CASSAVA PRODUCTION PRACTICES, UTILIZATION AND EVALUATION AS INGREDIENT FOR INJERA MAKING AT AMARO AND OFFA DISTRICTS, SOUTHERN ETHIOPIA

MSc. THESIS

SHIFERAW BOGALE MANDOYE

HAWASSA UNIVERSITY

COLLEGE OF AGRICULTURE

HAWASSA, ETHIOPIA

MAY, 2021

CASSAVA PRODUCTION PRACTICES, UTILIZATION AND EVALUATION AS INGREDIENT FOR INJERA MAKING AT AMARO AND OFFA DISTRICTS, SOUTHERN ETHIOPIA

SHIFERAW BOGALE MANDOYE

Major-advisor: - Hussien Mohammed B. (PhD)

Co-Advisor: Ashenafi Haile (Ass. Professor)

Co-Advisor: Beruk Berhanu (PhD)

A THESIS SUBMITTED TO THE

SCHOOL OF PLANT AND HORTICULTURAL SCIENCES

COLLEGE OF AGRICULTURE

HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGRREE OF

MASTER OF SCIENCE IN PLANT SCIENCE
(SPECIALIZATION: HORTICULTURE)

MAY, 2021

COLLEGE OF AGRICULTURE

SCHOOL OF PLANT AND HORTICULTURAL SCIENCES

APPROVAL SHEET I

(Submission sheet-1)

This is to certify that the thesis entitled "**Cassava Production Practices, Utilization and Evaluation as Ingredient for Injera Making at Amaro and Offa Districts, Southern Ethiopia**" submitted in partial fulfillment of the requirements for the degree of masters of science with specialization in Horticulture the Graduate Program of the School of Plant and Horticultural sciences and has been carried out by **Shiferaw Bogale Mandoye** under my/our supervision and no part of the thesis has been submitted for any other degree or diploma. The assistance and help received during the course of this investigation have been well acknowledged. Therefore I/we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

______________________	______________	______________
Name of major advisor	**Signature**	**Date**
______________________	______________	______________
Name of co- advisor	**Signature**	**Date**
______________________	______________	______________
Name of co- advisor	**Signature**	**Date**

SCHOOL OF GRADUATE STUDIES
HAWASSA UNIVERSITY
APPROVAL SHEET II
(Submission sheet-2)

We, the undersigned member of the Board of Examiners of the MSc Thesis Open defense by Shiferaw Bogale Mandoye have read and evaluated his/her thesis entitled "**Cassava Production Practices, Utilization and Evaluation as Ingredient for Injera Making at Amaro and Offa Districts, Southern Ethiopia**"evaluated and examined the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillments of the requirements for the Degree of Master of Science in Horticulture.

______________________	__________	________________
Name of chairperson	Signature	Date
______________________	__________	________________
Name of major advisor	Signature	Date
______________________	___________	________________
Name of internal examiner	Signature	Date
______________________	___________	________________
Name of external examiner	Signature	Date
_____________________	____________	_________________
SGS	Signature	Date

Final approval and acceptance of the Thesis is contingent upon the submission of its final copy to the Council of Graduate Studies (CGS) through the candidate's department or school graduate committee (DGC or SGC).

Stamp of SGS__________________ Date _________________

DEDICATION

This thesis is dedicated to my beloved Child, Ms Kalkidan Shiferaw, whom I got during entrance exam period.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLE IN APPENDICES

STATEMENT OF THE AUTHOUR

I declare that this thesis is my original work and all sources of materials used for this Thesis have been duly acknowledged. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

Shiferaw Bogale Mandoye	__________	_____________
Name of student	Signature	Date

Place: Hawassa University, Hawassa

Date of Submission: _________________________

ACKNOWLEDGMENT

First, I would like to thanks the Almighty God for giving me health and strength for the completion of this study.

I would like to express my sincere gratitude to my major advisor Hussein Mohammed Bashir (PhD) and co-advisor Ashenafi Haile (Ass. prof.) and Beruk Berhanu (PhD) for their invaluable comments, guidance and encouragement from proposal write up to submission of the thesis.

I am thankful to the School of plant and Horticulture, Hawassa University, College of Agriculture for allowing me to use their facilities and Areka Agriculture Research Center for providing me the experiment work sample.

I express my appreciation to Agricultural Officers in Offa and Amaro kello district for their support during my survey work, and all my friends (especially Zerhun Dotora and Shimelis Shibru for their idea of this study, Sunkurta Digasa and Legese Tunsisa who motivated and help me for my work) and all those who participated in this work in which ever capacity. My appreciation also goes to all the four Kebeles farmers who provided me with the information and the 4 Kebeles agriculture extension staff who helped with the survey work. I would like to thank all staff members of Hula district youth offices for their permission to get the MSc study chance especially the former Hula District youth head Officer Mr. Basaye Barasa. Finally, I would also like to express my gratitude to all my beloved families.

LISTS OF ABBREVIATIONS AND ACRONYMS

AWADO	Amaro woreda agricultural development office
ANOVA	Analysis of Variance
CN	Cyanide
CRD	Completely Randomized Design
CSA	Central Statistics Agency Ethiopia
CV	Coefficient of Variance
DM	Dry matter
FW	Fresh Weight
FAO	Food and Agriculture Organization
GDP	Gross domestic product
Masl	meter above sea level
MoARD	Minister of agriculture and rural development
SAS	Statistics Analysis Software
SNNPR	South Nations Nationalities and People’s Region
SPSS	Statistics Package for Social Science
WZFED	Woliata zone finance and economic development

Cassava Production Practices, Utilization and Evaluation as Ingredient for Injera Making at Amaro and Offa Districts, Southern Ethiopia

ABSTRACT

Cassava is commonly known as the poor man's crop and emerging as dominant staple and alternative food security crop in southern Ethiopia. However, limited research has been done so far for identifying suitability variety as ingredient for injera making. Therefore, household survey and laboratory analysis experiment were conducted to determine farmer's practices in selecting suitable cassava variety with its ratio as ingredient of injera making. Based on the survey result laboratory analysis was conducted with different ratio of cassava blended with teff to verify the farmer's practice. Purposive sampling technique was used to select the respondent households. The survey result revealed that Qulle (20.8%), Kello (12.5%) and both Qulle and Kello (70%) were identified as the common cassava varieties in the study area. The household reported that, yield, maturity earliness, resistance to disease and pest (53.3%) are the major criteria for selecting the variety. About 45% of the respondent were used 40 to 60 ratio of cassava with teff followed (38.3%) by 50 to 50 as ingredient of injera. During the laboratory analysis, two cassava varieties (Qulle and Kello) and five blending ratios (10, 20, 30, 40 and 50%) of cassva with teff were tested in Randomized Completed Design with three replications. Teff with 100% was used as a control. The result revealed that, cassava varieties and blending ratio had significant effect on protein, fiber, fat, ash and cyanide content while non-significant effect on moisture and carbohydrate, respectively. Higher protein, fiber and fat, ash content was recorded from 90% teff with 10% Qulle and Kello variety. The result further explained that, as cassava proportion were increased; protein, fat, ash and fiber content decreased but moisture and carbohydrate content were increase. Composite injera with 50% of Kello variety has highest cyanide content (0.48mg/100g) than that of Qulle. Higher score of acceptability for texture (7.23%), sourness (7.56%), aroma (7.58%) and taste (7.33%) were recorded from 10% of Kello variety than Qulle. Therefore, it can be concluded that, for cassava-teff injera preparation mixing the cassava up to 30% is found to be acceptable. Further research should be done in cassava starch characterization as the staling and less eye formation are the major traits to be improved for increasing the quality of injera prepared from teff mixed with cassava.

Key words: *Cassava variety, Blending ratio, Proximate, Cyanide content, Acceptability*

1. INTRODUCTION

1.1. Background and Justification

Cassava is a dicotyledonous plant of the family Euphorbiacea and in the genus Manihot. In the Manihot family, there are about 100 species of these, *Manihot esculenta* is the only one commercially cultivated and widely grown in the tropics and subtropics for its tuberous starch-filled roots (Benesi, 2005).

Cassava is originated from South America and introduced to different continents. For instance, it was introduced to Africa by the Portuguese traders, first in to western part of the continent through the Gulf of Benin and also through Congo River after the mid of 16th century, then later distributed into East Africa towards the end of the 18th century (Christopher, 2008).

Cassava is a perennial herbaceous shrub which can grow up to 4 m height, and the tuber is long and tapered with a firm homogenous flesh encased in detachable rind, about 1mm thick, rough and brown on the outside. The flash can be white or yellowish (Burns and Devendra, 2010). The mature cassava plant (12 months old) contains about 6% leaves, 44% stem and 50% tuber. It has leaves that are fingerlike with deep indented, palmate 3-7 lobed, which are attached with a slender stem by the long petioles. It is also characterized by having small, greenish-yellow flowers in the panicles; once the seeds are formed within the capsules, they will burst out distributing the loads during ripening (Aye *et al.*, 2013).

Lowland tropics are the favorable environment for cultivation of Cassava, where the mean annual temperature ranges between 25 and 30 ^{0}C and lies between 30^0 N and 30^0 S of the equator (MoARD, 2011). However, it can grow optimally when the annual rainfall is 1000-1500 mm per annum, with good lighting, sandy loam soil with medium fertility level and with good draining, and has a potential to survive when rainfall is as low as 500 mm, otherwise the cassava plant will stop the growth and shed out the older leaves in severe situation (cold climate < 10^{o}c, and regain its growth and produce new leaves when the stress is lesser (El- Sharkawy, 1993; MoARD, 2011).

In terms of production, the global production of cassava was more than 291 million tons in 2017, of this, nearly two-third were accounted for Africa. Among the cassava producing countries, Nigeria is the world's largest producer, covering about 20% of the total production, and earned

$136 million in 2013 by exporting it (IITA, 2021). Known with its broad adaptation to a variety of soil, climate, drought tolerance, and ability to grow on marginal soil, cassava has been recognized as an important crop for the agro-economy of several tropical and sub-tropical countries (Li *et al.,* 2007).

Cassava tubers can be left in the ground without harvesting for longer time and ability to be grown with other crops, and the potential of feeding the leaves and the tubers /roots as food and feed for human and animals, cassava can be considered as nutritionally strategic famine crop and could support food security in areas of low rainfall, where frequent drought episode and food insecurity problem prevail, and challenge the peoples of the rural poor depend on agriculture (El-Sharkawy, 1993).

These make cassava the 4th important source of energy for tropical farmers, next to rice, wheat and sugar, where up to a billion people are consuming it (FAOSTAT, 2015).

In Ethiopia, cassava was believed to be introduced around 1960 by the British citizens, but it was not consumed until 1984 (Amsalu, 2003; Aweke *et al.,* 2012). Majorly it has been grown in vast areas of the south and southwest Ethiopia, such as Amaro, Gamo goffa, Sidama, Wolayta, Gedeo primarily to fill the gap for subsistence farmers due to failure of other crops as a result of drought (Feleke, 1997) . Due to its multipurpose important to mitigate the ever-impacting climate change and variability impact and its being among the food security crops, it has been distributed and adapted to different drought areas of the country.

Cassava root is an energy-dense food. In this regard, cassava shows very efficient carbohydrate production per hectare. The root is a physiological energy reserve with high carbohydrate content, which ranges from 32 to 35% on a fresh weight (FW) basis, and from 80 to 90% on a dry matter (DM) basis (Julie *et al.,* 2009). The fiber content in cassava roots depends on the variety and the age of the root. Usually, its content does not exceed 1.5% in fresh root and 4% in root flour (Gil and Buitrago, 2002). It is a poor source of protein as it contains only 1-3% protein on dry matter basis (Montagnac *et al.,* 2009) and is low in essential amino acids such as methionine, lysine, tryptophan, phenylalanine and tyrosine (Falade and Akingbala, 2010). The lipid content in cassava roots ranges from 0.1 to 0.3% on a FW basis. Cassava roots have calcium, iron, potassium, magnesium, copper, zinc, and manganese contents comparable to those of many legumes, with the exception of soybeans. The calcium content is relatively high compared to that of other staple crops and ranges between 15 and 35 mg/100 g edible portion. The vitamin C (ascorbic acid) content is also high and between 15 to 45 mg/100 g edible portions (Charles *et al*., 2005). Usually, the mineral and vitamin contents are lower in cassava roots than in sorghum and maize (Gil and Buitrago, 2002).

Cassava varieties are classified according to morphological trait as well as taste, cyanide content, average yield disease performance pubescence (Gbadegesin *et al.*, 2008). It has bitter and sweet varieties. In the latter varieties, up to 17% of the root is sucrose with small amounts of dextrose and fructose (Charles *et al.*, 2005).

Cassava roots are cooked in various ways in order to turn them to food. The soft-boiled root has a delicate flavor and can replace boiled potatoes in many uses: as an accompaniment for meat dishes, or made into purées, dumplings, soups, stews, gravies, etc. Deep frying (after boiling or steaming) can replace fried potatoes, with a distinctive flavor. Cassava flour, can also replace wheat flour (Katz and Weaver, 2003). However, high quality cassava can be used to produce fine flour from whole freshly harvested cassava (9-10 months) after planting and contribute appreciably to cassava industrial evolutions (Sanni *et al.*, 2009).

It is a major food crop, which has different importance for households are consumed across the Amaro Woreda. For example, it is used as food for a human nutrition's (which is suitable for preparation of local foods and drinks like; bread, injera, unkuro, bille, qunchiissaa, boridee, marissaa, tsigina chaqqaaand, etc), for animal feed (such as for bee, poultry, cattle, goats, sheep, camels, donkeys, horses, mules, pigs and so on), for fencing of compounds and for so many other purposes in Amaro Woreda (MoFED, 2013).

Recently, the use of cassava as ingredient for injera making in the farming households of Amaro and Wolaita districts, and also in the commercialized injera in the urban areas of the SNNP region such as Hawassa, Soddo and Dilla towns by blending with teff (especially the red colored one) has been increasing dramatically. Specifically, the major reasons for the selling mothers to blend cassava with red injera are, a) the price for cassava is lower than teff, so that it will reduce the cost of teff flour, b) the use of red teff will reduce the cost for superior injera, which is white as per the consumer perception, due to the cost of white teff is lower than that of the red teff, in this case, the whiteness of the injera will come from cassava color, thus the profit margin will be increased. However, the injera produced by blending teff or other major cereals with cassava lacks the roll-ability and easily brittle feature and loss of eyes. These reasons also work for the poor households with an interest of eating injera in their families. Furthermore, the perception of cyanide presence in the cassava as a threat for the health by the consumers attract the interest of researches to explore the suitability of cassava for injera making, to further increase the economic benefit of cassava growing farming households.

1.2. Statement of problem

Cassava is a major staple food in the developing world, providing a basic diet for over half a billion people (FAO, 2003). It has a potential to increase farmer income, reduce rural and urban poverty and minimize the food insecurity gap for the rapidly growing population. For Ethiopians, the consumption of cassava as food has immense importance and regarded as the food security crop for millions of people. However, lack of awareness about cassava consumption and utilization considered it as less important and is planted at the backyards and farm borders as fence. In southern parts of Ethiopia, particularly in Amaro kebele special woreda, woliata and Gamo Gofa zones, cassava roots are widely consumed after washed and boiled or mixed with other crops to produce bread and injera. Beside this, the consumption of injera produced from cassava and teff has been observed in urban town of the region including Hawassa, Woliata and Dilla. The use of cassava for injera making and other food product development is encouraged these days, as the price of teff a sole crop for producing superior injera production is dramatically increasing. Therefore, using cassava for injera making by blending with teff is important to reduce the high cost of injera than the injera made from teff alone for household consumption and commercial purpose (Nweke *et al.*, 2001).

So far, there are different research findings that were done on injera produced from cassava and other cereal blends. Despite these, there is no study, which considers the suitability of different cassava variety as ingredient for injera making in the study area and the region at large. Currently, there are criteria at the farmer level to select the cassava variety for injera making. However, this is not studied yet. Furthermore, the cassava variety which has been used for injera making is not scientifically characterized, which might be used for improving the productivity and utilization of the cassava, and by improving the quality of injera to be produced from the cassava and other cereal blended flour at large scale by using different cassava improving agricultural technologies like breeding. It also helps the farmers to start commercialized cassava farming for Injera making. These may improve the livelihood of the farmer producing cassava in the region. Therefore, assessing the cassava utilization and evaluation for injera making at the cassava producing households, and characterizing the cassava variety selected at the farmer level for injera making at the field and laboratory level including injera making from the cassava variety suitable for quality injera making with teff is initiated in this study.

1.3. Objectives

1.3.1. *General objectives*

- To assess cassava production practices, utilization and evaluation as ingredient of injera at Amaro and Offa districts.

1.3.2. *Specific objectives*

- To study farming households' criteria for selecting cassava variety for injera making and their injera making ratio
- To evaluate the proximate composition and cyanide contents of injera prepared from two dominant cassava varieties (Qulle 44/72 and Kello 104/72) blended at different proportion with teff.
- To evaluate the consumer acceptability of injera prepared from two dominant cassava varieties (Qulle 44/72 and Kello 104/72) blended at different proportion with teff

2. LITERATURE REVIEW

2.1. Taxonomy and Description of Cassava

Cassava is little-branched woody herb that grows up to 5 m. It has large and starchy roots and leaves are 3-5(-7) lobed (Gilbert, 1995). The genus Manihot belongs to the Euphorbiaceous family with 2n=36 and has about 100 species, among which Manihot esculenta is the only one commercially cultivated (Nassar, 1978) and which grows continuously, with alternating plant growth periods and carbohydrate storage in its tuberous roots followed by periods of dormancy (Alves, 2002). In Ethiopia, cassava is locally known as "Yefurnoduketzaf" (Amharic), Mita boye (wolaitigna), Mogo (koregna) Batata (Soomaali), Deekikaa or Muka Furuno (Afaan Oromo) were commonly grown (Gilbert, 1995).

Stems, when planted, produce sprouts and adventitious roots within one week. Seeds are normally dormant and slow germinating. Seed dormancy does not break by scarifying the micropylar end; nevertheless, thermal treatment is the best, i.e., a temperature of 18^0c for 16 h or $26^0{}_C$ for 8 h to achieve seed germination. Seedlings ensuing from sexual seed are normally weaker than those from cuttings (Nassar and Ortiz, 2007).

2.2. Origin and Distribution of Cassava

Cassava is an ancient crop species, and estimated as domestication began 5000-7000 years BC. The origin of cassava (*Manihot esculenta*, *Cranz*) has been obscure for long time. This estimation receives support from archeological findings in the Amazon. According to this estimation, the crop was already cultivated in all Neo tropical America by the time when the first European reach there and wild population of cassava that is indistinguishable on morphological ground from the domestic one was found in central Brazil (Olsen and Schaal, 1999) and confirms the botanical origin of the Plant (Allem, 2002). Cassava is native to southern America but it is currently grown throughout the tropics and sub-tropics (Allem, 2002).

It has been called the drought, war and famine crops because it can be grown in challenging conditions (dry soil with low fertility) and it can be harvested when needed (not only at the end of the growing season), providing the reserve of food at the time of war and famine (Burns *et al.*, 2010). Cassava was introduced to West Africa coast by Portuguese sailors from Brazil in the

16th century. Initially the crop was not accepted but now it has spread and gained prominence as a major food for many communities in Sub-Saharan Africa (Were, 2004).

The crop is now produced in 40 of the 53 countries of SSA, account for 61% of global production (FAO, 2013). In Ethiopia, this crop has been cultivated in the southern and southwestern regions for decades as an alternative food insecurity crop (Taye, 2000; Desse and Taye, 2001). Cassava bread becomes the first Cuban industry established by the Spanish and sometime described as the bread of the tropics (Olsen and Schaal, 1999).

2.3. Importance of Cassava

For many tropical East Africa, Asia and Latina America, cassava is one of the major food sources for human beings and animals, because it is the cheapest source of starch. It is the third most important source of calories in the tropics, after rice and corn (FAO, 2001). It is very important for the agro economy of several tropical countries because of its broad adaptation to a variety of soil, climate, drought tolerance, and ability to grow on marginal soil (Anh *et al.,* 2007).

In addition, cassava roots provide more than 60% of the daily energy intake for the population of Northeast Brazil and many countries in Africa (Coursey and Haynes, 1970; Nassar *et al.*, 2009). Recently, cassava is used as a raw material in the production of ethanol, glue and glucose syrup (Bamidele*et al.,* 2008). In Southeast Asia, it had become an industrial cash crop where it has been a subsistence crop (Nassar and Ortiz, 2007).

It plays major role in efforts to alleviate the Africa food crisis because of its efficient production of food, year-round availability, and tolerance to extreme stress condition (Hahn, 1987). Cassava has same inherent characteristics which make it attractive, special to the smallholder farmer in Ghana (Bokanga, 1992). Cassava is the third most important food in the tropic, after rice and maize. It derives from the fact that its starch, tuberous roots are valuable source of cheap calories special for 500 million people, for those area where food supply is constantly threatened by environmental constraints such as drought and pest outbreak, because of its ability to grow under conditions considered as suboptimal for majority of food crops in many of the in Africa (Yeoh *et al.,* 1998).

Currently, cassava is fourth largest source of carbohydrates for human food in the world, and it has high growth rate optimal conditions tuberous root as well as leaf are used as human food, animal feed and industrial products (El-Sharkawy, 2004; Sheffield *et al*., 2006; and Gbadegesin *et al*., 2008).

