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Injera Preparation from Taro (*Colocasia esculenta)* and Teff (*Eragrostis tef*) *Flour*

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Abstract

Food formulation was done to increase the access of consumers to improved nutrients without any extra cost. Taro (Colocasia esculenta) is a root crop and it is a good source of carbohydrate minerals and vitamins. The objective of this study was done to evaluate taro flour for Ethiopian traditional flat sour pan cake “injera”. Taro Injera formulation was done using D-optimal mixture design to composite teff with taro. Mixing was done by two replication and has 10 runs. Injera was prepared by the method which is common to all nations. Sensory quality analysis was done using 5-point hedonic scale with 1 being disliked very much and 5 like very much. Proximate analysis was done using AOAC 2000 method to determine the organic materials of the products. Data analysis was done using Minitab17 for both parameters, significance was determined at p-value (0.05). From the result obtained, Sensory quality acceptance of injera decreased with the increment of taro level in the mixture for the product.

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The proximate composition for composite flour Injera moisture content, protein crude fiber, fat and carbohydrate was not show statically differences ($p>0.05$) in different mixing ratio. The ash content shows a significance difference ($p<0.05$) to show the effect of taro on composite flour Injera. The optimum point for both parameters (sensory and proximate composition) for injera preparation was15:85 for taro and teff respectively. Further studies on Taro flour production technology and on the effect of Taro based products on the general well being and improvement of its nutritional status would help to promote the utilization of taro.

Keyword: Food formulation; Taro; Wheat; Teff; bread; Injera.

1. Introduction

Injera is thin, fermented Ethiopian traditional bread made from flour, water and starter (ersho), which is a fluid, saved from previously fermented dough. Teff (Eragrostis tef (Zucc) Trotter) is the most popular grain for making injera, although other grains such as sorghum, maize, barley, wheat and finger millet are sometimes used. Teff (*Eragrostis tef*) has many prospects Ethiopia and outside due to its gluten-freeness, tolerance to biotic and abiotic stress, animal feed and erosion control quality. [1] Suggested that there is an increasing tendency for Teff export from year to year for Middle East, North America and Europe mainly for Ethiopian immigrants. Hence, diverse way of preparation and nutritional enhancement could have significant impact on the world wide trade and domestic utilization of the products. In this fact blending with other products would have help to improve the nutritional balance of food. Taro *(Coloacasia esculenta) L. Schoct*, a member of the Arecea family is an ancient crop grown throughout the humid tropics for its edible corms and leaves. About 60% (58 million metric ton) of the world production of 10.6 million metric ton is grown in Africa with Nigeria having the largest production [2].

aro *(Coloacasia esculenta) L. Schoct*, a member of the Arecea family is an ancient crop grown throughout the humid tropics for its edible corms and leaves. Taro is a fairly good source of protein, but rich in carbohydrate, vitamins and the essential amino acids such as lysine, leucine, isoleucine [3]. Despite the high starch content of edible aroids, they have higher content of protein and amino acids than any tropical root crops [4].

Taro is rich in energy or carbohydrate, low in fiber and is a fair source of oils and fats. When compared with other roots, it has the highest source of phosphorus, magnesium and zinc. The protein of taro is well supplied with essential amino acids though in low histidine and lysine. It is fairly rich in carotene, ascorbic acid, thiamine, riboflavin and nicotinic acid. Most of thenon-starchy nutrients such as proteins, minerals are concentrated in the outer peels of the corms [5]. Food and nutrition security is a major global concern, especially in the developing countries. Currently, many countries in sub-Saharan Africa depend on a narrow base of food because there are situation minimizes variety in food production that lead to insecurity in food and poor nutrition as well as limited purchasing power of the population. *Injera* from tef grain is most preferred and consumed daily by the majority of Ethiopian people [6].

