242>
- [24] Laryea, D., Wireko-Manu, F. D., & Oduro, I. (2018). Formulation and characterization of sweetpotato-based complementary food. *Cogent Food & Agriculture*, 4(1), 1517426. <https://doi.org/10.1080/23311932.2018.1517426>

- [25] Meilgaard, M. C., Carr, B. T., & Carr, B. T. (2006). *Sensory Evaluation Techniques* (0 ed.). CRC Press. <https://doi.org/10.1201/b16452>
- [26] Mengesha, A.K.; Bassore, D.G.; Endrie, S.G.; Brouwer, A.R. 2023. Evaluation of Nutritional Value, Consumer Preference and Profitability of Orange-Fleshed Sweet potato Puree Incorporated Bread and Injera. *Crop Science*. <https://doi.org/10.1002/csc2.21132>
- [27] Misgana Banti, Tegene Atlaw, Bilatu Agza(2020). Injera Making Quality Evaluation of Tef and Cassava Composite Flour. *American Journal of Bioscience and Bioengineering*. Vol. 8, No. 6, 2020, pp. 99-104. doi: 10.11648/j.bio.20200806.11
- [28] Montagnac J.A., Davis R.C., Tanumihardjo S.A. 2009. Nutritional value of Cassava for use as a staple food and recent advances for improvement. *Comprehensive reviews in food science and food safety*. Vol 8. 181-194. doi:10.1111/j.1541-4337.2009.00077.x
- [29] Neela Sathesh, Solomon, .W., and Fanta (2019). Review on Nutritional Composition of Orange Fleshed Sweet potato and its role in management of Vitamin A deficiency. *Journal of Food Science Nutrition*; 7:1920–1945
- [30] Nweke, F., Spencer, D., & Lynam, J. (2002). *The Cassava Transformation: Africa's Best-Kept Secret*. <http://www.jstor.org/stable/10.14321/j.ctt7ztc0t>
- [31] Tanumihardjo, S. A., Russell, R. M., Stephensen, C. B., Gannon, B. M., Craft, N. E., Haskell, M. J., Lietz, G., Schulze, K., & Raiten, D. J. (2016). Biomarkers of Nutrition for Development (BOND)-vitamin A review. *The Journal of Nutrition*, 146(9), 1816S-1848S. <https://doi.org/10.3945/jn.115.229708>
- [32] Shiferaw B., Ashenafi H., Beruk B., Hussien M. (2021). Cassava production practices in Ethiopia and its use as Ingredient for injera making. *Elisver*. Volume 6, December 2022, 100204. <https://doi.org/10.1016/j.fufo.2022.100204>
- [33] Wasihun Wale and Ermias Dureto (2021). Evaluation of maize-based, vitamin A-enriched flat bread from blending ratio of orange fleshed sweet potato (*Ipomoea batatas*) flour at Arbaminch, Southern Ethiopia. *Research Journal of Food Science and Nutrition*. Volume 6(2), pages 14-21, June 2021. <https://doi.org/10.31248/RJFSN2021.114>.