Cassava roots contain high energy and high levels of some vitamins, minerals and dietary fiber, and contain no trypsin inhibitor, but create a problem due to the presence of cyanide which is removed by postharvest treatments and cooking (Prathibha *et al.*,1995). The edible green leaves of cassava are good source of protein, vitamins and minerals and are often used to augment the rural diet (Bradbury and Holloway, 1988). Cassava root has been considered as a possible treatment for bladder and prostate cancer (Abeygunasekera and Palliyaguruge, 2013). However, according to the American Cancer Society, “there is no convincing scientific evidence that cassava or tapioca is effective in preventing or treating cancer”.

It generates billions of incomes both for families and government and then contributes a lot to food security at several levels (FAO, 2012). In Ethiopia, cassava, locally known as Mita Boye, Yenchet Boye, Furno tree, and Mogo, has been used in cultivation, particularly, in the south, south west, and western parts since its introduction in the 19th century (Amsalu, 2003). Its use as a potential food has increased during and after the 1984 famine in the country (Amsalu, 2006). Every part of the plant is used and has economic importance (Westerberg *et al.* 2012). Despite its importance, the research to improve cassava has lagged behind than that of other crops such as rice, wheat, maize, and potatoes.

2.4. Production trend

Globally, the five largest cassava-producing nations are Nigeria, Thailand, Indonesia, Brazil and Democratic Republic of Congo (DRC). Africa now produces more cassava than the rest of the world, mainly cultivated in the tropics for its starchy tuberous root. In SSA the major cassava producing countries include Nigeria (53 million mt in 2013), DRC (16 million mt), Angola (16.4 million mt), Ghana (15.9 million mt) and Mozambique (10 million mt) (FAOSTAT, 2013).

According to the estimation of FAO, 172 million tons of cassava was produced worldwide, in 2000. Africa accounted for 54%, Asia for 28%, and Latin America and the Caribbean for 19% of the total world production (IITA, 1990 and 2007). In the year 2006, the estimated global cassava production was around 226 million tons (FAO, 2008).

According to the report of FAO (2001) production yearbook of 1998, Africa produces 85,945 million tons of cassava in the year 1998, which is more than half of the world production of the same year that is 158,620 million tones. In 1998, Nigeria produced 30 million tons of cassava (Hillocks, 2002).

In the year 2004, Nigeria was the leading producer of cassava in the world and an estimated cassava output from Nigeria was approximately 34 million tones. This production performance has rated Nigeria as the largest cultivator of cassava in the world (Bamidele *et al*., 2008).

In recent times, Nigerian government has encouraged the use of the cassava to produce a wide range of industrial products such as ethanol, glue, glucose syrup and bread. Moreover, the government promulgated a law making it compulsory for bakers to use composite flour of 10 percent cassava and 90 percent wheat for bread production. The new regulation which comes into effect in January 2005 stipulated that the large flour mills that supply flour to bakeries and confectioneries must pre-mix cassava flour with wheat flour (Bamidele *et al.*, 2008). In Southeast Asia and Latin America, cassava has now taken on an economic role (IITA, 2007).

In Ethiopia, this crop has been cultivated in the southern and southwestern regions for decades as an alternative food insecurity crop (Taye, 200; Desse and Taye, 2001) and cassava grows in vast areas mainly in southern region (Mulualem, 2012). Its use as a potential food crop in Ethiopia has increased during and after the 1984 famine (Amsalu, 2006) and mainly to tackle seasonal food shortage.

The average total coverage and production of cassava per annual in southern region of Ethiopia is 4942 hectares with the yield of 53036.2 tones (Tadesse *et al.*, 2013). Although its first introduction in to the country is not yet known, the crop had been growing in south, south west and western part of Ethiopia for several years (Teshome, 2004).

Currently, some cassava varieties area being promoted in food insecure, particularly, in Amaro kello, Woliata and Sidama Zone cassava roots used as staple food and consumed after washing and boiling or in the form of bread or injera (Ethiopian staple food) after mixing its flour with that of some cereal crops such as maize, wheat, sorghum or teff (Desse and Taye, 2001).

2.5. Cassava varieties

Varieties (also called cultivars) are classified according to morphological trait as well as taste, cyanide content, average yield disease performance pubescence (MIC, 2007; Gbadegesin *et al.*, 2003). More than 5,000 cassava cultivars are recognized global (Best, 1993; Bokanga.1994; Gade, 2003). There are two major types of cassava; sweet and bitter (Chiwona-Karltun *et al*., 2004). The flavor is influenced by the amount of cyanogenic glycoside present (Chiwona-carltun *et al.,* 2004). The presence of cyanide in cassava roots is of concern for human and for animal health. Once it had been harvested, the bitter cassava must be detoxified by proper processing prior to human or animal consumption (Aye *et al.,* 2013) while sweet cassava can be used after simple boiling.

Different varieties (Amaro Kelo/red, Amaro Kelo white, Jima/won ago, Areka/Red, Umbure, 30786, TMS, Hulumdi, 44/72-red,104/72-Nigeria –Rd, Cyanurugha (NR) and local check were cassava varieties western areas obtained from Hawassa agriculture research center, exist in western Ethiopia (Aweke *et al.*, 2012).

Currently, some cassava varieties are being promoted in food southern areas of Ethiopia. Qulle and Kello were commonly- cultivated varieties (Aditya *et al*., 2018). They are well known for their high yield, disease resistant and low toxicity behavior and introduced into the country from Nigeria (Anshebo *et al*., 2004; Atser, 2012). The average yields of these varieties ranged between 20–24 t/ha on farm site in southern region (Tadesse *et al*., 2013) and 36 to 49 t/ha on research site in southwestern part (Jimma) of Ethiopia (Mulualem and Weldemicheal, 2013). The yield may vary significantly depending on the variety, the age of the plant, the plant density and soil fertility and climate conditions (Westerberg *et al.*, 2012).

Previous reports showed that, the toxicity (cyano-glycoside content) of Qulle and Kello cultivars from Ethiopia were 69 and 50 mg/kg in fresh peeled root, respectively, which may be reduced to below detection levels after processing into flour and the final preparation of fermented flatbread injera and no incident of acute or chronic cyanide toxicity (Nebiyu and Getachew, 2011; Kebede *et al*., 2012).

2.6. Farmers' perception to choose cassava varieties

Farmers' perception of benefits is not only based on superior yields of fresh tuber, but also on harvest duration, quality of processed product for food, labor needs, and the general economics of the improved varieties within local situations (Mohamed, 2018). Some farmers often prefer the bitter cassava varieties because they deter pests, animals, and thieves (Chiwona-Karltuna *et al.*, 2002).

Aweke *et al.* (2012 reported that farmers perception to identify varieties based on sweetness/bitterness, color of stem and leaf, size of leaves and tree height. The sweet varieties are called "Seetie" and "Wonde" give local name meaning Seetie (meaning to sweetness) and Wonde (meaning to signify the strength of bitterness). Early maturing varieties, high yielding, and resistant to pests and diseases were main farmers perception to selecting cassava variety in Cameroon (Emmanuel *et al.*, 2013). Morphological traits as well as the taste, cyanide content, average yield, disease performance and pubescence were reported as the criteria of cassava varieties (MIC, 2007; Gbadegesin *et al*., 2013). Shorter height, long storage root, red skin color, bigger sized and white fleshed root, short type were criteria to preferred cassava varieties for market purpose due to enlargement of flour after drying and home consumption, because farmer considers it as sweeter while prepared by local dish respectively, in southern region of Ethiopia (Tadesse *et al*., 2013).

2.7. Planting and Harvesting

Cassava is propagated vegetative by stem cuttings, which make it very advantageous (Andersen *et al.*, 2000). Stem cuttings, horticultural "stakes", were on average at least 20 cm long with 4 to 5 nodes of viable buds and were transported carefully to avoid damage (Leihner *et al.*, 2002). Cuttings can be plant either vertically, inclined, or horizontally at different planting depths on ridges, mounds, or flat ground (Malumo, 2001).

The general spacing is 75 to 100 cm between rows or ridges and 50 to75 cm between planting holes within rows or ridges for a mono crop cassava while wider spacing of up to 200 cm between rows or ridges is used when cassava is intercropped with 1 to 3 rows of fast-growing legumes or a cereal crop like maize or millets (Mohammed, 2018).

The recommendation for the cultivars Qulle and Kello from Hawassa Agricultural research center (Hawassa, SARI) was 120cm x 80 cm) spacing between row and plant to produce significantly higher yield compared to other interaction levels and could be harvested after 18 months according to recommendation of Hawassa Agricultural research institute (Markos *et al.*, 2016).

Planting season for cassava is designated as stretchy, because of roots can be harvested between eight month and three years after planting so that the planting and harvesting time depend on the local climate condition (FAO, 2010).

The practice was very similar to other SSA countries where cassava is planted at the beginning of the rainy season and harvested in the following long dry season when the starch content of the roots is highest (Howeler *et al.,* 2013). Markos *et al.* (2016) mentioned that the best time for cassava planting in the major cassava growing areas of Ethiopia would be from March to May. The optimal harvesting maturity for cassava is about 18–24 months (Cock 1985; Bokanga, 2000).

Manual or pull-tool assisted cassava root harvesting are universally the most prevalent methods, however, in some Asian and Latin American countries tractor mounted mechanical harvesters have been used on large commercial plantations (Parmar *et al.,* 2017b). In Ethiopian conditions a pull-tool (also sometimes referred as an up-rooter) can be introduced. In general, cassava roots are harvested between 6 and 18 months after planting (MAP) (Howeler, 200).

Recommendations for the cultivars Qulle and Kello from the local agricultural research station (Areka, Woliata) were to harvest after 18 months (Markos *et al.*, 2016). Cassava being a perennial, it can be stored in the ground for 2–3 months and harvested as and when required. Keeping roots in-ground for long may also result in lignification and an increase in the incidents of biotic stress (rodent, pest and microbial) (Uchechukwu-Agua *et al.,* 2015). Its wide harvesting window allows it to act as a famine reserve food crop and is invaluable in managing labor schedules (Stone, 2001).

2.8. Utilization of Cassava

Cassava flour has been successfully used as a substitute for wheat all over the world in the production of biscuits and confectioneries. In Indonesia, a survey conducted in West and East

Java in 2001 showed that 84% of respondents accepted cassava flour in the production of traditional dishes, cookies, cakes and noodles with substitution ranging from 20 to 100% (Widowati and Hartojo, 2001).

In Egypt, partial substitution of wheat flour by cassava flour at 20 and 30% levels resulted in good quality bread like that obtained from wheat flour, although with the addition of 1% malt (Khalil *et al.,* 2000).

Cassava flour was substituting with wheat and cocoyam flour up to 30% to produce rock cake as acceptable in Ghana (Sanful and Darko, 2010). In West Africa generally, especially in Nigeria, bread made with 10 to 20% substitution levels of wheat flour with cassava flour has overall acceptability like 100% wheat bread (Simonyan, 2014). Furthermore, bread made with the composite of cassava, wheat and maize flour has been reported with the cassava flour as high as 20 to 40% (Eduardo *et al*., 2013).

Also, in the production of cookies or biscuits, 100% cassava 502 AIMS Agriculture and Food Volume 5, Issue 3, 500–520. Cassava flour, composite with wheat or the incorporation of legumes such as cowpea or soybean as improvers have been reported to enjoy high acceptability and can favorably compete with wheat cookies/biscuits (Oluwamukomi *et al*., 2011). Bread, cookies and confectioneries have been successfully produced using 100% cassava flour with good acceptability (Maziya-dixon *et al*., 2017).

In recent times, Nigerian government has encouraged the use of the cassava to produce a wide range of industrial products such as ethanol, glue, glucose syrup and bread. Moreover, the government promulgated a law making it compulsory for bakers to use composite flour of 10 percent cassava and 90 percent wheat for bread production. The new regulation which comes into effect in January 2005 stipulated that the large flour mills that supply flour to bakeries and confectioneries must pre-mix cassava flour with wheat flour (Bamidele *et al.,* 2008).

The occurrence of peak hunger during periods from April to August in which a sudden increment price of (teff or maize), hence the high number of consumer switching to use cassava for making injera or high proportion of cassava in the composite flour to reducing the amount of the relatively costly maize and teff during the rainy season and the ratio of teff: maize :cassava was approximately 50:25:25.,howevery there were variations depending on the preference of consumer and price of the expensive cereals, such as teff in woliata zone, Ethiopia (Belta *et al.*, 2015).

An exceedingly increasing current price of teff in Ethiopia could be a good opportunity to utilize cassava flour as a supplement to teff and its dried chips are suitably mixed with teff, wheat and sorghum to prepare injera in producing farmers at Gofa and Belle areas of the southern region (Yared, 2012).

Cassava roots used as staple food and consumed after washing and boiling or in the form of bread or injera (Ethiopian staple food) after mixing its flour with that of some cereal crops such as maize, wheat, sorghum or teff, particularly, in Amaro kello, Woliata and Sidama Zone of Ethiopia (Desse and Taye, 2001).

Since cassava root contains high amount of starch traditional prepared foods like (“Injera (yeast-risen flat bread slightly spongy texture made out of cereals), “Dabbo (Ethiopian traditional bread)”, “Anebabero” (Injera with double thickness), Porridge, “Qitta” (Unleavened bread), “Kurkuffa”, “Fossosie” and “Cheqa”) were tried in kitchen by mixing cassava with cereals (Aweke *et al.,* 2012).

2.9. Nutritional value of cassava roots

The nutritional composition of cassava depends on the specific tissue (root or leaf) and on several factors, such as geographic location, variety, age of the plant, and environmental conditions. The roots and leaves, which constitute 50 and 6% of the mature cassava plant, respectively, are the nutritionally valuable parts of cassava (Tewe and Lutaladio, 2004).

The nutritional value of cassava roots is important because they are the main part of the plant consumed in developing countries. Cassava root is an energy-dense food. In this regard, cassava shows very efficient carbohydrate production per hectare. It produces about 250,000 calories/hectare/day (Julie *et al.,* 2009), which ranks it before maize, rice, sorghum, and wheat. The root is a physiological energy reserve with high carbohydrate content, which ranges from 32 to 35% on a fresh weight (FW) basis, and from 80 to 90% on a dry matter (DM) basis (Julie *et al.,* 2009).

Eighty percent of the carbohydrates produced are starch (Gil and Buitrago, 2002); whereas 83% is in the form of amyl pectin and 17% is amylose (Rawel and Kroll, 2003). Roots contain small quantities of sucrose, glucose, fructose, and maltose (Tewe and Lutaladio, 2004). Cassava has bitter and sweet varieties. In the latter varieties, up to 17% of the root is sucrose with small amounts of dextrose and fructose (Charles *et al*., 2005).

Raw cassava root has more carbohydrate than potatoes sand less carbohydrate than wheat, rice, yellow corn, and sorghum on a 100-g basis. The fiber content in cassava roots depends on the variety and the age of the root. Usually, its content does not exceed 1.5% in fresh root and 4% in root flour (Gil and Buitrago, 2002).

The lipid content in cassava roots ranges from 0.1 to 0.3% on a FW basis. This content is relatively low compared to maize and sorghum, but higher than potato and comparable to rice. Cassava roots have calcium, iron, potassium, magnesium, copper, zinc, and manganese contents comparable to those of many legumes, with the exception of soybeans. The calcium content is relatively high compared to that of other staple crops and ranges between 15 and 35 mg/100 g edible portion. The vitamin C (ascorbic acid) content is also high and between 15 to 45 mg/100 g edible portions (Charles *et al.,* 2004).

Cassava roots contain low amounts of the B vitamins, that is, thiamine, riboflavin, and niacin. Usually, the mineral and vitamin contents are lower in cassava roots than in sorghum and maize (Gil and Buitrago, 2002). The protein, fat, fiber, and minerals are found in larger quantities in the root peel than in the peeled root. However, the carbohydrates, determined by the nitrogen free extract, are more concentrated in the peeled root (central cylinder or pulp) (Gil and Buitrago, 2002). Thus, cassava roots are rich in calories but low in protein, fat, and some minerals and vitamins. Their nutritional value is, consequently, lower than those of cereals, legumes, and some other root and tuber crops such as potato and yam.

2.10. Processing techniques of cassava root

Fresh cassava roots cannot be stored for long period is because they rot within 48 h of harvest and it should be processed into increase its shelf life of the product, reduce cyanide content and palatability since they are bulky with about 70% moisture content (Hahn, 1994). Therefore, cassava must be processed into various forms in order to increase the shelf life of the products, facilitate transportation and marketing, reduce cyanide content and improve palatability. The nutritional status of cassava can also be improved through fortification with other protein-rich crops (Hahn, 1994).

Traditionally, cassava roots are processed by various methods into numerous products and utilized in various ways according to local customs and preferences. It is use in Africa probably originated from tropical America, particularly north-eastern Brazil and may have been adapted from indigenous techniques for processing yams (Hahn, 1994). Abass (2008), reported that, cassava processing was still done in the traditional way using traditional tools in Zambia, and most farmer used red mats for drying cassava and observed basic food safety rules by not drying on the bare floor (Oladeji *et al.*, 2019).

It should be important to improve or change the traditional processing equipment or systems presently used to accommodate the rural set up, rather than to change to entirely new, sophisticated, and expensive equipment, minor change in the tools used at the household level in processing could help to reduce anxiety, health hazard and labor for the working women (Hahn and Keyser, 1985). Therefore, processing methods include peeling, boiling, steaming, slicing, grating, soaking or seeping, fermenting, pounding, roasting, pressing, drying, and milling.

Raw fresh cassava roots were peeled, sized and placed in bredist and boiled for about 40 minutes (Maduagwu, 1978). Most cassava processing activities were carried out by females and their activities showed low participation of male which might be because their children were involved (Fapojuwo, 2007). Farnsworth *et al.* (2011) reported that cassava processing into chips or flour is often laborious and time consuming due to lack of the right equipment. One of the advantages of converting fresh cassava into dried chips is that the dry product can be stored for longer periods, can be used to fill seasonal gaps in availability of food (Oghenechavwuko *et al*., 2013).

2.11. Sensory evaluation

The best way of determining the quality of a food product is through sensory analysis. In sensory analysis, human beings are used as they have both critical faculties and emotion (Jellinek, 1985). However, a limitation to the use of untrained sensory judges is that they do not have a common language with which to communicate sensations and an agreed system of categorization (Ishii and O'Mahony, 1991). For example, a reddish-orange color could be categorized as 'red' by one judge and 'orange' by another. Similarly, the sensory concept of sourness for one judge could not exactly align with that of the other judge. This is analogous to using a set of instruments that are not calibrated in the same way (Ishii and O'Mahony, 1991).

Generally, two main groups of methods of sensory evaluation are identified: 1) Analytical or objective methods (difference, ranking and quality tests), and 2) Hedonic or subjective methods (preference, consumer and market tests). For analytical methods, a trained panel is required and the panel members have to act like an analytical instrument. For the hedonic methods, a large number of untrained persons have to be used and their evaluation should come spontaneously, based on emotion (Jellinek, 1985).

The use of descriptive sensory evaluation techniques to produce objective descriptions and evaluation of injera in terms of perceived sensory attributes remains as a gap in application. Descriptive analysis is a sensory method by which the attributes of a food product are identified and quantified using human subjects who have been specifically trained for this purpose (Stone and Sidel 1985; Lawless and Heymann, 1999).

It is a flexible and useful sensory method, providing detailed information on all of products sensory properties (Murray *et al.*, 2001). The data are easily analyzed statistically and can be represented in graph form. Descriptive techniques can be used when there is a need to define sensory-instrumental relationship (Lawless and Heymann, 1999).

3. MATERIALS AND METHODS

3.1. Phase-I Cassava production practices and utilization

3.1.1. *Description of study area*

The study was conducted in the two (Offa: Busha and Galda and Amaro: Golbe and Kobe kebeles) major cassava producing districts during 2019 cropping season. The main reason for conducting survey in these study areas was because they are places where cassava in Ethiopia has been cultivated and widely consumed. Cassava roots are used after washing and drying as staple food in the form of bread or ‘’injera’’ (Ethiopian staple food) by blending its flour with that of some cereal crops such as teff, wheat, or sorghum particularly in woliata zone Offa Woreda and Amaro special district in the region (Desse and Taye, 2001). Currently, some cassava varieties are being promoted as an alternative food security source in southern Ethiopia (Taye, 2000; Desse and Taye, 2001).

Offa district consists of 21 kebeles. The total area of the district is 37,387 and about 51.5% of which are women (CSA, 2007). It has diverse Agro-ecology with altitude ranging 1200 around river Gogara in the south, to 2800 masl in the north which is located in latitude of 6° 44′ 60” N and longitude of 37° 29′ 60” E. Amaro district, one of the special districts belonging to the SNNPR consist of 34 kebeles and has total area 1422.16 km^2. Kello is administrative center of district and located 510 km away from Addis Ababa. The woreda has a total population of 167,379 and out of which 84,411 (about 50%) are male and 82,968 (49.6%) are female. It has diverse agro-ecology with altitude ranging from 1080 from Dulbe to dello mountain to 3600 meter above sea levels masl of Amaro Woreda agricultural development office (AWADO, 2008) and located in latitude 5º 77' 47.3’’ N and Longitude 37º55' 64’’E.