Due to high domestic grain prices, exports of teff from Ethiopia are banned, but some fresh *injera* made from teff is being exported to the Ethiopian Diaspora and non Ethiopians. Although this positively impacts foreign currency earning, it further increases the price of teff making teff injera unaffordable for low income citizens that depend on it as a daily staple. Therefore, the aim of this particular study is to prepare nutritionally rich and socially acceptable *injera* from optimal mixture of Taro, Teff and wheat flours.

Objectives

To evaluate taro flour for injera preparation

Specific objectives

To have the optimum point for teff and taro injera formulation

To improve the nutritional quality of teff injera

2. Materials and Methods

2.1. Taro preparation

Taro tubers were collected from shewarobit integrated research and development farm of Debre Berhan University for common food preparation. The raw taro corms was undergo different physical treatments such as washing, peeling, chopping, soaking, sun drying) before they were processed into taro powder to reduce their anti-nutrient contents based on the study of [7]. Then dried taro tubers were milled using mini laboratory miller in Jimma University, College of Agriculture and Veterinary Medicine, post-harvest laboratory. The flours were packed in polyethylene bags to preserve the row material.

2.2. Wheat and Teff preparation

Teff variety which is known as “Kuncho” was collected from Debrezeyit farmers union. Teff grain undergoes different cleaning procedures and then milled using mini laboratory miller. Teff flour was packed in polyethylene bag to preserve the product.

2.3. Experimental design

The formulation was obtained based on a constrained D-optimal mixture design. Table1 presents samples codes and actual ratio of ingredients values for Injera. There were 10 sets of experimental combinations.

2.4. Injera preparation

The traditional method of Injera preparation varies from household to household and from region to region. However, in general Injera preparation involves two fermentation stages. The first takes 24-48hr (depending on the sourness desired) from mixing the flour with water and adding the back-slopped culture. Then a portion of the fermented dough was cooked and added back to the fermented dough to initiate the second fermentation. The mixture was brought to a batter consistency and subsided the batter was poured on a hot clay griddle, baked and covered.

Table 1: Constraints used for Injera formulation

Std	Run	Component A: Teff	Component B: Taro
1	1	**75**	**25**
2	2	**85**	**15**
3	3	**75**	**25**
4	4	**80**	**20**
5	5	**80**	**20**
6	6	**85**	**15**
7	7	**70**	**30**
8	8	**90**	**10**
9	9	**70**	**30**
10	10	**90**	**10**

2.5. Data collected

Proximate composition

Proximate composition of each *Injera* prepared from different levels of the composite flour was determined. All analyses were performed in duplicate. The details of each composition analysis were discussed as follow in the sub-section here under.

Moisture

Method number 925.05 of the AOAC 2000 was used to determine the moisture contents of the samples. The dishes were dried at 130^{0}C in drying oven (dry oven, DHG-9240A. shanghai) for one hour and placed in desiccators for about 15-20 min. The mass of the dish was measured (M1). About 2-3 g of the sample was weighed into the moisture dish (M2). Then the sample was dried at 100 ºC for 6 hrs. After drying was completed, it was measured as M3.

$$\boldsymbol{Moisture}(\%) = \frac{\boldsymbol{M3 - M1}}{\boldsymbol{M2 - M1}} \boldsymbol{X100}\%$$

Where, M_1= weight of dish, M_2= weight of dish plus fresh sample, M_3= weight of dish plus dry sample

Total ash

AOAC 2000, method number 941.12 was used to determine the total ash and the porcelain dish which was cleaned and dried in an oven at 120 ºC. The samples were ignited at 550 ºC in a Muffle furnace for 12 hrs. Then the dishes were removed from the furnace and cooled in desiccators. The mass of the dish was weighed (M1) using analytical balance. About 5g of the sample was weighed in to porcelain dish (M2).The sample was dried at 120ºC for one hour in a drying oven.

$$\boldsymbol{Ash}(\%) = \frac{\boldsymbol{M3 - M1}}{\boldsymbol{M2 - M1}} \boldsymbol{X100}\%$$

Where M_1 is mass of crucible in g, M_2 is mass of crucible and sample in g before ashing and M_3 is mass of crucible, the sample and ash after ashing in g.

Dietary fiber

Crude dietary fiber was determined following *(AOAC 2000, 920.169).* About 1.5g of the sample was weighed. If the sample contains fat>1%, the fat was extracted by diethyl ether:- by replacing 0.25-0.5g bumping granules, followed by adding 200ml of 1.25% sulfuric acid solution to the beaker near-boiling. The sample in the beaker was boiled for 30min by swirling it periodically. Near the end of refluxing, it was placed in Buchner funnel fitted with rubber stopper and filtered.

At the end of filtration the solids were washed by distilled warm water and 1.25% sodium hydroxide solution. The filtration continued until dry. The residue was, dried for 2h at 130^0C, cooled in the desiccators and weighed (M1). Then ignited and ashed at 550^0C in a furnace, cooled in desiccators and weighed (M2). Finally the crude fiber percentage was calculated as follows:

$$\boldsymbol{Crude\ fiber}(\%) = \frac{\boldsymbol{M1 - M2}}{\boldsymbol{weight\ of\ sample}} \boldsymbol{X100}\%$$

Crude protein

Crude protein was determined using Kjeldahl method as described in AOAC (1990). About 0.3g of ground sample (1mm sieve size) was weighed in to Kjeldahl digestion flask (distillation device, KDN-F, shanghai) and catalyst mixture (K_2SO_4 mixed with $CuSO_4.5H_2O$ in the ratio of 1:10) was added in to each flask. Then, 10 ml of concentrated H_2SO_4 (98%) was added and the sample was digested at a temperature of 420°C for about 3 hrs until the solution was clear white. With the completion of digestion (when the digested sample becomes colorless or light blue) the samples was allowed to cool. After the samples were cooling, 30ml of distilled water was added in to each digestion flask followed by 25ml of 40% NaOH. Immediately the content was distilled by connecting the digestion tube line in to the receiver flask that contains 25 ml of 4% boric acid solution. The collected ammonia distillate was then titrated against a standardized 0.1N HCl until the end of the titration is attained (where the titration color changes from green to purple). Then the volume of HCl consumed to reach the titration end point was read from the burette and the nitrogen content % was calculated as follows:

$$\boldsymbol{N}(\%) = \frac{\boldsymbol{NHCl} \times (\boldsymbol{VHCl - VBlank}) \times \boldsymbol{14.007}}{\boldsymbol{sample\ ewight} \times \boldsymbol{10}}$$

Where V_{HCl} is volume of HCl in liter consumed to the end point of titration, N_{HCl} is the normality of HCl used. V Blank volume of blank used for titration.

Crude Fat

About 3g of sample was weighed and put into a thimble lined with a circle of filter paper according to method number 4.5.01 *of* the *AOAC 2000*. The thimble and contents were placed into a 50ml beaker and dried in an oven for 2h at 110^0C. Thimble and contents were transferred in to extraction apparatus(fat determinator,SZC-C,Shanghai). The beaker was rinsed several times with diethyl ether. The sample contained in the thimble were extracted with the solvent diethyl ether in a Soxhlet extraction apparatus (2055 soxtec, sweden) for 2:30 hr. At the completion of the extraction, the extracted was transferred from the extraction flask into a pre-weighed evaporating small beaker (150-250ml) by rinsing with the solvent several times. The diethyl ether was evaporated until no odor was detected. The beaker and contents were dried in an oven for 45min at 100^0C.Then the beaker was removed from the oven and cooled in a desiccators. The beaker and its contents were weighed.

$$\boldsymbol{Crude\ fat}(\%) = \frac{\boldsymbol{M1 - M2}}{\boldsymbol{weight\ of\ sample}}\boldsymbol{X100}\%$$

Crude carbohydrate

Total carbohydrate was determined by difference according to AOAC (1990) with the exclusion of crude fiber.