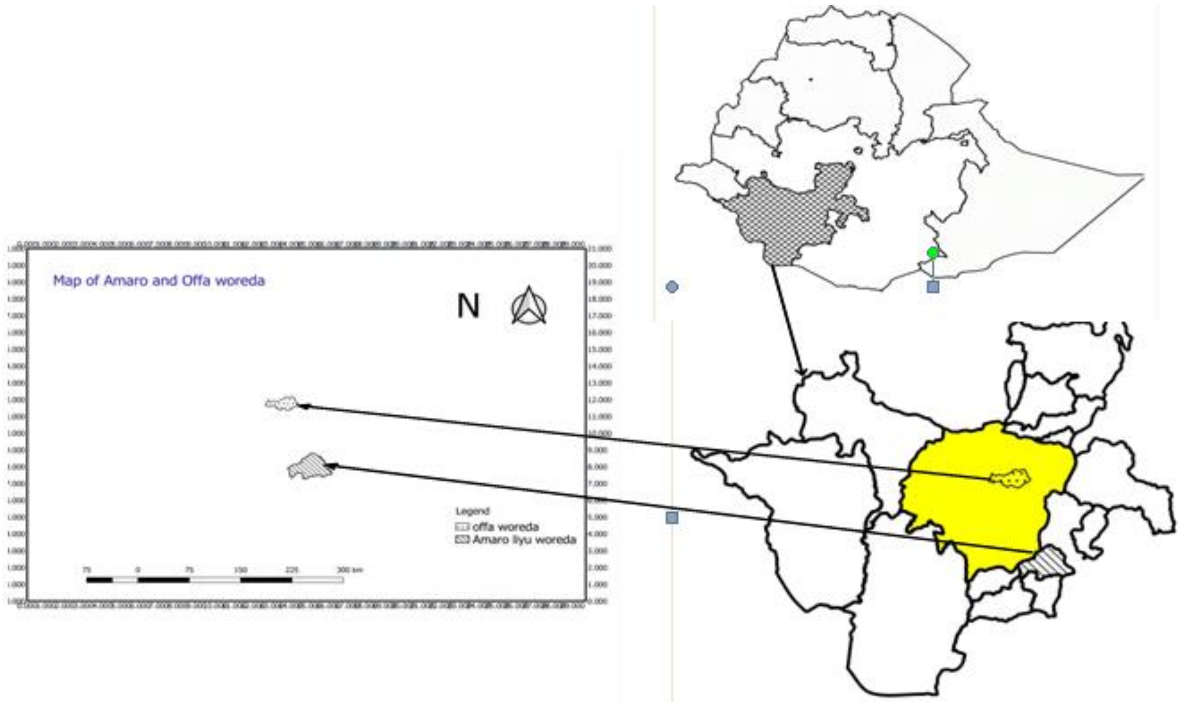

Figure 1 Administrative map of surveyed area

3.1.2. *Sampling techniques and Sampling size*

Two districts (Offa and Amaro) and two kebeles from each district (Busha and Gald from Offa; Golbe and Kobe from Amaro) were purposively selected based on their potential cassava production. A total of 120 (28 from Bush, 29 from Galda 30 from Golbe and 33 from Kobe) cassava producing farmers were selected by using simple random sampling techniques. about a third of the respondents were women. The samples of respondent household were randomly selected based on probability of proportionality using the formula developed by Yamane (1967).

$$n = \frac{N}{1 + N(e^2)}$$

Where n is sample size to be computed is the total size of cassava producer in the study area and e is the level of precision its minimum level acceptable precision is 10%.

3.1.3. *Data collection procedures*

Qualitative and quantitative data were collected from both primary and secondary sources. The primary data was collected from sampled households by using structured and semi-structured questionnaire (Appendix I) from cassava producing In addition to primary data sources, secondary data was gathered from various unpublished documents like Keble's and districts agriculture office weekly and annual reports. To triangulate the surveyed data, focused group discussion was also done with key informants. The key informants were cassava producers with broad knowledge on diverse social issues, government officials and development agents. For the interview, both males and females were represented through purposive sampling.

Socio demographic data like, main livelihood of farmers, purpose of cassava production ,cassava cropping patterns, commonly grown cassava varieties, farmers' knowledge to select cassava varieties, fertilizer application, source of planting materials, planting month, spacing, length of cutting, trend of production, weeding, months to maturity, harvesting month, storage, utilization, gender involvement and cassava processing, cassava processing tools used at household level, form of cassava consumption, important cereal crops mixed with cassava. Blending ratio of cassava with- teff to make injera, marketing and location of market, challenge of cassava market and market experience were collected through a structured questionnaire.

3.1.4. *Data analysis*

The collected data were analyzed using Statistical Package for the Social Sciences (SPSS, version 20). The important descriptive statistical measures such as percentage, frequency, and mean were used to summarize and categorize the research data.

3.2. Phase-II: Evaluation of cassava varieties as ingredient of Injera

3.2.1. *Material collection and Transportation*

Uniform weight (15 kg for each variety), free from defect and 18-month-old cassava roots were directly collected from Areka Agricultural Research Centre farming plot (Areka, SARI). The cassava roots were manually harvested, packed into a sack, and transported within one day to the Food Science and Nutrition (FSN); laboratory of Hawassa University and the *teff* grain (Tseday/Cr-37) was collected from Hawassa Agricultural Research Center (HARC).

The sample were peeled and chopped for the analysis of moisture within 24 hrs. and processing techniques was performed for sample preparation in the laboratory of Nutrition, Food Science and Technology of Hawassa University Agriculture of College, while proximate composition and Hydrogen Cyanide analyses were done in the Bless Agri food Laboratory service, Addis Ababa and Nigeria respectively.

3.2.2. *Experimental Materials, Treatments and Design*

The experiment was arranged in 2x5 factorial in complete randomized design (CRD) with three replications. The treatment consisted of two cassava varieties (Qulle and Kello) and five blending ratios with teff flour.

Table 1: Experimental lay out

	Factor-1 Cassava varieties combined with blending ratio	
Blending ratio	Qulle variety	Kello variety
B1	V1B1	V2B1
B2	V1B2	V2B2
B3	V1B3	V2B3
B4	V1B4	V2B4
B5	V1B5	V2B5

Where B1=Blending ratio1 (10% cassava flour and 90% teff flour), B2=Blending ratio 2 (20% cassava flour and 80% of teff). B3= Blending ratio3 (30% cassava flour and 70% teff flour), B4= Blending ratio 4 (40% of cassava flour with 60% teff flour), B5= blending ratio5 (50% of cassava flour and 50% of teff flour) whereas V1= Qulle variety and V2= Kello variety.

3.2.3. *Experimental procedures*

Cassava and Teff flour preparation

The cassava tubers were peeled manually using stainless steel knives. The peeled cassava tubers were washed and chopped manually with stainless steel knives, followed by drying in a hot air oven dryer at the temperature of 45°C for 16 hrs. The dried cassava chips were allowed to cool before being milled into flour using coffee grinder (ModelNCG-940, Japan). Finally, the milled cassava flour was sifted using sieves of aperture size of 710 µm and packed in polyethylene bags and store at 4°C until required for analysis. The teff grain was manually cleaned and milled by disk attrition mill traditionally used for injera processing at Hawassa University grain milling house. The flour was kept in airtight sealed plastic bucket at room temperature (AACC, 2000) for the duration of the analysis. The blend mixture was prepared for making injera.

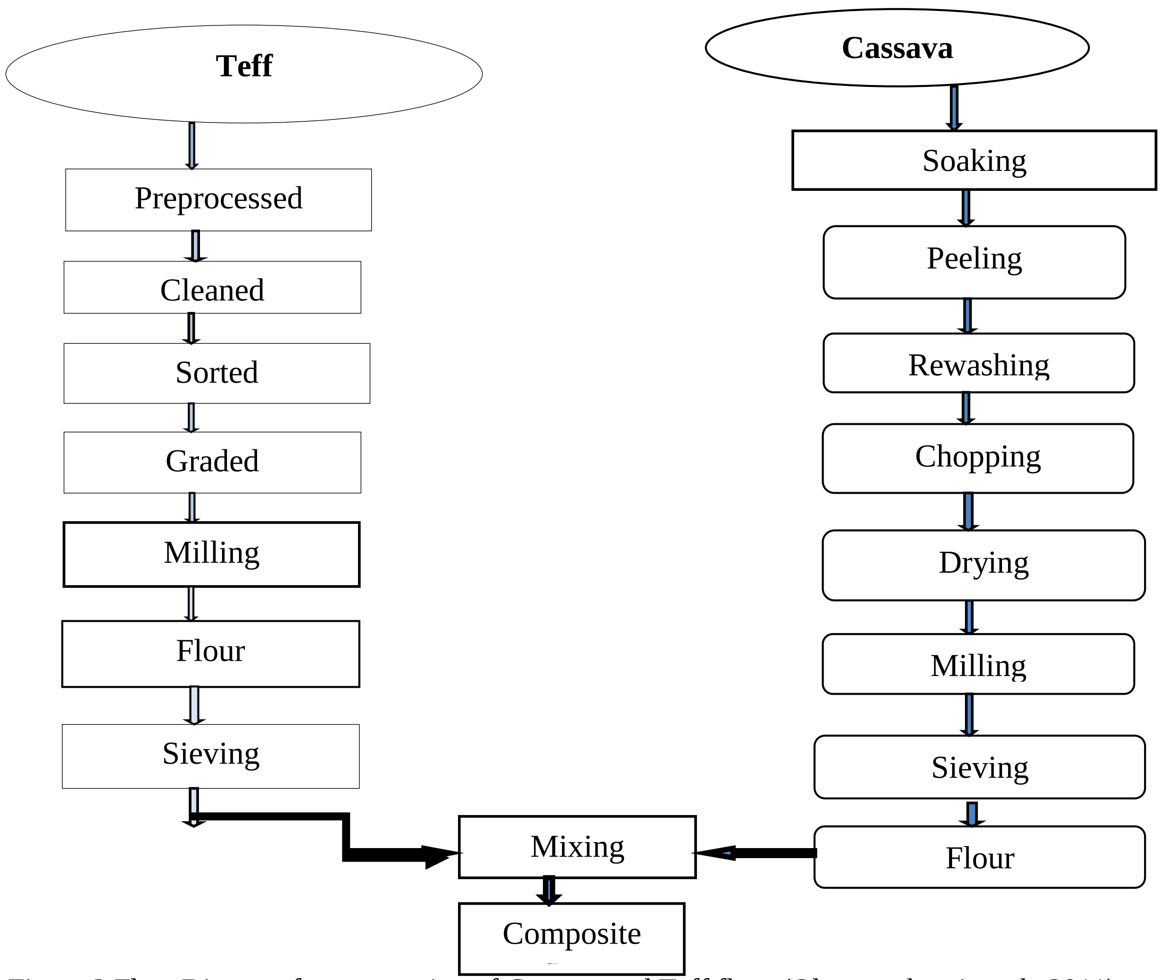

Figure 2 Flow Diagram for preparation of Cassava and Teff flour (Oluwamukomi *et al*., 2011)

Injera Making Procedures

Injera was baked using flowchart (Fig 3) of *Injera* making process as described by Bultosa and Taylor (2004). *Teff* and cassava composite flour was mixed with water (200 g flour + 180 mL water), dough was kneaded by hand to optimum consistency and after adding local yeast 5% of flour weight on the top of the dough. The dough was fermented at room temperature for 72 hr. After fermentation, 10% of the fermented dough was mixed with water (1:3) and boiled for 4 min. The boiled batter then was cooled at temperature of 46°C and added back to the fermenting dough. After thorough mixing, the batter was fermented at room temperature for 2hr and additional water was added to fermented dough to bring optimum batter consistency. Finally, injera was baked (3 min) by pouring fermented batter on hot clay griddle, covered with lid to prevent steam from escaping,

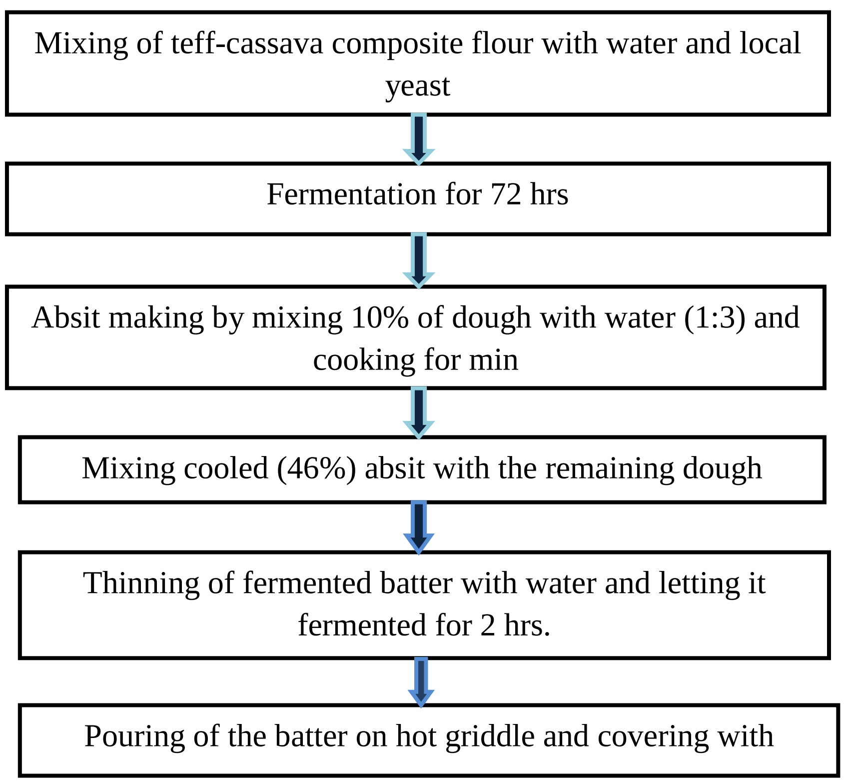

Figure 3. Injera making flow chart: Source Bultosa and Taylor (2004)

3.2.4. *Data collection*

3.2.4.1. Determination of proximate composition Moisture

The moisture content of the samples was determined according to AACC, (2000). Samples of 5 g (W1) were taken in a pre-weighed crucible (W0) and dried in hot air oven at 130ºC for about an hour. The dried samples were removed and placed in a desiccator to cool for 30 minutes and weighed (W2). The weight of the dried sample alone (W4) was given as the difference between W3 and W0.

The moisture content was calculated according to the following equation:

$$MC\ (\%) = \frac{W1 - W4}{W1} \times 100$$

Where:

W0 = Mass of empty crucible (g), W1 = Mass of sample before drying (g), W3 = Mass of sample and dish after drying (g); W4 = mass of dried sample alone.

3.2.4.2. Ash

The ash content was determined according to the AACC method (2000) using muffle furnace. Three grams of the sample was weighed and repeated in triplicated into porcelain crucibles, which was carbonated, cooled in a desiccator and weighed and placed in a cool electric muffle furnace. The temperature was 550°C overnight for complete ashing. The ashed crucibles were transferred directly into a desiccator and cooled for 30 minutes and it was weighed immediately.

The ash was determined by calculation and expressed as percentage using the equation:

$$\%\ ash = \frac{(M3-M1)}{M2-M1)} \times 100$$

Where:

M1 is mass of crucible (g), M2 is sampled mass with crucible (g) and M3 is final mass of sample with crucible (g).

3.2.4.3. Crude protein

Crude protein was determined by the Kjeldahl method as described in AACC, (2000). Samples of 1g were digested in digestion flask with 5 mL of H_2SO_4 and anhydrous Na_2SO_4 were used to raise the boiling point of H_2SO_4 and a catalyst $CuSO_4$ was used to speed up reaction in the presence of a digestion mixture for 6 hrs. till the contents of digestion flask turned clear. Samples were diluted by water and a concentrated 40 percent NaOH was added to neutralize the acid and to make the solution slightly alkaline. The ammonia from the samples was distilled in to receiving flask consisting of standard strong acid (4 percent boric acid) solution using methyl red as an indicator to determine nitrogen content in a sample. Boric acid was used for indirect titration and ammonia bound to an equivalent of borate ion was directly titrated with standard acid (0.1 N HCl).

The crude protein percentage will be calculated by using the following formula:

$$N\% = \frac{\text{VHcl in L} \times \text{NHcl} \times (\text{ca.}0.1) \times 14}{\text{Sample weight in g on dry matter basis (db)}} \times 100$$

Where V is volume of HCl in L consumed to the end point of the titration, N is the normality of HCl, 14.00 is the molecular weight of nitrogen. Protein (%) was calculated by multiplying N (%) with factor 6.25.

3.2.4.4. Crude fat

The crude fat content was determined according to AACC (2000) method. The method of solvent extraction using a Soxhlet extraction was used. Sample of 2 g was taken in a thimble lined with a circle of filter paper. Thimble and contents were placed in to a 50 mL beaker and dried in an oven for 2 hrs. at $1100^{c}{}_{0}$. Thimble and contents were transferred to the extraction apparatus. The beaker was rinsed several times with the solvent and the sample contained in a thimble was extracted with the solvent in a Soxhlet extraction apparatus for 8 hrs. at a condensation rate of at least 3 drops per second. At the completion of the extraction, the fat extract was transferred from the extraction flask in to a pre-weighed (Mi) evaporating small counterpoised beaker (250 mL) with several rinsing with the solvent. The evaporating small beaker was placed in a fume hood and evaporated off the solvent on steam bath until no odor of the solvent was detectable. The beaker with its contents was dried in an oven for 30 min. at100℃ and it was removed from the oven and cooled in desiccators and beaker plus contents were weighed as Mf.

Fat percentage was calculated according to the following formula:

$$\text{Crude fat \%} = \frac{\text{Mf} - \text{Mi}}{\text{Sample mass on dry basis (db)}} \times 100$$

3.2.4.5. Crude fiber

Crude fiber content was determined according to AACC (2000) method. Sample of 2 g was taken and placed in 1000 mL beaker. Two hundred mL solution of 1.25 percent H_2SO_4 was added in the beaker. The sample was digested by boiling for 30 min and filtered by using suction apparatus. The residue was washed with hot water until it became acid free and transferred to 1000 mL beaker and boiled with 200 mL solution of 1.25 percent NaOH for 30 min. It was filtered and the residue was transferred to pre-weighed crucible and dried in an oven at 100ºC for 24 hrs.. The dried residue was charred on a burner and ignited into muffle furnace at 550ºC for 6 h, cooled in desiccators and weighed. The loss in weight during incineration represents the weight of crude fiber in sample.

The crude fiber percent was calculated by using the following formula:

$$\text{Crude fiber \%} = \frac{\text{Weight of residue} - \text{Weight of ash}}{\text{Weight of sample}} \times 100$$

3.2.4.6. Total Carbohydrate

The total carbohydrate content was determined by subtracting the sum of other constituents from 100.

%C = 100 –% (M + P + Fb + F + A)

Where: C-is utilizable carbohydrate, M-is moisture, P-is protein content, Fb-is fiber, F- is fat and A- is ash contents

3.2.4.7. Determination of hydrogen cyanide level from cassava-teff blended Injera

Hydrogen cyanide content was determined using as the alkaline picrate paper method as described by Bradbury et al. (1999). Around disc containing buffer at pH 6 and enzyme was placed (identified by a black spot) in a flat-bottomed plastic bottle and 100 mg of cassava-teff injera product and 100 mg of cassava-teff product sample was poured on top of it 0.5 mL of clean water and a yellow picrate paper was added in plastic bottle. Immediately the bottle was closed with the screw-capped lid and allowed bottles to a stand for 24 hours at room temperature. Then the bottles were opened and the plastic backing sheets removed carefully from the picrate paper. The picrate paper was placed to the in a test tube 5.0 mL water was added. After that, the test tube was the left at the room temperature for about 30 min with occasional gentle stirring. The absorbance of the solution was measured at 510 nm using content was calculated by the equation. Total cyanide content (ppm) =396 × absorbance

Sensory analysis

The sensory acceptability in terms of color, texture, sticking, sour character, aroma, taste, bottom eye and overall acceptability were evaluated by 17 panelist those were *injera* consumers using9 point hedonic scale (where 1- extremely dislike, 2- dislike very much, 3- dislike moderately, 4- dislike slightly, 5- neither like nor dislike, 6- like slightly, 7- like moderately, 8- like very much, and 9– extremely like) in order to assess the acceptability of i*njera* samples prepared from the different blending ratios, in 3 replication.

3.2.5. *Statistical Analysis*

The analysis of variance (ANOVA) was used to test for significant variations between means of varieties, blends and their interactions SAS, version 9.00. As the two-way ANOVA did not include the only teff injera (100% teff, control), one way ANOVA was done depending on the two-way ANOVA result. When the interaction in the two ways ANOVA was significant, the combination of variety and blending ratio was analyzed as one way ANOVA including 100% teff injera as a control. When the interaction was not significant but blending ratio was significant, only the blends (not the combinations of blends and variety) were analyzed as one way ANOVA by including 100% teff injera as a control (case of moisture, carbohydrate, color, sticking and appearance were presented blends plus 100% teff injera). Simple CRD was used for analysis as one way ANOVA for proximate composition. But RCBD was used for sensory evaluation by considering the taste panel as blocks. Tukey's HSD should have been used as a robust tool

4. RESULTS AND DISCUSSION

4.1. Phase-I: Cassava production practices and utilization

4.1.1. *Socio-demographic characteristics of the respondent households*

Table 2 presented the socio-demographic characteristics of the cassava producing farm households at the study area. From the total respondents, about 67.5% were male whereas the remaining 32.5% were female. About two-third (61.6%) of the farmers involved in this study were aged in the range of 29.1-39 years. Studies have shown that women's involvement in farming households in rural Ethiopia is immense. However, the proportion of farming women in the district was higher than found in study conducted in Sodo Zuria district farming households (Biruke, 2013). Study conducted by Kuye (2015) explained that majority of the active farmers were aged below 37 years, which is in agreement with what we found in the present study.

More than two-third (65%) of the participants did not attend any formal education while only 1.7% was completed education at diploma level. This was also true in previous studies on farm households, where higher proportions of subsistent farmers were not educated or small proportion of them completed high school and above education level (OECD, 2006). The average family size of the households included in this study was 7, where the maximum and minimum members living were 13 and 3 respectively, while the average land holding was 0.6 hectare, with the maximum land holding was 1.25 ha. Previous studies in rural Ethiopia showed that rural households are known with large family size and scarcity of production land. In fact, these contribute for reduction of the household food share distribution among members; as the source of many rural households' food is their own productions which are produced from small plot of land, thus contribute for the existence of food and nutrition insecurity at the household and community level at large.

Table 2**:** Socio-demographic characteristics of the respondents' household

Characteristics	No. of respondents	%		
Sex				
Male	81	67.5		
Female	39	32.5		
Total	**120**	**100**		
Age (Years)				
19 -29	24	20		
29.1-39	74	61.6		
39.1 – 49	15	12.5		
49.1 - 59	4	3.4		
59.1 – 69	3	2.5		
Total	120	**100**		
Education level completed				
Non formal education	78	65		
Primary education	30	25		
Secondary	10	8.3		
Diploma	2	1.7		
Total	**120**	**100**		
Family and farm size	Min	Max	Mean	(SD)
HH family size	3	13	7.26	2.66
Farm size (in hectare)	0.12	1.25	0.6	0.27

4.1.2. *Main livelihood of the respondent households*

About 57.17 % of the respondent households revealed that their livelihood are depend on both crop production and rearing of animals, while only one-third of households' depend only on crop production alone (Figure 2). Among the crops grown in the farm lands, cassava, maize, teff, sorghum, barely, wheat, enset, coffee (in small scale), haricot bean, pea, taro, and yam, vegetables and fruit crops are mentionable while animals such as oxen, horse, donkey, ship, goat and cattle are reared in the districts. Similarly, a study conducted by Tagesse *et al.* (2020) reported the economic dependence of rural farm households of Kembata Tembaro district majorly on crop production and livestock and on off-farm income activities. Integration of animal rearing was an essential part for household for provision of manure fertilizer to diversify the product, used for local agricultural work (harrowing and trashing,) in a crop production (Robert *et al.*, 2007) and horses and donkeys are kept for transportation of crop product to nearby market where as the oxen usually serve as traction animals in agriculture (Berhanu and Yoseph, 2011).

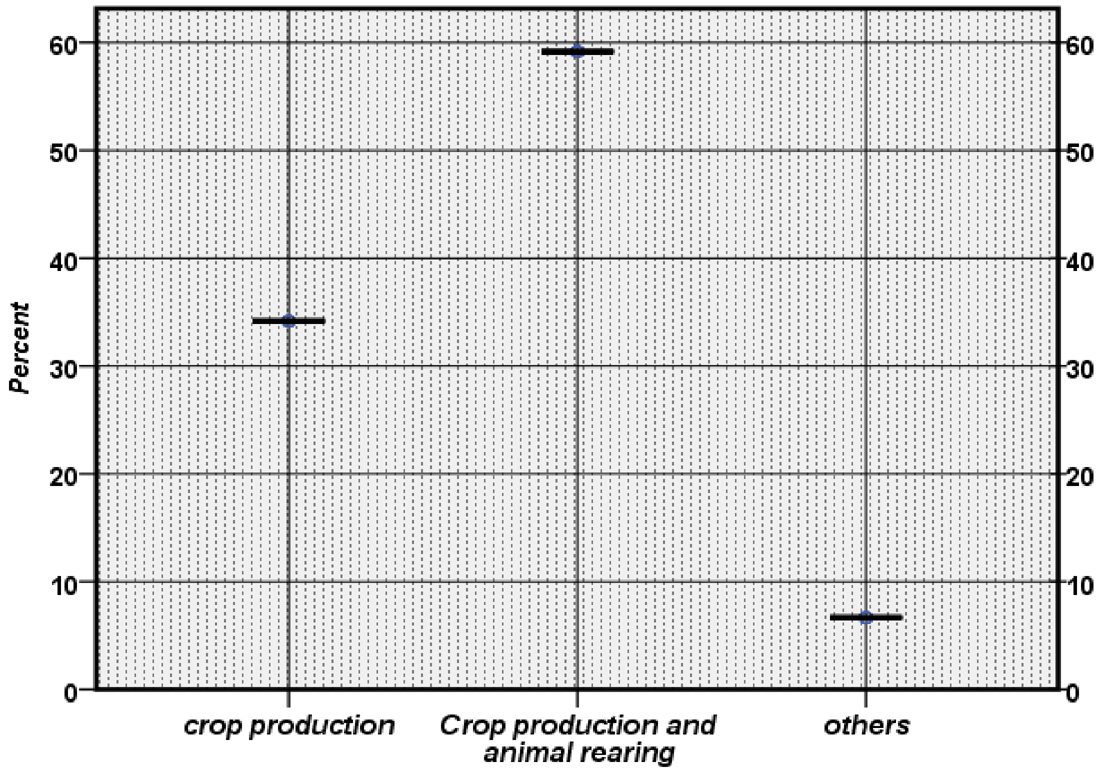

Figure 4 Livelihood activities of the respondent at the study area.

4.1.3. *Purpose of Cassava production and cropping pattern*

Figure 3 presents the purpose of cassava production in the study districts. More than half (51.7%) of the households were producing cassava for multiple purposes including for plant material, as animal feed, for income generation and for consumption as staple food and one-fourth (25%) of the included households in this study produced only for household consumption purpose.

Some cassava stems are used for the on-farm purpose or sold to other farmers while others are used as the firewood (after drying) and for fencing their farms. About 15% of the farm households included in this study were producing cassava for selling purpose only even if cassava has been cultivated primarily for its root use, due to fear of toxicity of consuming the leaves and the cultural food taboo cultural against using leaf as the human food. The leaves were produced by the selected farming households (3.8%) for animal feeding purpose only. Study conducted by Tadesse and his colleagues reported that higher proportion (81%) of the cassava growing households are using for the purpose of consumption and they also sold it in the form of chips and flour in Amaro and Woliata districts of Ethiopia (Tadesse *et al.*, 2013). Westerberg *et al.* (2012) and Nweke (2004) also reported cassava is an excellent source of income for subsistent farmers and is its every part of plants are used as an essential part of the diet and income for farmers in several African countries.

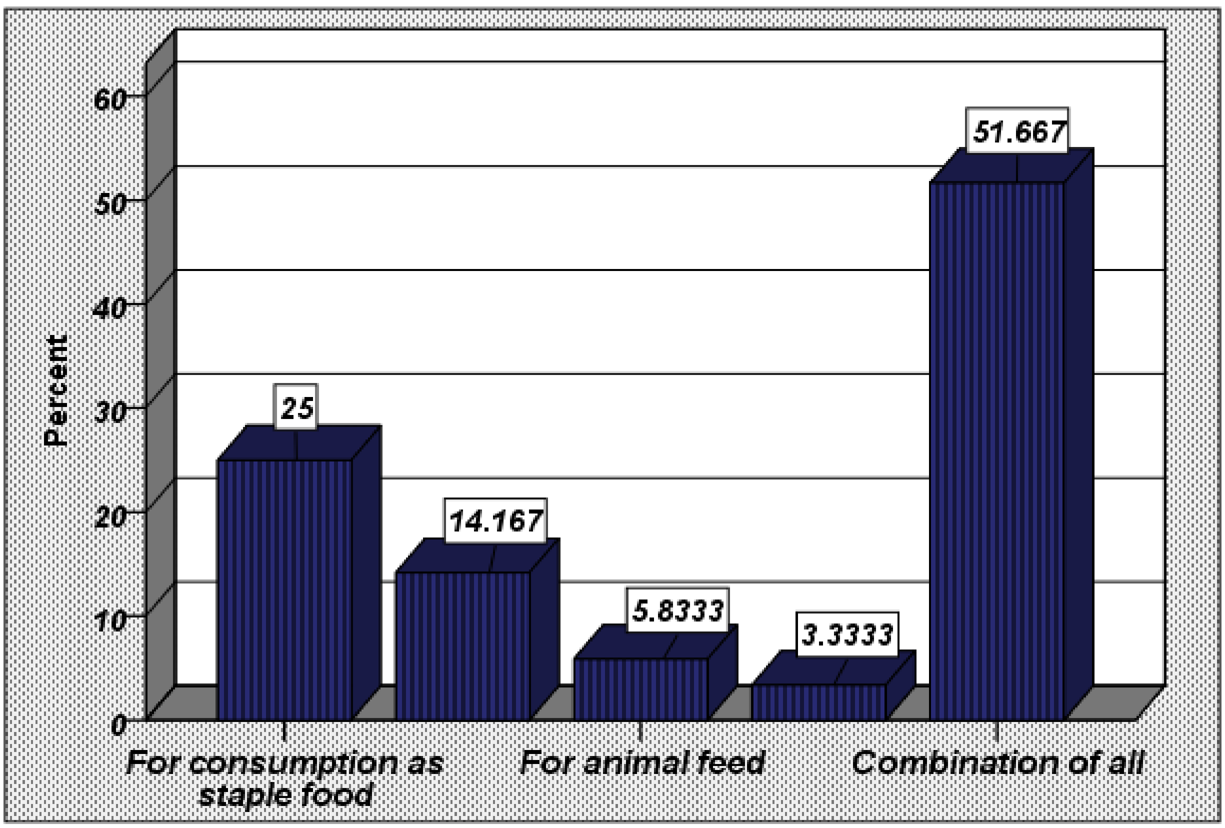

Figure 5. Purpose of cassava production in the study area

Cassava cropping pattern evidenced from Table 3 revealed that, comparable proportion of households included in this study were cultivating cassava solely (42.5%) or intercropped (40%) with other crops while about one of the studied households were practicing both mono cropping and inter-cropping with others. Mono cropping is practiced in Offa district than Amaro with their percentage value of 64.9 and 33.3%, respectively. These results are similar to those reported by Tadesse *et al.* (2013) who explained that cassava usually produced as a sole, but sometimes intercropped/mixed with maize, sorghum, finger millet, haricot bean and sweet potato in the region. Despite cassava has been grown with different cropping patterns, intercropping it with other crop/crops will give advantage of harvesting crops year-round, which can increase the total food production of the households, resulted in improved livelihoods. Otherwise, practicing mono-cropping of cassava will have an advantage of increased yield (Ile *et al.*, 1996; Mbah *et al.*, 2014).

Table 3**:** Pattern of cassava cropping in study area

Cropping pattern	Amaro (n=63)	Ofa(n=57)	Both
	Frequency	Frequency	Percentage
Mono-cropping	21	37	42.5
Inter-cropping	29	12	40
Both	13	8	17.5

4.1.4. *House hold growing the various cassava varieties*

Cassava varieties, which were grown in the study area, presented in Figure 4. Small proportion of households included in this study were using local cultivar (8.33%), Kello (12.50%), and followed by those households using Qulle (20.83%) variety. otherwise, majority (58.3%) of the cassava growing households in the two major cassava producing districts were dependent on both of Qulle and Kello variety. The reason for using the improved cassava (Qulle and Kello) variety was due to the high yielding potential, early maturates, and resistance to disease and pest, good in taste while eating across district. Wonde and Seties are common local cultivar in Offa district, where this name was given by the farmers to express more strongly toxic or late mature (Wonde) and sweet tested (Setie) and Bukama (local name) is a person name given to recall who brought the local cassava variety to them. Aditya *et al.* (2018) who reported that Qualle and Kelle were the commonly grown improved cassava varieties at stud y area in the region. It is well known for their high yield, disease resistant and low toxicity and introduced into the country from Nigeria (Anshebo *et al.*, 2004; Atser, 2012). The average yields of these varieties ranged between 20–24 t/ha on farm site in southern region (Tadesse *et al.*, 2013) and 36 to 49 t/ha on research site in southwestern part (Jimma) of Ethiopia (Mulualem and Weldemicheal, 2013). The yields may vary significantly depending on the variety, the age of the plant, the plant density and soil fertility and climate (Westerberg *et al.*, 2012). Earlier studies in Woliata district showed that cyanide contents of Qulle and Kello variety were 69 and 50 mg/kg in fresh peeled root, respectively, but they were reduced to undetectable levels after processed into flour and later fermented to produce injera and not acute or chronic toxicity related with consumption of cassava in the district (Nebiyu and Getachew, 2011; Kebede *et al.*, 2012).

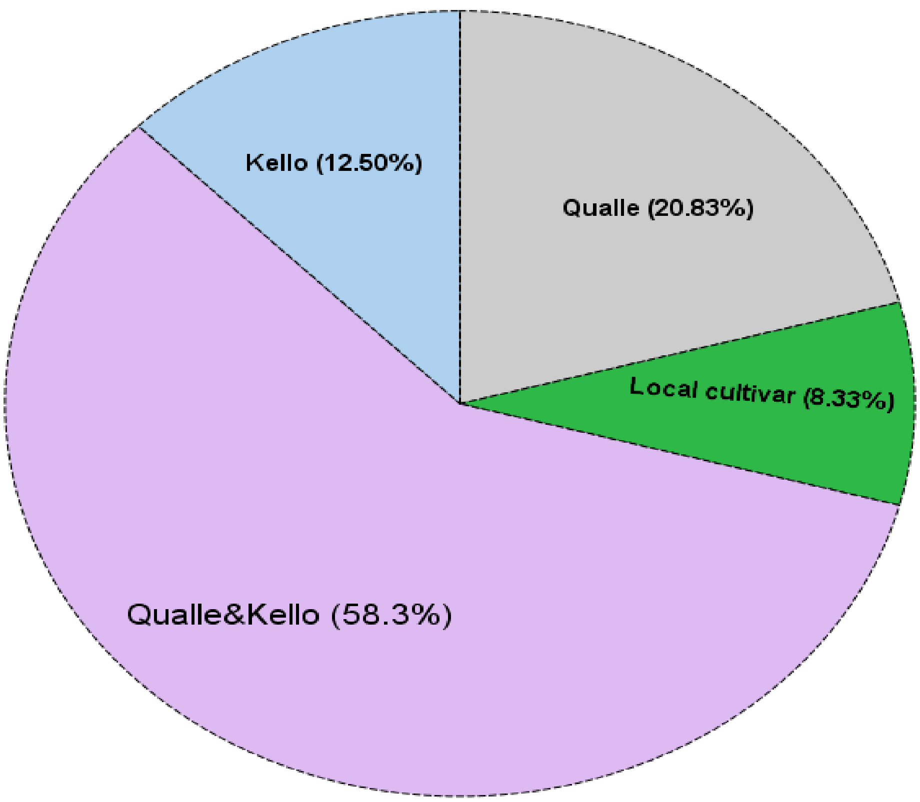

Figure 6 Commonly used cassava varieties in study area

4.1.5. *Farmers' criteria to select cassava variety*

Farmer cassava variety selection criteria are presented in Figure 5. Accordingly, slightly more than half (53.3%) of respondents mentioned a combined criteria to select cassava variety such as high yielding, early maturities, resistance to pest and disease; whereas less proportion of households have a sole criterion tuber, shape, size and color (19.2%); resistance to pest and disease (8.3%); high yielding (5%), early maturing (5.8%) and to select it. In addition to these, Qulle variety with different morphological characteristics like shorter height, easy of peeling, semi-erected orientation of petiole, light green leaf colored, reddish leaf vein color, long storage root, red skin color and bigger sized. These were criteria by which farmer used to select Qulle variety for market purpose, due to their higher flour contentment after drying while white fleshed root, difficultness of peeling, shortening of storage type, green stem color, zigzag growth habit were farmer criteria used to select of Kello variety for home consumption, as the farmer considers it as somewhat sweeter while prepared for local dish (my observation).

These results are similar to those reported by Emmanuel *et al.* (2013) that, early maturing varieties, high yielding, and resistant to pests and diseases were main farmers selecting criteria for cassava variety in Cameroon. Morphological traits as well as the taste, cyanide content, average yield, disease performance and pubescence were also reported as the criteria of cassava varieties (Gbadegesin *et al*., 2013).

Tadesse *et al*. (2013) explained that, shorter height, long storage root, red skin color, bigger sized and white fleshed root, short type were criteria to prefer cassava varieties for market purpose due to enlargement of flour after drying and home consumption, because farmer considers it as sweeter while prepared as local dish, in southern Ethiopia

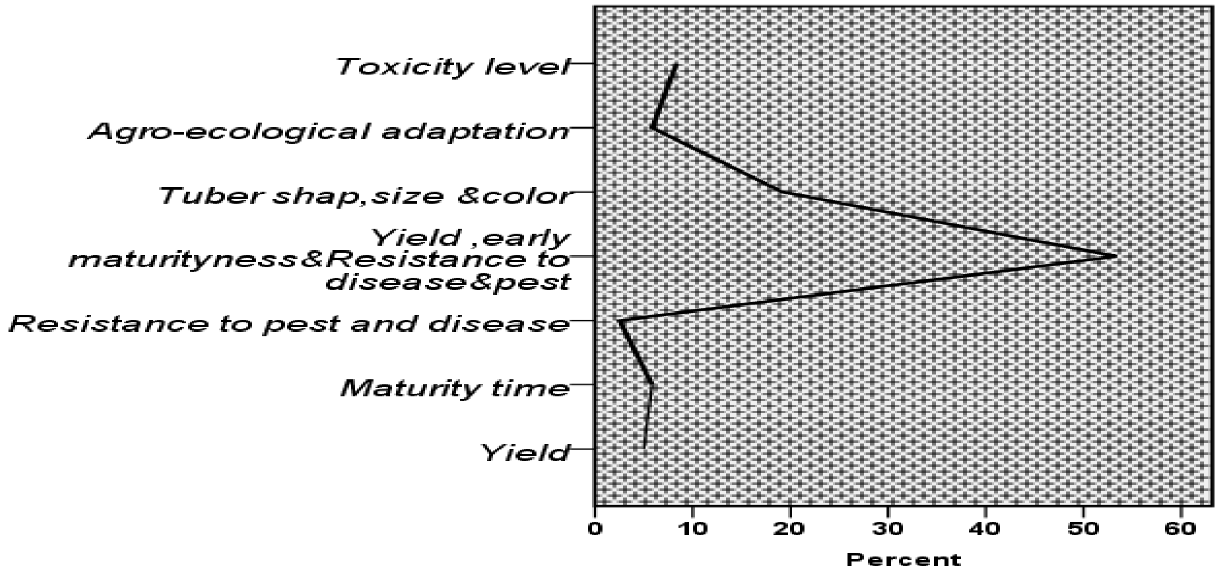

Figure 7 Farmer’s cassava variety selection criteria

4.1.6. *Inputs used for cassava production:*

4.1.6.1. Fertilizer application

Table 4 presented the status of fertilizer application for cassava production in the studied households. Majority (79.1%) of the cassava producers were not using any kind of fertilizer for increasing yield. Whereas, less than one-fourth proportion of cassava producers were using inorganic (8.5%) or organic fertilizer (6.6%) or both (5.8%). NPS and UREA, and compost/farm yard manure are the common inorganic and organic fertilizers, which have been used for increasing the productivity of cassava in the two districts. They are applied in circular form around the stem of cassava tree during the sunny season is the common practice in the study area. This could be related with the farmers perceived that application of fertilizer is not important as that of the other crops, and due to high cost of synthetic fertilizer. Aditya *et al.* (2018) reported more than 90% of the farmers did not have access to synthetic fertilizers due to cost and availability issues in Ofa district. Another study in Wolaita zone revealed that the availability of synthetic fertilizer was not sufficient to reach need by (Laekemariam, 2016).

Table 4**:** Input used for cassava production

	Districts	
	Frequency	Percentage (%)
Inputs		
Inorganic fertilizer	10	8.5
Organic fertilizer	8	6.6
Both	7	5.8
None	95	79.1
Total	120	100

4.1.6.2. Cassava planting material and its sources

According to Figure 6, the source of planting materials for cassava production in the study districts were own farm, neighbor, government and non-government. However, slightly more than half (51.5%) of the cassava growing households were obtaining the planting materials from their own farm, followed by, from neighbors (31.8%), provided by government (9.2%) and non-government organizations (7.5%), respectively. In this case, health of the cuttings (disease free), age of plant and the number of nodes per stem cutting are the essential criteria for ensuring quality of planting material in the study area. A study in Ashanti region of Ghana revealed that the major source of planting materials were own farm and neighboring farmers (Ntawuruhunga *et al*., 2007).

Such results indicate that the improvement in the production and productivity of cassava in African countries including Ethiopia should exert efforts to provide local adaptive variety to farmers, and encourage them to prepare the planting materials by themselves and engage some of the farmers in self-multiplication and planting material distribution in their locality (Aditya *et al.*,2018).