Total CHO = Total sample of food-(Crude protein + Total Fat + Moisture + Ash)

2.6. Sensory evaluation

Sensory evaluation was conducted by using randomly selecting 46 semi-trained panelists were participated from JUCAVM post-harvest post graduate students and staff members. Samples were presented in identical sample presenting dishes coded with 3-digit random number with a sensory data ballot paper.

The results were obtained by giving a score using 5 point Hedonic scales with 1 being dislike very much and 5 like very much. The order of presentation of the samples to the panel was randomized according to (Ihekonronye and Ngoddy, 1985).

2.7. Data analysis

The data was analyzed using minitab17 software package. Significant differences in proximate composition and sensory evaluation was identified at ($P<0.05$), descriptive statistics was used for organizing and presenting the data.

3. Result and Discussion

3.1. Sensory Quality of Injera

Sensory quality and proximate composition for Injera was determined using standard methods. Injera preparation was done using traditional method which was commonly applied to all nations. From the mean values observed on table2 the compositing ratio of taro lied in between 10-30% developed by mixture soft ware. The maximum level of taro used to composite Teff was fixed by previously done preliminary taste to fix top level (30%).

To evaluate the acceptance of consumers for newly developed taro-Teff composite Injera at different level, sensory data were collected from semi-trained panelists from JUCAVM staff members and students. As shown in Table 3, acceptance of panelists decreased with the increment of taro level in the mixture for the product. The sensory quality parameters whiteness of bottom surface, eye evenness, eye distribution, eye size, shinnies of top surface, stickiness, roll ability, sourness, bitterness, sweetness, sourness after taste and sweetness after taste were not statically significant($p>0.05$). Whiteness of top surface and softness were shows statically significant ($p>0.05$) differences.

For the taro level in composite flour above 15% the stickiness of injera was increased this is not accepted by consumers and considers as low quality injera. In the same way the sourness after taste was increased with higher level of taro this is due to its richness in carbohydrate.

Roll- ability is one of the criteria to evaluate the quality of injera in Ethiopia, good quality injera were rolled without fracturing and sticking the roll-ability of composite injera was accepted up to 15% taro. Eye evenness and eye distribution was good at taro level of up to 15%. In general compositing teff injera with taro at 15% level gives an acceptable and good quality injera.

3.2. Proximate Composition for Injera

Laboratory analysis was done to determine the organic materials found in formulated Injera. Result determination was done using internationally developed AOAC methods. Data collection was done in Jimma University animal nutrition laboratory.

The mean values presented in table4 shows that the percentage of carbohydrate is increased with the level of taro.

The proximate composition for composite flour Injera moisture content, protein crude fiber, fat and carbohydrate was not show statically differences ($p>0.05$) in different mixing ratio.

The ash content shows a significance difference ($p<0.05$) to show the effect of taro on composite flour Injera. Both taro and teff were rich in their mineral composition. Naturally teff have high amount of iron content when compared with other cereal grains especially in calcium and iron [8].