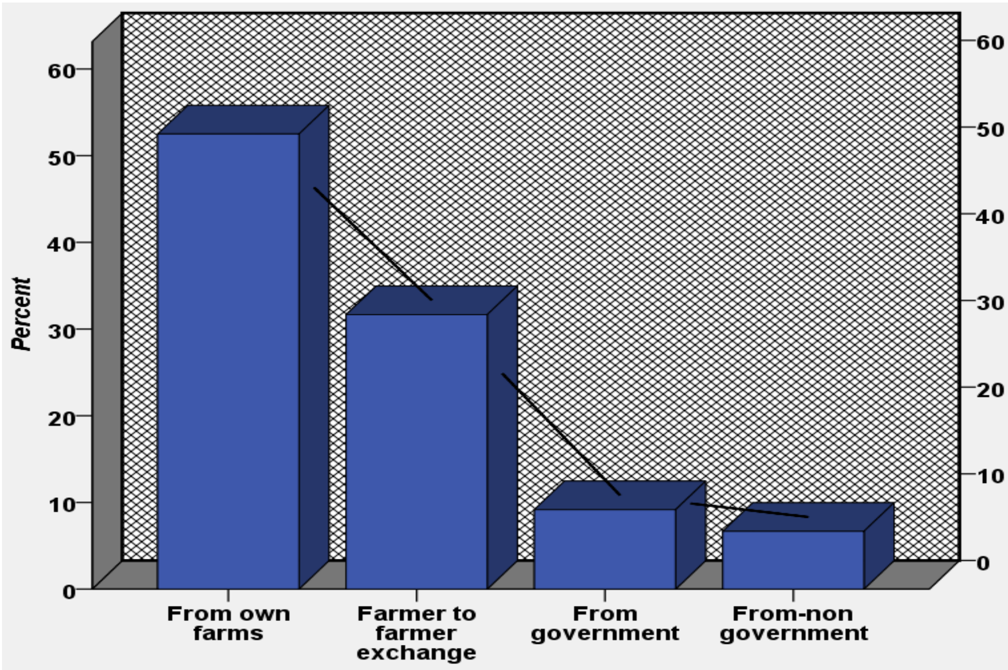

Figure 8 Source of cassava planting material

4.1.7. *Planting, harvesting and storage of cassava*

As it was indicated in Table 4, the respondent households revealed that the majority (38.3%) of cassava planting month was April to May followed by February to March (32.5%). The planting and harvesting activities overlapped with each other and take place in the dry season because of the farm harvesting and tillage activities during the dry season may become tedious where the soils are not sandy. The survey revealed that more than 29% of the crop holders were planting cassava in the first four months of the dry season. However, about 32.5% were planted at the onset of the first rains in February and March. The best time for cassava planting in the major cassava growing areas of Ethiopia would be from March to May (Markos *et al.*, 2016).

About 63.3 % of the respondents were also reported that, weed removal was done three times during the cropping season due to the weed infestation can reduce the yield. Control weeds would be happened in the first 3-4 months after planting. Any delay in carrying out the weeding operation will have an effect on the yield of the crop (Choiana *et al.*, 2016). Controlling cassava weeds in sub-Saharan Africa could costs about 60% and more than 40% of the total cost of growing cassava (Adebayo *et al.*, 2014).

The respondent also reported that area per plant length of cutting and the number of months (16) taken to mature were 0.43 m^2 (84x51.5 cm), 18 cm and 16 months, respectively. Planting season for cassava had been designated as stretchy, because of roots could be harvested between eight month and three years after planting so that the planting and harvesting time depend on the local climate condition (FAO, 2010). Whereas, harvesting was dominantly (36.6 %) done during January followed (24.3%) by December. The primary reason for harvest to take place in these months was due to the availability of higher solar radiations and minimal rains, which are required for the sun-drying process. The optimal harvesting maturity for cassava is about 18–24 months (Cock, 1985; Bokanga, 2000).

The result indicated that majority of the interviewed respondents did not follow the recommended harvesting schedule due to increment of demand special in Offa than Amaro district. The harvesting pattern was gradual or progressive harvesting (depending on the processing capacity of the individual crop holders and market demand) over five months starting October until February. Markos *et al.* (2016) also reported that, Qulle and Kello cultivar were recommended to harvest after 18 months from Hawassa agricultural research center (Hawassa, SARI). However, interviewed farmers reported that delayed harvest aid root to become bulk enough. The reason provided by the farmers for delayed harvest was to obtain higher yield, which may be due to the low input production systems where root growth takes a longer time to reach optimal yields. The optimal maturity for harvesting of cassava is about 18–24 months (Cock, 1985; Bokanga, 2000).

Storage

Cassava storage used by farmers is presented in Table 5 and the respondents household revealed that about 63% of the farmers were not store their products followed by ground storage (37%). Since the farmers have limited capacity to storage their products, ground storage is considered as an important food reserve to maintain its quality for the next season Moreover, farmers harvest cassava roots in bulk only when there is availability of buyers; otherwise, harvesting is mostly done in bits for contingency purposes such as for sale and home consumption and beside of this respondent disclosed that disadvantage of this form cassava storage as it ties up large amounts of land that could be used to grow other crops. At the same time, the roots become woody and there can be impairments to flavor because cassava roots have an optimum harvest age after which there is a loss in yield.

This practice called piecemeal harvesting and common when cassava used for food security. However, it is not suited for commercial production (Chiona *et al.,* 2016). When the most of the cassava for sell rather than consumption, postharvest physiological disordered create a series problem for processor farmer and collectors due to the high manual labor requirements in a short period, which diminishes the producer's profit.

The inherent perishability of fresh cassava roots due to post-harvest physiological disorder (PPD) is a major problem for cassava producers and processors around the globe (Bokanga, 2000; Oguntade, 2013; Uchechukwu-Agua *et al.,* 2015; Parmar *et al.,* 2017b). The only practical solution, which is currently available to the smallholders in the study area, was to harvest a part of the total production, which can be processed within a day (Nduwumuremyi *et al.,* 2016).

Table 5**:** Storing of cassava

Farmer storage of cassava	Percentage (%)
I don't store, I will sale / it will be consumed during harvesting	63%
Store in- ground	37%
Store in sack	-
Store in plastic container	-
Others	-
Total	100%

4.1.8. *Trends of Cassava Production*

The majority (84%) of respondent households revealed that the trends of Cassava production for last five years were increasing. According to the southern regional agricultural bureau estimates, that cassava production has increased fivefold since the introduction of improved cultivars and the expansion of area under cultivation. The growth in cassava production has been primarily due to rapid population growth, large internal market demand, and availability of high yielding improved varieties of cassava (Onyinbo *et al.,* 2011).

The increasing trend in the year 2000 to 2004 approximately 50,000-60,000 tons of cassava was produced on ~ 5000 ha in comparation to 250, tons on 12,800 ha (average yield of ~ 19.53 tons/ha) in 2011 (Tadesse *et al.,* 2013; Haile, 2015). Cassava production increasing was doubled in the world, when it appeared as food crop in the sub-Saharan country (Howeler, 2013) and with increasing of cassava price advantage over maize (Kim *et al.,* 2015). Moreover, Okao *et al.* (2017) reports that, trend of cassava production has been on increase due to the increasing number of farmers who grown improved cassava varieties while increasing of cassava outputs and might be decrease because of high disease pressure in the northern Uganda.

The cassava yield increment is based on its yearly plantation in fresh area where organic manure is applied (Kharlyngdoh *et al.,* 2018). Trend of cassava increase due to fits well in to the farming system of the small-holder farmer because it available in all year round compared to grains, and is more tolerant to low soil fertility and more resistant to drought, pests and diseases (Obisesan, 2012) and its root store well in the ground for months after maturity (Ope-Ewe *et al.*, 2011).

Table 6**:** Planting, harvesting and production trends of cassava in the study area

Variable	**Frequency (N)**	**%**
Planting month (%		
October-November	15	12.5
December-January	20	16.6
February-March	39	32.5
April –May	46	38.3
Total	120	100%
Harvesting month	**Frequency (N)**	**%**
October	11	9.2
November	12	10
December	24	24.2
January	44	36.6
February	29	20
Total	120	100
Weeding frequency	**Frequency (N)**	**%**
Once	-	-
Twice	44	36.7
three time	76	63.3
Total	120	100
Spacing, length of cutting, month takes for maturity		**Mean**
Spacing b/n row		84
Spacing b/n plant		51.5
Length of cutting		18
Month take for maturity		16
Cassava Production Trends	**Frequency (N)**	**%**
Increasing	84	70
Decreasing	11	9.2
Same	19	15.8
Not known	6	5
Total	120	100

4.1.9. *Utilization of cassava at household level*

The respondent households revealed that, composition formation (31.67%) with other crops was the major reason for cassava processing followed by consumption and income generation (Figure 7). This result was in line with the findings of Oladeji *et al*. (2019) who reported that, income generation and consumption was the major reason in Zambia. However, it was in contrary to the findings of Hahn and Keyser (1985) who reported the primarily purpose of cassava processing for increasing its shelf life and improving its palatability.

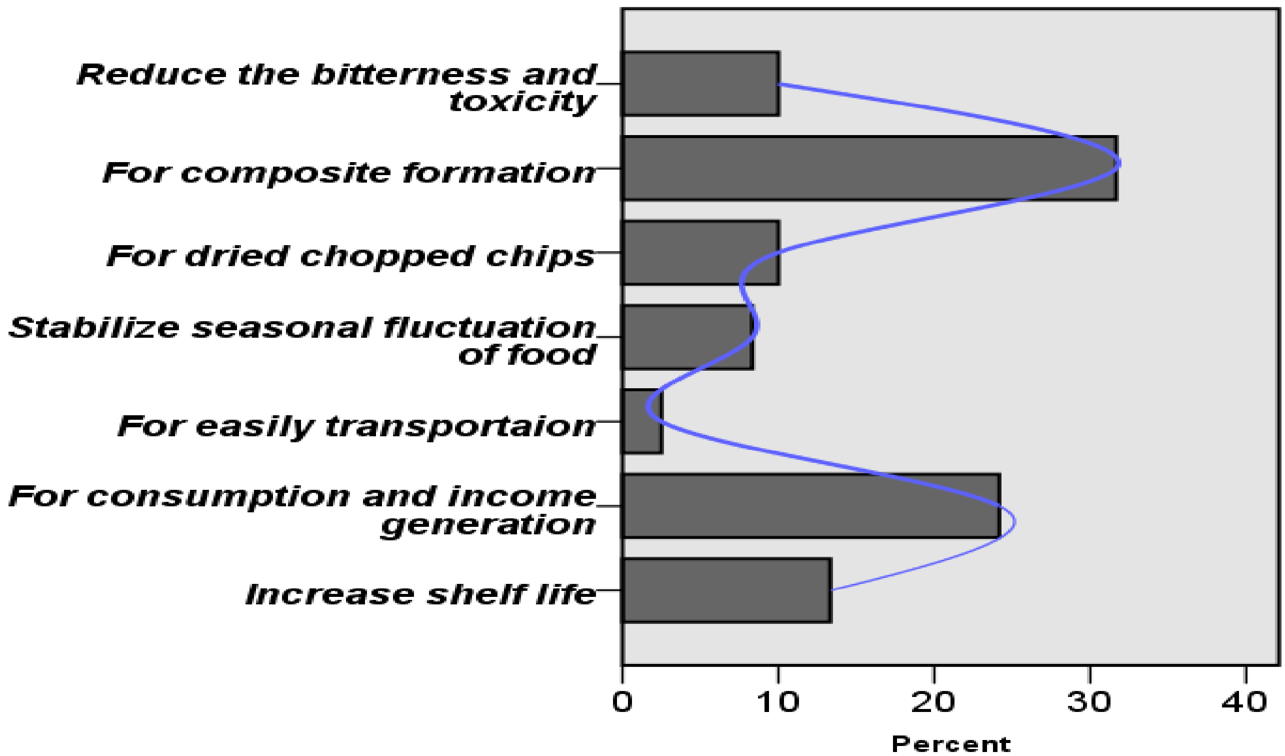

Figure 9 Reason of cassava processing at household level

4.1.10. *Gender involvement and cassava processing*

Table 7 revealed that both male and female were involved in various stages of cassava processing at the household level. However, female households were dominantly engaged in all processing activities. Women households covered more than 70% of the overall cassava processing activities. On average, except in drying (20%), male households were involved less than 10% of the cassava processing activities. This might be because the activity is exclusively given for female and considered as a female job.

Farnworth *et al.* (2011) reported that cassava processing into chips or flour is often laborious and time consuming due to lack of the right equipment. One of the advantages of converting fresh cassava into dried chips is that the dry product can be stored for longer periods, can be used to fill seasonal gaps in availability of food (Oghenechavwuko *et al.,* 2013). The result was similar with Fapojuwo (2007) who reported that females carried out most cassava processing activities.

Table 7**:** The role of gender in cassava processing

	Labor division in cassava processing (n=120)		
Activities in traditional cassava processing	Male	Female	Both (male and female)
Washing (%)	5	87.5	7.5
Peeling (%)	3.3	92.5	4.2
Boiling (%)	2	94	4
Chopping (%)	7.5	84.2	8.3
Drying (%)	20.8	70.8	8.4
Milling (%)	2.5	95	2.5

Traditional processing tools used by household ranged from simple procedures such as peeling and boiling for immediate consumption up to injera backing was presented in Table 8. More than (90%) of the respondent households own traditional processing tools. Whereas, less than 50% of respondents owned bucket (local jerkina), black plastic and mortar stone (4.6%) tools.

The kitchen knife was the most common tool for peeling cassava across the district Similarly Abass (2008), reported that, cassava processing was still done in the traditional way using traditional tools in Zambia, and most farmer used red mats for drying cassava and observed basic food safety rules by not drying on the bare floor (Oladeji *et al.,* 2019).

Table 8**:** Cassava processing tools owned by households

Traditional tools used for processing	**Percentage (%)**
Knife	100
Local mats	97.1
Black Plastics	47.1
Chopping boards	100
Mortar miller (electric motor run stone)	4.6
Mitad	100
Buckets	49.82
Dish/clay pot	100

4.1.11.*Form of cassava consumption in the study area*

The forms of cassava consuming are presented in Figure 8. The respondent revealed that cassava is majorly (34.2%) consumed in the form of injera combined with teff followed by boiling and consuming (20.8%) of the cassava roots alone, the major reasons for the selling mothers to blend cassava with red injera are, the price for cassava is lower than teff, so that it will reduce the cost of teff flour and the use of red teff will reduce the cost for superior injera, which is white as per the consumer perception, due to the cost of white teff is lower than that of the red teff, in this case, the whiteness of the injera will come from cassava color, thus the profit margin will be increased

Abuye *et al*. (2008) reports that all meals in Southern Ethiopia incorporated cassava during summer and they justified that this is commonly used to tackle seasonal food shortage in potential producing area. Desse and Taye (2001) also reported that cassava roots are widely consumed after washing and boiling or in the form of bread or “injera” (Ethiopia staple food) after mixing its flour with that of some cereal crops such as maize, wheat, sorghum, or teff in Woliata and Sidama Zone.

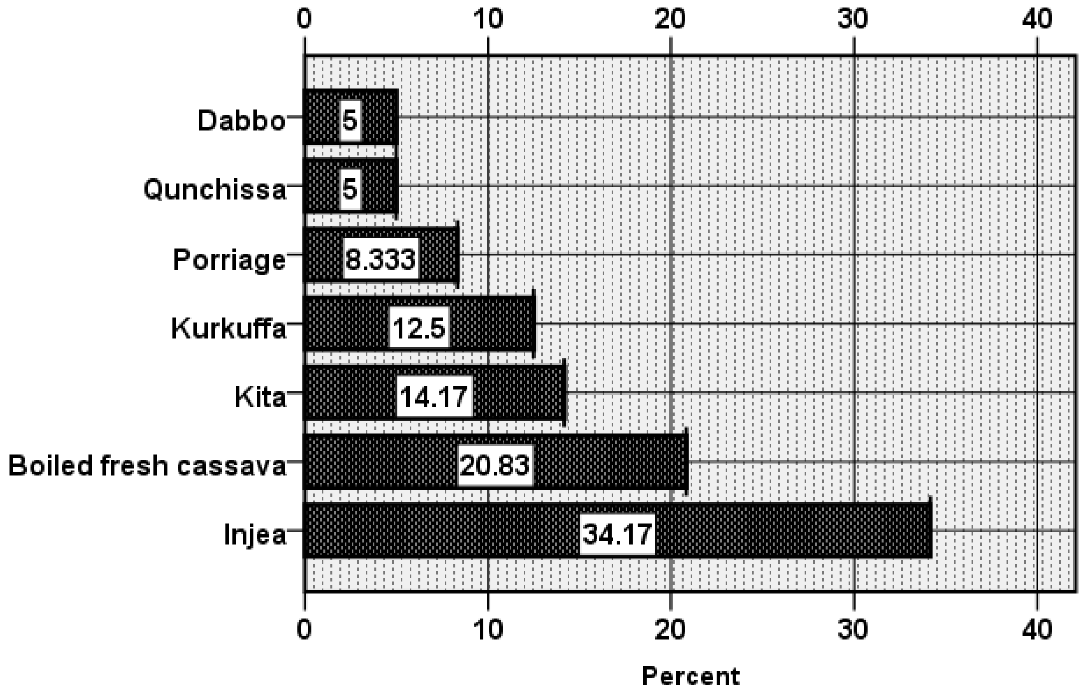

Figure 10 Food produced by mixing cassava in study area

4.1.12. *Important cereal crop mixed with cassava*

The survey result shows that, about 71% of the respondents were mixed cassava with teff followed by sorghum (25%) and barley (24.17%). This result is in line with Agza *et al.* (2018) and they noted that mixing of teff with cassava has superior functionality compared with others cereal crops (wheat, barley and sorghum) for its iron, calcium and zinc content. In addition, teff is preferred for making injera in terms of flavor quality, texture and softness (Bultosa *et al.,* 2002 and Zegeye, 1997). Roots and tuber flour can also possibly in partially substituting the cereals flour (NRC, 1996). Currently, some cassava varieties have been used as ingredient of staple food and widely consume a washing and boiling or in the form of bread or "injera" (Ethiopia staple food) after mixing its flour with that of some cereal crops such as maize, wheat, sorghum, or teff (my observation). Most of the dehydrated cassava chips were traded and were later milled into flour to serve as a supplementary to teff (Eragrostis teff) and maize (Zea mays) in composite flour for the preparation of injera (Misgana *et al.,* 2020).

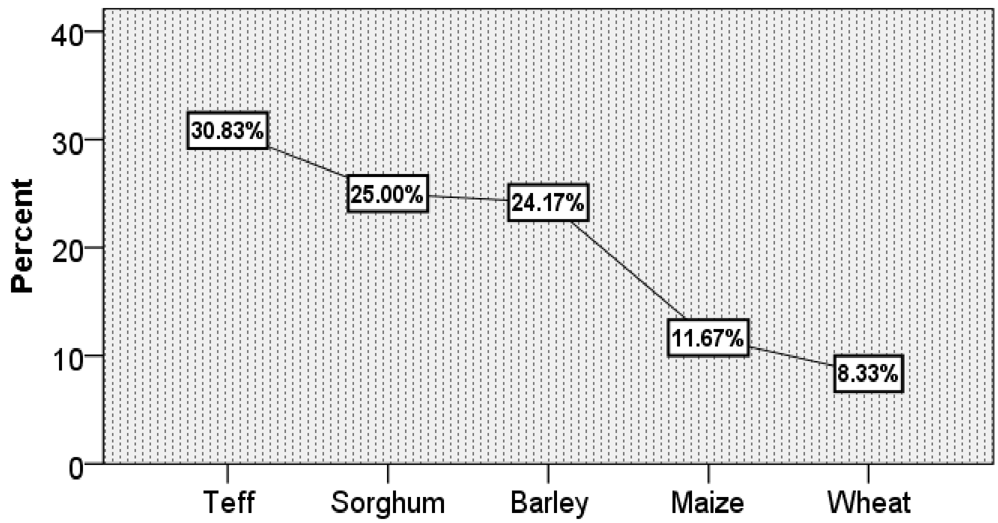

Figure 11 Mixing cassava with cereal flour

4.1.13. *Blending ratio of Cassava with teff to make injera*

Based on the information collected during the household survey it is evident that different proportion of cassava was mixed with teff in making injera (Figure 10). From the total respondents, about 45% were used the ratio of 60% of teff with 40% of cassava for preparation of injera which was followed (38.8%) by 50% of teff with 50% of cassava. The lowest percentage of respondents was reported about 90 to10 ratios.

Belta *et al.* (2015) reported that, the occurrence of peak hunger during periods from April to August in which a sudden increment price of (teff or maize), hence the high number of consumer switching to use cassava for making injera or high proportion of cassava in the composite flour to reducing the amount of the relatively costly maize and teff during the rainy season and the ratio of teff: maize: cassava was approximately 50:25:25. Nigeria recently raised its levy on wheat flour to 100 percent, and will use revenue for a cassava bread development fund (Kanto *et al.,* 2009). An exceedingly increasing current price of teff in Ethiopia could be a good opportunity to utilize cassava flour as a supplement to teff and its dried chips are suitably mixed with teff, wheat and sorghum to prepare injera in producing farmers at Gofa and Belle areas of the southern region (Yared, 2012).

On the contrary, teff is of high demand both in domestic and international market due to its high quality including nutritional and health benefit and its price is escalating from time to time. In order to minimize the price of products like injera, at least partially substituting teff, highly expensive cereal with relatively less expensive flour sources like cassava is very important. Similar example was reported by Cock (1985) that, an increment of price of staple and more valuable crops like rice leads to higher consumption of cassava-based food products, in country of Indonesia. Cassava consumption is being promoted in much country, aimed at substituting imported cereals with domestically produced cassava flour are considering, mandatory blending of mostly imported wheat flour with domestically produced cassava flour in bread making (Wanapat *et al.*, 2010).

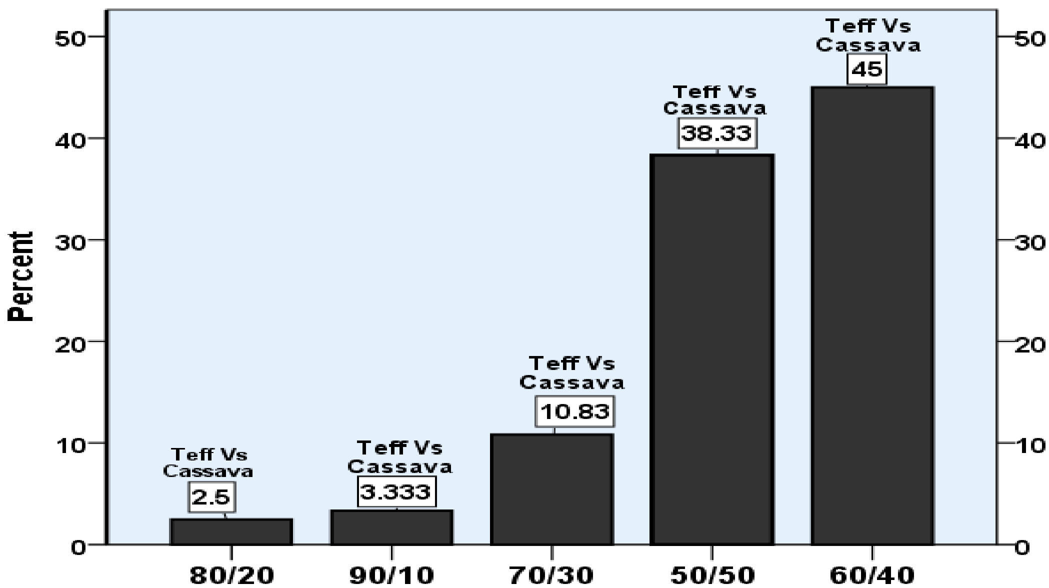

Figure 12 Blending ratio of teff with cassava to make injera

4.1.14.*Marketing, location and challenges of cassava*

Cassava marketing, marketing location, potential buyer, and cassava forms to be sold in market are presented in Table 9. As it was explained in survey result, cassava is sold from home, nearby market place and in the major cassava market place. However, it was majorly (45.8%) sold from home followed by nearby market place (35%) and major cassava market place (19.2%) was marketing place (Table 9). It is also evident from the respondents the potential buyers of cassava were merchant sell in same local merchant (75.8).

The respondents reported that, about 34.1% of the household sell their products in unpeeled form; whereas the other 30.8% sold in peeled/chip form. Marketed cassava products include fresh tuber, chips and flour; fresh tuber as standing on farm being the most the traded product but trading fresh cassava most more dynamic and highly streamlined than its processed versions, due to its short shelf-life which demands which demands immediate movement from producers to consumer with minimal (Odongo and Etany, 2018).

Table 9**:** Sell, potential buyer and sell place of cassava at study area.

Variable	Frequency (N)	Percentage (%)
Major sell place		
From home	55	45.8
Nearby market place	42	35
Major cassava market place	23	19.2
Cooperative	-	-
Others	-	-
Total	120	100
Potential buyer	Frequency (N)	Percentage (%)
Local household	7	5.8
Merchant selling in same local market	91	75.8
Wholesaler/local merchant selling outside local merchant	22	18.4
Others	-	-
Total	120	100
In which form do you sell cassava		
An un peeled root	41	34.1
Peeled/chips	37	30.8
Powder form	17	14.4
Composite	20	16.6
Animal feed	5	4.1
Total	120	100

A challenge of cassava marketing was presented in Table 10. The survey result revealed that, lack of storage facility (30%) was the dominant factors of marketing in the study area followed by poor road (25%). Whereas the other factors were covered by price fluctuation (4.2%), low quality of chips or flour (15%), high coast of transport (14%), lack of market information (6.8%), and heavy rains (5%). Poor infrastructure also makes movement goods and people difficult. This is more so during the rainy when many part of rural area were in accessible. The road link with major towns area usually quiet and this has significant implications for marketing, cost of input ,access to health facilities and other social service, therefore have adverse effects on production and rural standard of living. Information in marketing is not restricted, but could not said to be perfect due to poor processing source of information (Broderick and Awerije, 2014).

Odongo and Etany (2018) suggested that, both producer and trader can encountered similar challenges, when they comes to marketing cassava product and mentioned cassava price fluctuation, low quality of product, lack of market information and poor infrastructure were main challenge in Northern Uganda.

Table 10**:** Marketing challenge and experience at study area

Variable	Frequency	(%)
Marketing challenges		
Price fluctuation	5	4.2
Low quality (chips and flour)	18	15
High cost of transport	17	14
Heavy rains	6	5
Poor roads	30	25
Lack of storage facility	36	30
Lack of market information	8	6.8
Total	**120**	**100**

4.2. Phase -II: Evaluation of cassava varieties as Ingredient for Injera

4.2.1. *Proximate composition of cassava-teff injera*

The combination of variety and blending ratio showed significant difference on protein; fat, fiber, ash and cyanide content (Table 11). The result revealed that, next to 100% teff injera, the two highest (9.47 and 9.30%) crude protein contents were recorded from Qulle and Kello at 10% of cassava blends with 90% teff, respectively (Table 11). This could be due to the fact that relatively higher protein content of Qulle variety compared to kello. Protein content of all blend injera was lower than that of 100% teff. Due to crude protein contents found in cassava was lower than that of teff. Kuzayil *et al.* (1996) reported that mixed up varietal difference in protein content might have been has something to do with the genetics, soil, climate, and strain and fertilizer treatment etc.

It is evident from Gebrekidan T. (2016), protein content of 10% Qulle containing injera was recorded higher protein than Kello variety with the same ratio. As it was also reported by Teka *et al.* (2013), higher protein content was recorded from Qulle variety than Kello. The addition of more cassava flour had reduced the protein content of injera; this may be attributed to the general low of protein content of roots and tuber crops including cassava (Misgana *et al.*, 2020).

The two highest crude fat contents (1.89 and 1.83) were recorded from Kello and Qulle at 10% blends mixed with 90% teff, respectively (Table 11). The lowest was recorded from 50: 50 % blends of Qulle and Kello. Fat contents of all blended injera were lower than that of 100% teff. The fat content estimated in this study had shown a decreasing trend with increasing level of cassava flour and might be due to higher fat content of teff than cassava **(**Misgana *et al.*, 2020).

As it was evident from Table 11, Kello has higher ash content than Qulle when it was blended with 90% teff and it was statistically similar with 100% teff. The result further explained that, Kello was better than Qulle for ash content in all ratios. Ash content of all blend injera was lower than 100% of teff.

The highest crude fiber contents (2.42%) were recorded from 100% teff and it was followed by 10% Qulle mixed with 90% teff (Table 11). The lowest crude fiber from 50: 50 % ratio of cassava and teff (Table 11). The result further explained that, blending teff with Qulle cassava variety had better crude fiber than Kello variety. This could be due to the higher fiber content of Qulle variety than Kello variety. Similarly, Teka *et al.* (2013) reported that, crude fiber content of Kello variety had lower than Qulle. Moreover, Gebrekidane (2016) also reported that, the highest crude fiber content was recorded from 10% Qulle variety containing injera.

Across all treatment, the highest value of (0.48 mg/100g) hydrogen cyanide content was recorded from 50% of Kello mixed with 50% of teff. The lowest (0.17 mg/100g) was recorded from 10: 90 ratio of Qulle variety of cassava and teff and it was statistically at par with 20 to 30% of Qulle and Kello cassava variety (Table 11). Thus, blend of injera from Kello has more hydrogen cyanide than blend of injera from Qulle. However, the hydrogen cyanide contents in all of the blended treatment were far below the WHO minimum (10 mg/kg) permissible amount (FAO/WHO, 1991).

Table 11**:** Proximate composition and hydrogen cyanide content of cassava-teff injera

Blending ratio	Crude Protein (% db)	Crude Fat (db %)	Ash (% db)	Crude Fiber (% db)	Hydrogen Cyanide (mg/100g)
Qulle (10%)*Teff (90%)	9.47[b]	1.83bc	2.79bc	2.42b	0.17e
Qulle (20%)*Teff (80%)	9.15b	1.74cd	2.52d	2.20c	0.19ced
Qulle (30%)*Teff (70%)	7.40d	1.68de	2.06f	1.76e	0.21cebd
Qulle (40%)*Teff (60%)	6.80e	1.54e	1.55g	1.75e	0.23cbd
Qulle (50%)*Teff (50%)	6.78e	1.20f	1.07h	1.68ef	0.26b
Kello (10%)*Teff (90%)	9.30b	1.89b	2.94ab	2.31c	0.18ed
Kello (20%)*Teff (80%)	8.20c	1.72cd	2.76c	2.08d	0.19ced
Kello (30%)*Teff (70%)	7.38d	1.64de	2.53d	1.58f	0.21cebd
Kello (40%)*Teff (60%)	6.57ef	1.55e	2.26e	1.33g	0.24cb
Kello (50%)*Teff (50%)	6.30f	1.21f	2.10ef	1.04h	0.48a
Teff (100%)	9.98a	2.26a	3.05a	2.65a	Non detect

Moisture and Carbohydrate

The moisture and carbohydrate contents of the blending ratio, which were analyzed as simple CRD by including 100% teff injera, showed significant difference (Appendix Table 3). The highest moisture content was recorded from injera made from 50% teff blended 50% cassava. Injera prepared from teff alone has the lowest moisture content. As the proportion of cassava increased in the blend, moisture content of injera also increased (Table 12). Moisture content of cassava-teff injera had shown increment as the proportion of cassava increased. This might be due to the high-water absorption capacity of cassava flour (Misgana *et al.*, 2020). With regard to carbohydrate, 50% and 40% cassava blend injera resulted in the highest carbohydrate content. Similar to moisture content, carbohydrate content increased with increasing the cassava proportion. 100% teff injera and 10% cassava were the lowest in Carbohydrate (Table 12). The carbohydrate contents of all the cassava-teff injeras except injera containing 10% of cassava were significantly higher than that (100% teff injera) because the two cassava varieties had higher carbohydrate content than teff (Gebrekidane, 2016). The increase in carbohydrate content may be attributed to high carbohydrate composition of cassava as is in other roots and tuber crops (Misgana *et al.*, 2020).

Therefore, protein, fat, ash and fiber content found in 100% teff injera were higher than when comparing with those of blend injera with cassava while moisture and carbohydrate contents found to be lower in 100% of teff injera. Among the blend injera, as cassava proportion increase, protein, fat, ash and fiber content of composite injera decreased but moisture and carbohydrate content increased (Tables 12).

Table 12**:** Moisture and carbohydrate content of cassava and teff blended injera

Blending ratio (%)	**Moisture**	**Carbohydrate**
Teff 90:Cassava 10	60.21e	83.37d
Teff 80:Cassava 20	62.74d	84.75c
Teff 70:Cassava 30	64.18c	86.62b
Teff 60:Cassava 40	64.93b	88.44a
Teff 50:Cassava 50	65.97a	89.16a
Control (100% teff)	57.42f	82.56d

4.2.2. *Sensory acceptability of cassava teff injera*

The combination of variety and blending ratio data ran as simple CRBD showed significant difference among the different combinations of teff: cassava varieties along with the control (100% teff) for Color, texture, sticking, sourness, aroma, taste, Appearance, bottom eyes and overall acceptability (Appendix Table 5). The data of sensory acceptability for Color, texture, sticking, sourness, aroma, taste, Appearance, bottom eyes and overall acceptability are presented in Table 13.

The two highest score for color were 7.84 and 7.78 which were injera containing the 10% of (Qulle and Kello) variety with 90% teff, respectively. It can be observed that injera prepared from 10% Qulle and Kello with best color (liked very much by the panelist). On the other hand, injera prepared from 50% Kello was the lowest score value which was neither liked nor disliked by the panelists. Injera made from all blends including 100% teff neither scored from the lowest 5.41 to the highest 7.84 that is mostly ranged from neither liked nor disliked to like very much (Table 13). This indicates that injera made from 50% cassava with 50% teff can be acceptable in color.

The two highest score for texture were 7.23 and 7.03 which were injera containing the 10% of (Kello and Qulle) variety with 90% teff, respectively. It can be observed that injera prepared from 10% Kello was the best texture (moderately liked by the panelist) of all except 10% Qulle with 90% teff. On the other hand, injera prepared from 50% Qulle was the lowest score value which was slightly disliked by the panelists. Injera made from all blends including 100% teff neither scored from the lowest 4.61 to the highest 7.23 that is mostly ranged from slightly dislike to liking moderately (Table 13). This indicates that injera made from 40% cassava with 60% teff can be acceptable in texture. Gebrekidane (2016) also reported, similarly, the highest texture acceptability score recorded for injera containing 10 % (Qulle and Kello) variety while as the proportion of cassava increased score recorded for texture acceptability decreased.

Score acceptability recorded for sticking presented is presented in Table 13. The two highest score (7.39 and 7.03) of sticking acceptability were recorded in injera containing of 10% Kello and Qulle with 90% of teff respectively, next to 100% teff injera (Table 13). The blend Injera made from 10% Kello was statistically similar with 100% of teff injera. The two lowest score of 5.47 and 5.37 had been recorded injera containing 50% of Qulle and Kello variety with their corresponding teff proportion. At these proportions, the blend of Kello was better liked for sticking than the blend of Qulle Variety.

The score of sourness of the cassava -teff injera presented (Table 13). The result revealed that, highest score recorded for sourness acceptability was from 10% of Kello containing 90% teff injera and 100% teff injera (Table 13). Injera prepared from 30% Kello with 70% teff are close to like moderately (score 7) upon the panelists score test for sourness which very close to 100% teff injera (Table 13). At these proportions, the blend of Kello was better liked for sourness than the blend of Qulle. Study conducted by Gebrekidane (2016) explain that, highest score value recorded for sample containing 20% of Qulle and 10% Kello mix, the lowest score for sourness belonged to sample with Qulle variety hence Kello liked better than that of the Qulle varieties.

Score acceptability recorded for Aroma presented is presented in Table 13. The two highest score (7.58 and 7.47) of aroma acceptability were recorded in injera containing of 10% (Kello and Qulle) variety with 90% of teff next to 100% teff injera (Table 13). The blend Injera made from each of 10% Kello and Qulle with 90% teff were statistically similar and they are very close to like very much in aroma by the test panelists. The lowest score of 5.15 had been recorded injera containing 50% of Qulle variety. Still blend injera (50% Qulle) was in the score of neither like nor dislike that can be acceptable for eating.

The two highest (7.33 and 7.31) score of taste acceptability were recorded in blended injera containing of 10% (Kello and Qulle) variety with 90% of teff, next to 100% teff injera. In addition, score value 6.92 had been recorded injera product blending with 20% of (Kello or Qulle) variety with 80% teff. Injera made from 30% Kello with 70% teff was very close to like moderately in taste. Score of taste acceptability scored in the injera containing Kello variety was better than the score found in injera blends containing Qulle variety. The blend of injera containing 10 to 50% Cassava were in the range of neither like nor dislike to the like moderately in taste (Table 13). The acceptability of the taste were highest (6.13 and 5.8) scores recorded injera containing 10% of (Kello and Qulle) respectively in a scale of 7 points (Gebrekidane, 2016).

The two highest score (7.43 and 7.41) were recorded for Appearance acceptability of injera containing of 10% (Qulle and Kello) variety with 90% of teff flowed by 100% teff. The lowest values were recorded for blends of injera containing 50% (Kelle and Qulle) variety with their proportion of teff. Statistically same score appearance of acceptability of injera were recorded in blend containing 10% to 50% (Qulle and Kello) variety with the corresponding proportions of teff.

The two highest score (7.45 and 7.27) were recorded for bottom eyes acceptability of injera containing of 10% Qulle variety with 90% of teff and 100% teff. The lowest values were recorded for blends of injera containing 40% and 50% Qulle and 50% Kello with their proportion of teff. Better score of acceptability of injera eyes were recorded in blend containing 10%, 20% and 30% Qulle variety than the same proportion of Kello with the corresponding proportions of teff.

With regard to overall acceptability, the three highest score 7.56, 7.52 and 7.50 was recorded from injera containing 10% of Qulle and Kello with 90% teff and 20% Kello with 80% teff, respectively next to the 100% teff injera. In addition, the lowest two score (5.21 and 5.01) were recorded injera containing 40% and 50% of Kello variety with 60% and 50% of teff, respectively. Gebrekidane (2016) reported, as cassava increase the score overall acceptability decreased and score of injera containing 10% cassava higher than the 100% of teff but 20% and 30% cassava blend lower than comparing with the 100% teff injera.

Table 13**:** Effect of interaction between varieties and blending ratio on sensory acceptability cassava-teff fresh *injera* product

Treatment	Color	Texture	Sticking	Sourness	Aroma	Taste	Appearance	Bottom eyes	Overall acceptability
Qulle (10%)*Teff (90%)	7.84a	7.03ba	7.29ba	7.05b	7.47a	7.31a	7.41a	7.45a	7.56a
Qulle (20%)*Teff (80%)	7.25b	6.70c	7.07bc	6.35d	6.52c	6.92b	6.92b	7.25a	7.25b
Qulle (30%)*Teff (70%)	6.17c	6.27d	6.66d	6.37d	6.19d	6.19c	6.49c	6.88b	7.03b
Qulle (40%)*Teff (60%)	5.76d	5.21f	5.96e	5.09e	5.72e	5.49d	5.76d	5.70e	5.45e
Qulle (50%)*Teff (50%)	5.52d	4.62g	5.47f	4.86f	5.15g	5.15e	5.56d	5.58e	5.70d
Kello (10%)*Teff (90%)	7.78a	7.23a	7.39a	7.56a	7.58a	7.33 a	7.43a	7.27a	7.52a
Kello (20%)*Teff (80%)	7.43b	6.88bc	7.21ba	6.90cb	6.96b	6.92b	6.66c	6.50c	7.50a
Kello (30%)*Teff (70%)	6.25c	6.35d	6.84dc	6.76c	6.60c	6.72b	6.60c	6.07d	6.11c
Kello (40%)*Teff (60%)	5.60d	5.70e	5.80e	4.92fe	5.58fe	6.01c	5.68d	5.98d	5.21f
Kello (50%)*Teff (50%)	5.41e	5.41f	5.37f	4.82f	5.45f	5.45d	5.60d	5.50e	5.01f
Teff (100%)	6.80c	6.93b	7.61a	7.45a	7.73a	7.73a	7.32a	7.75a	7.81a

Data are mean of triplicate. Values in a column with the same latter are not significantly different ($p>0.05$).

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Slightly less than half of the cassava-producing farmers were planting either cassava alone or intercropped with other cereals, but majority of these producers were not using any kind of fertilizer for increasing the cassava productivity. More than half (51.7%) of the farmers were producing cassava for planting material, animal feed, income generation and for household consumption purposes. About two-third (63%) of the producers were selling the cassava in the farm or harvest cassava once and immediately sell and use for household consumption, but the others (37%) were storing it in the ground and harvesting progressively and sell and use for household consumption at different times.

Cassava processing activities are mainly carried out by women's and these include washing, peeling, chopping, drying, boiling and milling. The common type of foods prepared and consumed in the cassava-producing households are injera, boiled cassava, kitta, kurkufa, porridge, dabbo and qunchissa respectively. In the study districts, the two improved (Kello and Qulle) and three local (Sate, Wonde and Bukama) cassava varieties are cultivated, but the improved varieties covered majority of the cassava farmer's land. More than half (53%) of the cassava farmers consider yield, early matureness and resistance to disease and pest were the criteria for selecting the cassava variety to grow; whereas, the rest farmers criteria were: the cassava tuber shape, size and color (19.2%); resistance to disease and pest (8.3%), yield (5%), early matureness (5.8%). However, there was no criterion by the farmers to select cassava variety intended for injera making, therefore, they are using cassava regardless of the variety for household injera making for household consumption or for selling regardless of the type of food prepared from it.

The cassava producing farmers were using different proportion of teff mixed with cassava flour to make injera, but higher proportion of the households (45%) were producing from 60% teff with 40% cassava flour, followed by 50% teff with 50% cassava, but less proportion of households were producing injera by incorporating 10% cassava on teff for injera making. Even if the acceptability of injera prepared from different proportion of cassava with teff flours mix was acceptable by the injera consumer panelists at Hawassa, yet they are below the injera prepared from 100% in most parameters and in overall evaluation. As the amount of cassava (both variety) incorporated increased, the rollability, aroma, taste, upper eye and overall acceptability were decreased. Therefore, both cassava varieties (Qulle and Kello) can be mixed up to 30% with teff for injera making, without acceptability and safety problems.

5.2. Recommendation

- Further research should be done in starch characterization as the staling and less eye formation are the major traits to be improved for increasing the quality of injera prepared from teff mixed with cassava.
- Cassava is advisable to be included in daily diet plan for the production of cassava –teff injera.
- Further research should be done in shelf life, physio-chemical, functional properties and remaining antinutrients of cassava-teff injera, which are not included in this study.

6. REFERENCE

AACC. 2000. Approved Methods of the American Association of Cereal Chemists. America Association of Cereal Chemists, Inc; St Paul, Minnesota, USA.

Abass, A. 2008. Recent developments in cassava processing, utilization and marketing in East and Southern Africa and lessons learned. Paper presented at the FAO Expert Consultation Meeting held at the Natural Resources Institute, University of Greenwich, United Kingdom.

Abeygunasekera and Palliyaguruge, 2013. Does cassava help to control prostate cancer? A case report, J. Pharm. Tech. Drug Res. 3 pp.

Abuye, C., Kelbessa, U. and Wolde-Gebriel, S. 1998. Health effects of cassava consumption I south Ethiopia. East African Medical Journal, 75(3), 166– 170.PubMedGoogle Scholar

Adebayo, B., Abass, E. T., Ivor, M., Richardson, O., Roger, R., Gbassey, T. and Edward, K. 2014. Growing cassava: A training manual from production to postharvest pp. IITA, Ibadan, Nigeria.