Table 2: Mean value table for sensory quality of Injera

Trt	Teff%	Taro%	whb	wht	Eyev	Eyed	Eyes	Sht	Sof	Stk	Rol	Sor	Bit	Swt	SorA	BitA	SwtA
T1	**75**	**25**	2.1	2.1	2.0	2.0	2.3	2.3	2.8	2.6	2.6	2.7	2.6	2.4	2.6	2.6	2.6
T2	**85**	**15**	3.0	3.1	3.1	3.2	3.2	3.2	3.3	3.1	3.0	3.0	3.1	3.2	2.9	3.0	3.1
T3	**75**	**25**	2.2	2.4	2.2	2.5	2.7	2.7	2.7	2.6	3.1	3.0	2.8	2.6	2.8	2.7	3.0
T4	**80**	**20**	2.8	2.6	2.9	3.1	2.9	2.8	3.2	3.2	3.2	3.0	2.7	2.9	3.1	2.9	3.0
T5	**80**	**20**	3.1	2.6	3.0	3.0	3.0	3.3	3.2	3.0	3.2	3.2	3.1	2.9	3.2	2.8	3.1
T6	**85**	**15**	3.0	3.0	3.4	3.4	3.4	3.2	3.3	3.0	3.3	3.0	2.6	3.0	3.2	3.0	3.2
T7	**70**	**30**	2.4	2.4	2.3	2.6	2.8	3.0	3.2	3.0	3.1	3.2	2.6	2.6	2.9	3.0	2.7
T8	**90**	**10**	3.5	3.4	2.9	2.8	3.0	3.1	3.6	3.0	3.2	3.2	3.0	3.1	3.0	3.0	3.1
T9	**70**	**30**	2.4	2.3	2.2	2.3	2.5	2.7	3.0	2.7	3.0	2.8	2.7	3.2	2.7	2.6	2.8
T10	**90**	**10**	4.0	4.1	4.0	4.0	4.0	3.8	3.9	3.9	3.9	3.4	3.3	3.4	3.7	3.6	3.7

Whb=whitness of bottom surface **Wht**= whitness of top surface **Eyev**=eye evenness **Eyed**=eye distribution **Eyes**=eye size **Sht**=shiness of top surface **Sof**= softness *Stk=stikness Rol= rollability Sor=sourness Bit= bitterness Swt= sweetness SorA=sourness after taste BitA=bitterness after taste SwtA=sweetness after taste*

Table 3: mean values for proximate composition of Injera

Trt	Teff%	Taro%	MC%	Ash%	Protein%	Crude fiber%	Fat%	CHO%
T1	75	25	9.3	18.5	1.23	8.56	1.9	82.6
T2	85	15	9.2	14.6	1.77	6.09	2.05	65.6
T3	75	25	9.3	18.1	1.39	8.0	0.85	81.7
T4	80	20	9.3	16.74	1.41	7.83	1.75	70.4
T5	80	20	9.4	16.5	1.55	7.41	3.27	73.2
T6	85	15	9.3	14.0	1.85	5.86	1.39	70.1
T7	70	30	9.4	21.0	1.12	8.50	1.35	86.1
T8	90	10	9.4	7.2	1.93	5.67	1.35	58.1
T9	70	30	9.3	20.0	1.05	9.06	1.65	85.9
T10	90	10	9.2	7.5	2.01	5.03	2.87	60.3

MC= moisture content CHO=carbohydrate

4. Conclusion and Recommendation

Injera preparation was done from Teff-taro formulated flour respectively. The formulation was done using D-optimal mixture design and the prepared food (Injera) was evaluated for sensory quality and proximate composition of their blend. The parameters were analyzed using Minitab software and their statistical significance test level was set at 5% probability level.

Sensory quality and proximate composition of Injera was determined using standard methods. Injera preparation was done using traditional method which was commonly applied to all nations. Sensory quality acceptance of injera decreased with the increment of taro level in the mixture for the product. The proximate composition of composite flour Injera moisture content, protein crude fiber, fat and carbohydrate was not show statically differences ($p>0.05$) in different mixing ratio. The ash content shows a significance difference ($p<0.05$) to show the effect of taro on composite flour Injera. The optimum composition point (85:15) teff with taro respectively to obtain a good quality injera for both sensory parameters and nutritional quality when compared with other combination in both parameters.

5. Recommendation

Based on the study result the following future line work recommendations may be suggested:

Addition of other micro nutrients like Vitamins and other essential minerals will help to Increase the food value of Injera.

Further studies on Taro flour production technology and on the effect of Taro based products on the general well being and improvement of its nutritional status would help to promote the utilization of it.

Strong attention should be given to perform further work on the promotion of the taro crop and their value added products in all parts of Ethiopia.

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