Adesiji, G. B., Akinsorotan, A. O. and Omokore, D. F. 2010. Farmers‘ assessment of extension Services on Ogun State, Nigeria. Journal of Agricultural and Food Information, 11(2):; 143-156.

Aditya, P., Asnake, F., Barbara, S. and Oliver, H. 2018. Post-harvest management and associated food losses and by-products of cassava in southern Ethiopia.

Agza, B., Ruth, B. and Legesse, S. 2018. Quinoa (Chenopodium quinoa, Wild.): as potential ingredient of injera in Ethiopia, Journal of Cereal Science.

Allem, A.C. (2002). The origin and Taxonomy of cassava In: Hillocks RJ, Thresh JM, Bellotti AC, eds. *Cassava*: *biology, production and utilization*. CAB International, 1-16.

Amsalu, A. 2006. Caring for the Land Best Practices in Soil and Water conservation

Amsalu, N. 2003. Characterization and Divergence Analysis in Cassava (*Manihot esculenta* crantz) accessions at Jima.

Andersen, M. D., Busk, P. K., Svendsen, I. and B. Møller, L. 2000. "Cytochromes P-450 from cassava (*Manihot esculenta Crantz*) catalyzing the first steps in the biosynthesis of the cyanogenic glucosides linamarin and lotaustralin, Journal of Biological Chemistry, 275 (3): 1966–1975.

Anh, L.B., Le, V.B., Soytong, K., Danh, D.N. and AnhHong, L. T. 2007. Plant regeneration of cassava (Manihot esculenta CRANTZ) plants. vol.3, pp.121–127," Journal of Tropical Agriculture.

Anshebo, T., Tofu, A., Tsegaye, E., Tadesse, T., Kifle, A., and Dange, Y. 2004. New cassava varieties for tropical semi-arid climate of Ethiopia. In N. M. Mahungu & V. M. Manyong (Eds.), Proceedings: 9th International Society for Tropical Root CropsAfrica Branch (ISTRC-AB) Symposium, Nairobi, Kenya, 526–531.Google Scholar

Ashaye, O.A., Adegbulugbe, T.A. and Dawodu, O.J. 2005. Evaluation of the Processing Assessment. United States for International Development (USAID) Report, pp 63.

Atser, G. 2012. Cassava varieties developed by IITA shows promise of tackling famine in the horn of Africa International instate of tropical Agriculture. Accessed 17 Aug 2017.

AWADO. (Amaro Woreda agricultural development office). 2010. Annual Agricultural production and crops performance report data.

Aweke, K., Beka, T., Asrat, W., Adamu B., Birhanu, W. and Aynalem, L. 2012. Detoxification and Consumption of Cassava Based Foods in South West Ethiopia. Pakistan Journal of Nutrition 11 (3): 237-242

Aye, T.M., Fahrney, K., Bolliger, A. and Lefroy, R. 2013. Debunking myths on cassava Bamidele, F.S., Babatunde, R.O. and Rasheed, A. 2008. Productivity Analysis of Cassava-based

Banea-Mayambu, J.P., Tylleskar, T., Gitebo, N., Matadi, N., Gebremedhin, M., Rosling, H. Benesi, I.R.M. And Mahungu NM. 2004. Genotype X Environment interaction effects on native cassava starch quality and potential for starch use in the commercial sector. Afr. J. of Crop Sci., 12: 205-216. (Best, 1993; Bokanga.1994; Gade, 2003; IFAD/FAO, 2005)

Benesi, I.R.M. 2005. Characterization of Malawian cassava germplasm for diversity, starch extraction and its native and modified properties. PhD Thesis.

Bokanga, M. 2000. Cassava: Post-harvest operations. In D. Mejia & B. Lewis (Eds. *Information network on post-harvest compendium*. Rome: FAO.

Bolhuis, G. G. 1966. Influence of length of the illumination period on root formation in cassava. Netherlands J. Agri. Sci. 14: 151–262.

Bradbury, J. H., Holloway, W. D. 1988. Cassava, M. esculenta. Chemistry of tropical root crops: Significance for nutrition and agriculture in the pacific. Australian Centre for Int. Agri. Research monographs no. 6, Canberra, Australia, p 76–104.

Broderick, O. and Awerije. 2014. Exploring the potential of cassava for agricultural growth and economic development in Nigeria. University of Plymouth pp263-264.

Buckland, L. 1993l. Gender Analysis in Agricultural Production: IITA Research Guide Vol. 58. pp 6–14.

Buckland, L. 1993. Gender Analysis in Agricultural Production: IITA Research Guide Vol. 58. pp 6–14.

Bultosa, G., Hall, A. N. and Taylor, J. R. 2002. Physicochemical characterization of grain teff Eragrostistef (Zucc.) Trotter starch. Starch Stärke, 54 (10), 461-468.

Burns A., Gleadow R., Clif J., Zacarias, A. and Cavagnaro, T. 2010. Cassava: the drought, war and famine crop in a changing world. Sustainability. 2:3572–607.

Cassava and the upper motor spastic paraparesis in Mozambique. Journal of Tropical

Chanie, D.M. and Walelign, D.B. 2020. Tuber yield ad Yield components performance of cassava (Manihot esculenta) Varieties in faven District in Ethiopia. International Journal of Agronomy; vol. Article ID5836452, 6page.

Charles, A.L; Sriroth, K., Huang, T.C. 2005. Proximate composition, mineral contents, hydroge Cyanide and phytic acid of 5 cassava genotypes. Food Chem. 92:615–620.

Chiona, M., P. Ntawuruhunga, I. Mukuka, A. Chalwe, N. Phiri, P. Chikoti, and Simwambana, M. 2016. Growing Cassava: Training Manual for Extension and Farmers in Zambia. International Institute of Tropical Agriculture (IITA), Zambia.

Chiwona-Karltun, L., Brimer, L., Kalenga, S.J.D., Mhone, A.R., Mkumbira, J., Johansson, L. and Bokanga, M. 2004. Bitter taste in cassava roots correlates with cyanogenic glucoside levels. J. Sci. Food Agric

Chiwona-Karltun, L., et al. 2002. Bitter cassava and women: An intriguing response to food Security, 14–15.

Christopher, C. O. (2008). Comparative analysis of enterprise combination costs and returns in cassava-based food crop farming Systems in delta state, Nigeria. *ARPN J. of Agri. and Biol.Sci*.**3** (4): 27-32.

Cock, H., J. 1985. Cassava: new potential for a neglected crop, in IADS Development-Orientated Literature Series, West view Press, Boulder, CO, USA,

Coursey, D.G. and Haynes, P. H. 1970. Root crops and their potential as food in the Tropics.World Crops, 22: 261–265.

CSA. (Central Statistical Agency). 2007. Summary and statistical report of the 2007 population and housing census: population size by age and sex: Federal Democratic Republic of Ethiopia Population Census Commission Addis Ababa.

Desse, G. and Taye, M. 2001. Microbial load and microflora of cassava (*Manihot esculenta* Crantz) and effect of cassava juice on some food borne pathogens. Afr. J. Food Tech. 6: 21-24

Eduardo, M., Svanberg, U. and Oliveira J., et al. 2013 Effect of cassava flour characteristics on properties of cassava-wheat-maize composite bread types. Int J Food Sci 2013: 305407.

El-Sharkawy, M. A. 2004. Cassava biology and physiology. Plant Mol. Biol. 56: 481-501.

Emmanuel, O. A., Pheneas, N., Terence, C., Ivor, M. and Martin, C. 2013. Evaluation cassava processing and utilization at household level in Zambia.

Eyasu, E. 2002. Farmer's perceptions of change and management of soil fertility. SOS Sahel-

FAO. (Food and agriculture organization). 2008. Cassava as alternative food source. Food and Agriculture Organization of the United Nations, Rome

FAO. (Food and agriculture organization). 2013. Food and agriculture organization of the united nation. Rome, 2013

FAO. (Food and agriculture organization). 1991. Save movement of cassava germplasm. In: (Frison, E.A. and Feliu, E. eds.).

FAO. (Food and agriculture organization). 1997b**.** FAO Production Year Book 85, 88.

FAO. (Food and agriculture organization). 2000. Championing the cause of cassava. FAO News and Highlights

FAO. (Food and agriculture organization). 2001. The Global Cassava Development Strategy and Implementation Plan Volume Proceedings of the validation forum on the global cassava development strategy. Food and Agriculture Organization of the United Nations, Rome.

FAO. (Food and agriculture organization). 2003. Cassava production data (http:/www.fao.org).

FAO. (Food and agriculture organization). 2010. *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Rome.

FAOSTAT (Food and Agriculture Organization of the United Nations). 2015. Cassava production by country in sub-Saharan Africa in 2013, mt.

Fapojuwo, O.E. 2007. Gender Participation in Cassava Processing activities in Ayetoro Area of Ogun State. pp 9

Farnworth, R. C, Akamandisa, M.V., Hichaambwa, M. 2011. Zambia feed the future gend assessment. United States for International Development (USAID) Report, pp 63. assessment.pdf

Feleke, A. 1997. Participatory rapid rural appraisal of Abaya Woreda, North Omo, FARM Africa, Addis Ababa, Ethiopia.

FMANR. (Federal Ministry of Agriculture and Natural Resources). 2006. Cassava Development in Nigeria: A Country Case Study Towards a Global Strategy for Cassava Development Prepared by Department of Agriculture, Federal Ministry of Agriculture and Natural Resources.

Foulkes, D. and Preston, T. R. 1978. Cassava or sweet potato forage as combined sources of Protein and roughage in molasses based diets: effect of supplementation with soybean meal.Trop. Animal Production 3:186–192.

Gbadegesin, M. A., Wills, M. A. and Beeching, J. R. 2008. Diversity of LTR-re-trotransposons and Enhancer/Suppressor Mutator-like transposons in cassava (Manihot esculenta Crantz). Mol Genet Genomics. 280, 305-317.

Gebrekidan, T .2016. Effect of Cassava Variety and Blending Ratio on the proximate composition and Sensory Acceptability of Cassava – Teff Injera. Vol.49. pg 21- 26.

Geremew, W. 2017. The Nexus between livelihood diversification and farmland management strategies in rural Ethiopia. Cogent Economics & Finance,

Ghosh, S.P., Nair, G.M., Prabhakar, M., Pillai, N.G., Mohankumar, B., Kabeerathumma, S., Ramanujam, T., Pillai, K.S., Thankappan, M., Lakshmi, K.R. and Pal, T.K. 1987. Cassava based multiple cropping systems. Technical bulletin No. 6.Trivandrum, India, CTCRI. GIAR.

Gil, J.L. And Buitrago, A.J.A. 2002. La yuca en la alimentacion animal. In: Ospina B, Ceballos H, editors. La yuca en el tercermilenio: istemasmodernos de producción, procesamiento, utilizacio comercializacónn. Cali, Colombia. Centro International de Agricultural Tropical. pp. 527–569.

Gilbert, M.G., Edwards, S., Mesfin, T. and Hedberg, I. 1995. The national herbarium of Addis Ababa, Uppsala. Euphorbiaceae. In: Flora of Ethiopia and Eritrea 2(2): 265-380.

Hahn, S. K. 1987. An overview of traditional processing and utilization of cassava in Africa. Outlook on Agri., pp 110-118.

Hahn, S. K., and Keyser, J. 1985. Cassava: A basic food of Africa. Outlook on Agriculture, 4, 95–100.

Haile, A. 2015. Cassava plantation, consumption and post-harvest processing in Ethiopia. Cassava Cyanide Diseases & Neurolathyrism Network (CCDN), 26, 7– 9.Google Scholar

Hillocks, R.J., In: Hillocks, R.J., Thresh, J.M. & Bellotti, A.C. 2002. CAB International Cassava: Biology, production and utilization. National Resources Institute, University of Green which Cassava in Africa.

Howeler RH, Tan SL (eds), Cassava's potential in Asia in the 21st Century: Present Situation and Future Research and Development Needs. Proc. of the Sixth Regional Workshop held in Ho Chi Minh City, Vietnam, 21-25 February 2000.CIAT.

Howeler, R., Lutaladio, N. and Thomson, G. 2013. Save and grow Cassava. A guide for Sustainable production and intensification. Rome: Food and Agriculture Organization of the United Nations.

IITA. (International Institute of Tropical agriculture). 1990. Cassava in tropical Africa, A reference manual. IITA labadon, Nigeria, 176p.

IITA. (International Institute of Tropical agriculture). 2007. Research for development. International Institute of Tropical agriculture.

IITA. 2021. Cassava Accessed on May6, 2021at4:00pm. https://www.iita.org/cropsnew/c sava Cur Bulletin/bulletin.pdf (accessed on 19 July2010).

Ishii R, and O'MahonyM. 1991. Use of multiple standards to define sensory characteristics for descriptive analysis: aspects of concept formation. J Food Sci 56:838–42.

Jellinek, G. 1985. *Sensory Evaluation of Food: Theory and Practice*. Ellis Horwood Series in Food Science and Technology, Chichester, England. Google Scholar.

Julie A. Montagnac, Christopher R. Davis, Sherry A. Tanumihardjo.2009. Nutritional Value of Cassava for Use as a Staple Food and Recent Advances for Improvement. Volume 8 issue 3/p181-194.

Jones, W. O. 1959. Manioc in Africa Stanford University Press, Stanford.Katz, S.H.; Weaver, W.W. Encyclopedia of Food and Culture; Schribner: New York, NY, USA, 2003.

Kanto, U., Tirawattanawanich, C., Juttupornpong, S., Promthong, S. and Moonthong, O. 2009. Advantages of cassava in animal health improvement. In R.H. Howeler, ed. The use of cassava roots and leaves for on-farm animal feeding. Proc. regional workshop, held in Hue city, Viet Nam, Jan. 17-19, 2005. pp. 187-203. 12.

Katz, H.S. and Weaver .2003. Promotion of Indigenous Food Preservation and Processing Knowledge and the Challenge of Food Security in Africa. *Journal of Food Security*. 2003; 1:75-87.

Kebede, A., Teshome, B., Wondimu, A., Belay, A., Wodajo, B. and Lakew, A. 2012. Detoxification and consumption of cassava based foods in south West Ethiopia. Pakistan Journal of Nutrition, 11(2), 237–242.

Khalil, A.H., Mansou, E.H. and Dawoud, F.M. 2000. Influence of malt on rheological and baking properties of wheat–cassava composite flours. LWT-Food Sci Technol 33: 159–164.

Kharlyngdoh, A.M. Kharlyngdoh, A.M. Anantharaman, E. Shanpru, and D. Naziri,

Kleih, U., Phillips, D., Jagwe, J. and Kirya, M. 2012. Cassava market and value chain analysis. Uganda Case Study. C: AVA Final Report. Natural Resources Institute, UK and Africa Innovations Institute, Uganda,

Kuye, O.O. 2015 ‘’Comparative analysis of performance of Bank of Agriculture and selected commercial banks (FBN and UB) in enhancing cassava production by farmers in South-south Nigeria (2009-2013)’’ Unpublished PhD Thesis submitted to the Department of Agricultural Economics, Management and Extension, Ebonyi State University, Abakaliki.Pp138-139.

Kuzayli, M.V., J.W. Cowan & Z.I. Sabry. 1996. Nutritive value of Middle Eastern food stuffs II. Composition of pulses, seeds, nuts and cereal products of Lebanos. Journal of Food Science and Agriculture, 23:52-61.

Laekemariam, F. 2016. Soil nutrient status of smallholder cassava farms in southern Ethiopia. *Journal of Biology, Agriculture and Healthcare, 6*(19), 12–18.

Lawless, Harry T., Heymann, Hildegarde.1999. Sensory evaluation of food principle and practices. ISBN 978-1-4615-7843-7.

Leihner, D. 2002. "Agronomy and cropping systems," in Cassava: Biology, Production, and Utilization, R. J. Hillocks, Ed., pp. 91–113, CAB. International, Oxfordshire UK.

Malumo, N. 2001. Effect of Cassava Stake Orientation and Planting Depth on Planting Material Multiplication atio Tuberous Root Yield, M.S. thesis, University of Zambia, Lusaka, Zambia,

Markos, D., Hidoto, L., & Negash, F. 2016. Achievements of cassava agronomy research in southern Ethiopia in the last two decades. Agriculture and Food Sciences Research, 3(1), 12–18.

Maziya-Dixon, B., Alamu, and Popoola, E.O. 2017. Nutritional and sensory properties: Snack food made from high-quality cassava flour and legume blend. Food Sci Nutr 5: 805–811. Medicine Hygiene, 93: 257-261.

Misgana, B., Tegene, A. and Bilatu, A. 2020. Injera Making Quality Evaluation of Teff and Cassava Composite Flour

Mohamed, Z. 2018. Cassava production guidelines for food security and adaptation to climatic Change in Asia, Africa, and the role of isotopic technique. International atomic energy Agency (IAEA).

Montagnac, J. A., Davis, C.R. and Tanumihardjo, S. A.2009. Nutritional Value of Cassava for use as a Staple Food and Recent Advances for Improvement. Comprehensive Review in Food Sci. and Food Safety. 8: 181-188.

MoRAD. (Ministry of agriculture and rural development). 2010. Household asset building Programme. Programme implementation manual: Addis Ababa, Ethiopia.

Mulualem, T. (2012). Cassava (Mannihot esculenta Cranz) varieties and harvesting stages influenced yield and yield related components. Journal of Natural Sciences Research, 2(10), 122–129.Google Scholar

Mulualem, T. and Weldemicheal, G. 2013. Evaluation of the adaptability and acceptability of improved cassava (*Manihot Esculenta Crantz*) varieties in southwest. Greener Journal of Agricultural Sciences, 3(8), 658–562.CrossRefGoogle Scholar

Nassar, N.M.A. and Ortiz, R. 2007. A Review on Cassava improvement: challenges and impacts'.of Agri. Sci. 145: 163–171.

Nduwumuremyi, A., Melis, R., Shanahan, P. and Asiimwe, T. 2016. Participatory appraisal of preferred traits, production constraints and postharvest challenges for cassava farmers in Rwanda. Food Security, 8(2): 375–388.

Nebiyu, A., & Getachew, E. 2011. Soaking and drying of cassava roots reduced cyanogenic potential of three cassava varieties at Jimma, Southwest Ethiopia. African Journal of Biotechnology, 10(62), 13465– 13469. https://doi.org/10.5897/AJB10.2636.Google Scholar

Nord and M. Andrews. 2002. Household food security in the United States, Washington, D.C Economic research service, U.S. department of agriculture.

NRC. (National Research Council of the USA).1996. Lost crops of Africa, vol. 1. Grains. National Academy Press, Washington, D. C, pp. 215–234.

Ntawuruhunga, P., J. Legg, J. Okidi, G. Okao-Okuja, G. Tadu and Remington, T. 2007. Southern Sudan Equatorial Region, Cassava Baseline Survey Technical Report. IITA. Ibadan, Nigeria, pp: 65.

Nweke, Felix, I., Spencer, Dunstan, S., Lynam and John, K**.** 2001. The Cassava transformation:

Obisesan, A.A. 2013. Credit accessibility and poverty among smallholder cassava farming households in southwest Nigeria. Greener Journal of Agricultural Sciences, 3(2): 120-127.

Odongo, W. and Etany, S. 2019. An assessment of value chain and Marketing margin of Cassava: in northern Uganda.

OECD, 2006. Agricultural policy reform in the South Africa, policy briefe organization for economic cooperation and development. www.oecdorg/pupplication/policybriefe.

Oghenechavwuko, U. E., Saka, G. O., Adekunbi, T. K., & Taiwo, A. C. 2013. Effect of processing on the physico-chemical properties and yield of gari from dried chips. Journal of Food Processing and Technology. 4, 255.

Oguntade, A. E. 2013. Food losses in cassava and maize value chains in Nigeria: Analysis and recommendations for reduction strategies. Eschborn: Deutsche Gesell's chaft für Internationale Zusammenarbeit (GIZ) GmbH. Google Scholar

O'Hair, S. K. 1995. Cassava new Crop Fact sheet. Okao-Okuja, G., Hamba, S., Omara Nuwamanya, E., Kawuki, R and Alicai, T. cassava applied research for food and income security in northern Uganda project cassava baseline survey report 2017. National Crops Resources Research Institute (NaCRRI-NARO)

Oladeji, F.E. Adelowo, D.T. Ayodele, K.A. Odelade.2019. Phytochemistry and Pharmacological Activities of Cymbopogon citratus: A Review Scientific Afr,

Olsen KM, Schaal BA. 1999. Evidence on the origin of cassava: phylogeography of *Manihot esculenta*. Proc. Nat. Acad. Sci. USA 96: 5586-5591

Olukosi, J. O. and Isitor, S. V. 1990. *Introduction to Agricultural Market and Price; Principle and Application.* Living Book Series, G .U Publication.

Onyinbo, O., Damisa, M.A., Ugbabe, O.O. 2011. An Assessment of the Profitability of Small scale Cassava Production in Edo State: A Guide to Policy. From (Retrieved on 28 June 2013.)

Ope-Ewe, OB., Adetunji, M.O., Kafiya, MR., Onadipe, O.O., Awoyale, W., Alenkhe, B.E. and Sanni, L.O. 2011. Cassava Value Chain Development by Supporting Processing and Value Addition by Small and Medium Enterprises in West Africa – Nigeria. Technical Report August 2008 – August 2011

Parmar, A., Kirchner, S. M., Langguth, H., Do, T. F., and Hensel, O. 2017a. Boxwood borer Hetero bostrychus Brunneus (Coleoptera: Bostrichidae) infesting dried cassava: A current record from southern Ethiopia. Journal of Insect Science, 17(1).

Plucknett, D. L., Phillips, P. T. & Kagbo, R. B. 2000. A global development strategy for cassava: Transforming a traditional tropical root crop. Surring rural industrial development and raising incomes for rural poor. FAO Plant Production and Crop Protection Division, Rome, Italy.

Prathibha, S.; Nambisan, B.; Leelamma, S. 1995. Enzyme inhibitors in tuber crops and their thermal stability. Plant Food Hum Nutr. 48, 247-257.

Production Systems in the Guinea Savannah: Case Study of Kwara State, Nigeria. Am-

Rawel HM, Kroll, J. 2003. Die Bedeutung von Cassava (*Manihot esculenta*, Crantz) AlsauptnahrungsmittelintropischenL¨andern.DeutscheLebensmittel-Rundschau 99:102-110.

Reta, H. and Ali, H. 2012. Livelihood diversification among the agricultural land scarce peasants in the centeral highlands of Ethiopia. International Journal of Agricultural Science, Research and Technology, 2(1), 1-8.

Robert, T. F, Sutter, Ph., Amdissa, T., Alemtsehay, A., Mulugeta, T., Moges, T., Alemayehu, S.,Tanguy, B., Spangler, T. and Yeshewamebrat, E. 2007. Ethiopia: The Path to Self-resiliency, Canadian Network of NGOs in Ethiopia (CANGO), Vol. 2: Sahel and Institute of Development studies. Addis Ababa, pp. 252.

Samuel, S.D. Wolde, Y., Ashenafi, W. 2017. Value Chain Analyses of Cassava in Wolaita Zone, Snnpr, Ethiopia. Journal of Economics and Sustainable Development ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online) Vol.8, No.5, 2017

Sanful RE, Darko, S. 2010. Production of cocoyam, cassava and wheat flour composite rock cake. Pak J Nutr 9: 810–814.

Sanni, L. O, Adebowale, A. A., Awoyale, W. and Fetuga, G.O. 2009. Quality of gari (roasted cassava mash) in Lagos State, Nigeria. Nigerian Food Journal, pp 1-12 ·

Sheffield, J., Taylor, N., Fauquet, C. and Chen, S. 2006. The cassava (Manihot esculenta Crantz) root proteome: Protein identification and differential expression. Proteomics. 6: 1588-1598.

Simonyan, KJ. 2014. Cassava postharvest processing and storage in Nigeria: A review. Afr J Agric Res 9: 3853–3863.stone, G.D., Both Sides Now, Current Anthrop. 43 (2002) 611–630.

Sims, B.G., Ellis-Jones, J. and Twom Low, S.J. 2000. The development of low cost soil and water Conservation for smallholder farmers in the mid-Andean valleys of Bolivia. Paper Presented at the 16th Symposium of the International Farming Systems Association and fourth Latin American Farming Systems Research and Extension Symposium on Globalization and local Development: Challenges to small-scale production. Santiago

Tadesse, T., Degu, G., Shonga, E., Mekonen, S., Addis, T. and Yakob, B. 2013. Current status, Potentials and challenges of cassava production, processing, marketing and utilization: Evidence from southern Ethiopia. Greener Journal of Agricultural Sciences, 3(4), 262–270.CrossRef Google Scholar.

Tagesse, A. M., Endrias, G. and Stefan, S. 2020. Understanding Livelihood Diversification Patterns among Smallholder Farm Households in Southern Ethiopia. Sustainable Agriculture Research; Vol. 9, No. 1; 2020. ISSN 1927-050X E-ISSN 1927-0518. Published by Canadian Center of Science and Education.

Teka, A.T., Emire, A.S., Haki, D.G., and Gezmu, B.T. 2013. Effect of Processing on Physicochemical Composition and Anti-Nutritional Factors of Cassava (Manihot Esculenta Crantz) Grown in Ethiopia. *International Journal of Science Innovations and Discoveries*, 3 (2): 212-222.

Taye Mengesha. 2000. Some quality changes during storage of cassava root. Afr. J. Food Tech; 5: 64-65.

Technologies of Cassava Chips and Flour in Oyo and Ogun States of Nigeria. World J. of

Tesfaye, T.; Getahun, D.; Ermias Sh.; Shiferaw M.; Temesgene, A.; Birhanu, Y. 2013. Status, Potentials and challenges of Cassava production, processing, marketing and utilization: Greener J. of Agri. Sci.3, pp 262-270.

Teshome, S.; Demel, T.; Sebsebe, D. 2004. Ecological study of the vegetation in Gamo Gofa zone, Southern Ethiopia. J. Trop. Ecol. 45, 209-221.

Tewe, O.O.; Lutaladio, N. 2004. The global cassava development strategy. Cassava for livestock feed in sub-Saharan Africa: Rome, Italy: FAO,

Tongglum, A., et al. 1998. Recent progress in cassava agronomy research in Thailand, In: RH Howeler (Eds), Cassava breeding, agronomy and farmer participatory research and development needs, Proc. 6th Regional Worksop held at Danzhou, Hainan, China, 211–234.

Tylleskar, T., Banea, M., Bikangi, N., Cooke, R.D. and Rosling, H. 1992. Cassava cyanogens and “konzo” an upper motorneuron disease found in Africa. Lancet 33:208-221.

Uchechukwu-Agua, A. D., Caleb, O. J., & Opara, U. L. 2015. Postharvest handling and storage of fresh cassava root and products: A review. Food and Bioprocess Technology, 8(4), 729–748.

Wanapat, M., Chanthakhoun, V., Cherdthong, A. and Wanapat, S. 2010. Development of practica uses of cassava as feed for livestock. In R.H. Howeler, ed. A new future for cassava in Asia: Its use as food, feed and fuel to benefit the poor. Proc. 8th regional workshop, held in Vientiane, Lao PDR, Oct. 20-24, 691-696.

Were H.K., Winter, S. and Maiss, E. 2004. Viruses infecting cassava in Kenya. Plant dis. 88(1): 17-22.

Westerberg, A., Zhang, J. & Sun, C. 2012. Cassava: A multi-purpose crop for the future. In Pace (Ed.), Cassava: Farming, uses and economic impact (pp. 145–159). New York: Nova Science Publishers, Inc Google Scholar

Widowati S, Hartojo, K. 2001. Production and use of cassava flour: A new product of potenti in Indonesia. p. 578–586. In:

Williams, C.N and Gazhali, S.M.1969. Gowth and productivity of Topioca (Manihotutilissima). Leaf characteristics and yield. Experimental Agri.**5**: 183–194.

WZFED. 2013. (Wolaita Zone Finance and Economic Development). Yearly Report on Wolaita zone and Rural Woredas' Economy, Unpublished.

Yamane, T.1967. Statistics: An Introductory Analysis, 2nd edition, New York: Harper and Row.

Yared, D. 2012. Demonstration and scaling up of improved cassava cultivars in moisture Stressed areas of the Southern region: Areka, Ethiopia.

Yeoh, H. H.; Tatsuma, T.; and Oyama, N. 1988. Monitoring the cyanogenic potential of cassava: the trend towards biosensor development. Trends Anal. Chem. 17, 234-240.

Zegeye, A. 1997. Acceptability of injera with stewed chicken. Food quality and preference, 8 (4), 293-295.

7. APPENDICES

7.1. Appendix I:- Survey questionnaires

Hawassa University, Collage of Agriculture, School Of Plant and Horticultural Sciences This research survey questionnaire is purely for academic purpose with the title of Assessment of cassava production, processing, and utilization as Injera form in Amaro special district and Offa district in Wolaita Zone SNNPRS.

Consent Form

Are you volunteer to participate in this study? Yes …… No…………

I have understood the aim and importance of the study and decided to participate in this study and confirm with my signature.

Name …………………………. Signature/finger print ……………… dates…………….

Interviewer name…………………….…………… Signature………...……date …………

Supervisors/Researcher comment

………………………………………………………………………………………………

<u>SECTION I: General information (Socio-demographic and economic information)</u>

1. Date of interview ---
2. Name of interviewer --
3. Name of respondent: ________________________, Age of the respondent _________
4. Ethnic group _______________, Religion __________________________
5. Education level ______________________, Sex __________________
6. Wealth category? Rich [ ] Medium [ ] Poor [ ]
7. Location: Region-------_Zone--------Woreda name.............Kebeles...........Village.............
8. Marital status: A) Married B) Single C) Divorced D) Widowed
9. Age of the mother (years)………………Age of the father (years)………………...
10. Total family size…………of these, Male…………..Female…………….
11. Main livelihood activity of the respondent: A) Crop production B) Animal rearing C) Both crop and animal production D) others, please specify…………Total land owned for agricultural purpose (hectare or timed)………
12. Total area of the land is covered by(you can choose more than one answer for this): a) perennial crops b) annual crops c) plantation of forestland d) natural forestland e) others please specify…….
13. GPS Co-ordinates: Latitude:__________ Longitude:__________ Altitude:________

SECTION II: Information on cassava production

1. Are you currently producing cassava in your farm? a) yes b) no (If the answer is NO, please SKIP Q2, 3, 4, 5, 6, 7 and 8)
2. If your answer is YES for Q1, since when did you grow or produce cassava in your farm?.................(years)
3. Land for cassava plantation (ha) a. Home garden b. main field
4. How long you experienced in cassava production? ______
5. How was the trend of land covered by cassava during the past 10 years? [√]

a) Increasing [ ] b) Decreasing [ ] c) Same [ ]

6. If the trend is decreasing or increasing what would the most common reasons?

____

____

7. How do you grow cassava? [√] Monoculture cropping [ ] Multiple cropping [ ]

8. If your answer is multiple cropping, which crops do you grow in association with cassava and what are the reasons using intercropping?

SN	Crops grown in association with cassava	Reason for using intercropping
1		
2		

9. If your answer is NO for Q1, what is your reason for not growing cassava?
   a) Lack of sufficient land
   b) Lack of information of its productivity
   c) Lack of its planting materials
   d) If others please specify your reason …………………..
10. Do you have any information on the existence of cassava variety/ies? A) yes b) no
11. Which types of variety do you use in your farm? a) introduced/improved b) local variety c) both
12. If you are producing local variety, what was the reason? a) lack of information about improved variety b) lower availability of improved variety c) higher productivity d) disease resistance e) early maturity f) preference of taste g) other (specify------------)
13. Is there name for local cassava? a) Yes b) No
14. If your answer is YES for Q-13, please list the name/s of the local cassava----------------------- --
15. If you use improved varieties, which of the following variety you are using? a) Qulle b) Kelle c) Hawassa-04 d) others (please specify------------------------
16. What are the advantages of improved varieties you are using? a) productivity b) early mature c) disease resistance d) good taste while eating e) other(specify----------------)

17. In which month/months you usually plant cassava in your farm/production area? ---------------
----
18. Do you use production technology for cassava production? A/ yes B/ No
19. If your answer is yes then which technology do you use for planting of cassava? A) row b) broadcasting c) both d) other specify--
20. Current Cassava Production Trend, Situation and Outlook

Year	**Acreage (in '000')**	**Production (in '000' MT)**	**Yield Rate (MT)**

21. From where do you obtain planting materials? a) from farmers b) from gov.t c) from donors d) from garden e) from other/ specify------------------------------------
22. What types of planting materials do you use for planting of cassava? a) Stem cutting b) seed of cassava c) Tuber) both
23. If you are using stem cutting, how many number of cutting you usually planting per hectare? --
24. If you use stem cutting, what is length of cutting -------------------------in cm
25. If you use seed, amount of seed------------------------------in k.g
26. How and on what characteristics you select a particular planting material for planting? --
27. How do you treat these propagation materials before, during and after planting? --
28. Have you faced problem of planting materials? a) yes b) no
29. If yes, what were the reasons and how do you think such problems would be coped up? --

Field management

30. Do you have specific spacing arrangement of the crop? A) Yes b) no
31. If yes, specify spacing between rows _______ spacing between plants _____
32. Do you use of fertilizers and weeding for the crop? A) Yes b) no
33. If yes, specify the following:

Organic: method _____________ rate ___________ time ______

Chemical: type ___________ method _______ time __________

Weeding: Number ___________ time ________

34. Is there any practical management disparity among cassava at field and at home garden? [√] Yes [ ] No [ ] If yes, please illustrate the difference

____

Disease and pest management

Disease management

No.	Name of disease	varieties infected	Control measures used
1			
2			

Pest management

No.	Name of the pest	varieties infected	Control measures used
1			
2			

35. How many months that takes for maturity of cassava variety you are planting in your farm? --
36. The age of cassava plant that you harvest ---------------------in number?
37. Maturity indicators or determination of cassava for harvesting? ....
38. Harvesting months of cassava? --------------------
39. The amount of cassava produced per hectare in last year (quintal)…………….
40. What are the special techniques used for cassava harvesting? ……………..
41. For how long do you store your cassava?

A) I don't store, I will sale / it will be consumed during harvesting b) One to six months c) Seven to twelve months d) One year to two years e) More than two years

42. For what reason do you store your cassava? ____________________________________
43. What is the maximum storage year of your cassava? __________Years/month/days.
44. Select the storage types you have been used to store your cassava, price, service years and problems you have been encounter during storage.

No	Types of container used	Price (Birr	Service (years)	Problems observed by using it
1	On farm (in-situ)			
2	Ground			
3	Earthen pots			
4	Sacks			
5	Plastic container			
6	Others (specify)			

SECTION III: Information on cassava processing

1. Which type of cassava processing are you usually use for your household consumption (you may choose more than one answer? a) Boiling b) Peeling) c) both d) other, specify
2. Is/ are there improved cassava processing equipment's in your household? a) Yes b) no
3. If you say yes on Q-2 list names of equipment that you are using in your household-------
4. What are the cassava processing tools that you have? ---
5. Do you have improved cassava processing equipment? a) Yes b) no

6.If you say No on Q- 5 what is/are the problems of not having improved cassava processing materials a) it is costly b) difficult to use c) lack/ shortage of supply shortage d) other, please specify ……………………………………………………………………………………

7. If you say **yes** on Q-5 from where do you get the improved processing equipment? a) Gov't b) trader c) NGO d) other /specify-----------------------

8. Is method of processing of cassava is difficult? a) Yes b) no

9. If your answer is yes on Q-8 what are the basic difficulties to use it? a) it takes long time b) it consume energy c) need labor d) shortage of labor e) other, please specify……………….

10. Which cassava varieties are easy for processing? a) Improved b) local cultivar (please specify the name of the varieties)

11. Who usually involve in various stage of cassava processing? a) Male b) female c) both

12. What are the common traditional processing methods in your area?
a) Peeling b) soaking c) Chipping d) grating e) pressing f) drying

13. Do the traditional processing methods of cassava have difficulty for users? a) Yes b) No

14. If your answer is Yes on Q-13, what is/are the difficulties of the traditional processing methods? a) it takes long time b) it consume energy c) need labor d) shortage of labor e) other, please specify--

15. What is/are the reasons for processing cassava? a) Increase shelf life b) reduce food losses c) to improve palatability d) to stabilize seasonal fluctuation of food e) food for income f) for consumption g) both income and consumption h) to reduce the bitterness and toxicity

<u>SECTION IV: Information on cassava utilization</u>

1. For what purpose you are majorly producing cassava in your farm? 1) for consumption 2) for market 3) for seed 4) other (please specify, -------------------------------------)
2. If you produce for consumption purpose, what type of food you are preparing from cassava? Please list…………………………………………………
3. Do you produce different food by mixing cassava with other food items? Yes………….No…….
4. If your answer is YES for Q3, could you please exhaustively list the type of foods produced by mixing cassava with other food items? Please also include the proportions that usually mixing cassava with other food items for preparing different food…………………………….
5. Do you use different cassava variety to prepare different food? Yes……No……
6. If you answer is YES for Q5, please list the type of variety for preparing different food……..
7. Do you mix processed cassava with other cereal crop flour in order to produce injera?
   a) Yes b) No
8. If your answer is YES, please list the name of the cereals you are mixing with cassava for Injera making…………………………………………………………………
9. Do all varieties of cassava are appropriate/suitable for making Injera? A) Yes----b) no)-

10. Which cassava varieties are the most suitable for making Injera mixed with other cereal crops? A) Local Cultivar B) Kello C) Qulle D) Other, please specify------------------
11. Justify the reason why this cultivar is selected for mixing -------------------------------
12. What proportion mixes cassava with Wheat, Teff, Sorghum, Finger Millet or other crops? ---- --
13. Which cassava variety/ies is/are the least suitable for preparation of injera with cereal crops? A) Local Cultivar B) Kello C) Qulle D) other, please specify--------------------------------

14. Which cereal crop is most suitable for making injera mixed with Cassava?

a) Teff b) Maize c) Barley d) Sorghum e) Wheat f) other g) other, specify---------------

15**.** If your answer in Q14 is Teff, which cassava cultivar is most suitable in making quality injera at what proportion (teff to cassava)? A) 80/20 b) 70/30 c) 60/40 d) 50/50 e) others-----------

16. Is cassava storage time reduces the quality of injera mixed with Teff? A) Yes b) No

17. If your answer in Q17 is yes which storage time is more preferred for mixing?

a) Immediately after harvesting b) 1 to 2 weeks storage c) 3 to 4 weeks 1 to 2 months d) other, specify ---

SECTION V: Information on cassava marketing and value chain

1. Do you sell cassava in the local market? A) Yes……………b) No…………
2. If you answer is YES, Where is your major sell place? (More than one answer is possible)
   a. From home b) Nearby market place c) Major cassava market place d) cooperatives
   e) Other (specify) ________
3. Who is your potential and frequent buyer? (More than one answer is possible)
   a. Local household consumer
   b. Local merchants selling in the same local market
   c. Local merchants/wholesalers selling outside the local market
   d. Others please specify………..
4. What is the demand of cassava in the market?
   a) Very high b) High c) Medium d) Low e). Very low
5. What is the supply of cassava in the market? A) Excess b) Enough c) Not enough
6. Out of your family members, who is responsible for cassava marketing? A) Male b) female c) other, specify--
7. In which form do you present the cassava in the market?
   a) as unpeeled root (Fresh cassava)
   b) peeled root (Cassava chips)
   c) powdered/ flour
   d) Other, please specify……
8. What are the marketing challenges you faced in your cassava products
   a) Price fluctuation b) Low quality (flour and chips) d) High costs of transport e) Heavy rains f) Poor roads g) Lack of storage facilities h) Lack of market information

9. Do you know the final destination of your product if you sell for local merchants/wholesalers? Did you probe to know each destination of cassava market destination? ………………………………………………………………
10. Which variety of cassava is more preferred by the local merchants/wholesalers selling?
    a. Local cultivar b)Kello c)Qulle d)Other, please specify-----------------------------------
11. What are the intermediaries Distribution Channels in cassava marketing……………...
    e) Can you please justify the reason of selecting the above cultivar………………….....
12. What are the factors that govern the price of the cassava in your locality?
    a) Seasons of the year b) Colour c) Distance from the market d) Traditional ceremonies e) Others (specify): ___________________________
13. How do you evaluate the local market price?
    a) High b) Medium c) Low
14. How is the price trend of cassava in your locality?

No	Price trend	Reasons
1	Increasing	
2	Stable	
3	Decreasing	

15. What are the years for cassava marketing experience?
    a) 1-5 b) 6-10 c) 11-15 d) 16-20 e) other please specify

<u>SECTION VI: Information on cassava variety/ characterization as ingredient for Injera</u>

1. Would you please list the currently available cassava varieties on your farm used as food?

No	**Local name**	Synonyms name	Meaning of the name
1			
2			

2. How do you differentiate those named and identified varieties each other?
    A. By using their morphology
    B. By their ecological adaptation
    C. Tuber characteristics (shape, color, weight and other)
    D. Combination of all
3. Would you please characterize those named and identified varieties based the following characters

		Characteristics	
No	**Local name**	Morphological variation	Tuber quality variation
1			
2			

4. Mention use-values of cassava and list your preferential varieties for each use.

S.N	Local use-value of cassava	Mode of use/products	Name of your preferred varieties for specific use

1.			

5. Please list your favorite cassava cultivars

S.N	Favorite cultivars	Special/important features
1.		
2.		

6. What is your criterion to select and cultivate those named varieties on your farm used as food? a) Yield b) Tuber quality c) Tuber shape, size and color d) Maturity time e) Agro-ecological adaptation f) resistance to pest and disease g) Toxicity level h) Planting material availability i) all j) other, specify
7. If you say only two or three of the above criteria's are the best, justify the reason
   ----
8. If you use all criteria's listed in Q6, would you please specify the level of your preference?

Characteristic	**Level of preference**			
	Very high	**High**	**Medium**	**Low**
Yield				
Tuber quality				
Size and shape of tuber				
Maturity time				
Agro-ecological adaptation				
Resistance to pest and disease				
Toxicity level				
Planting material availability				
Other, specify				
1				
2				

9. Do all improved cassava varieties are suitable as ingredient for injera? a)Yes b) No
10. If you say no on Q9 which improved Cassava variety is most suitable as ingredient for injera? a) Kello b) Qulle c) Hawassa-04 d) local variety e) other specify------------
11. Does improved Cassava varieties vary morphological from local cultivar? A) yes b) no
12. If you say yes, on Q-11 on what part of plant do you observe variation?
    a) Leaf part b) stem part c) Tuber part d) all e) other (specify-------------------)
13. What are those variation do you observed on the leaf part of improved cassava from local Cultivar? Color b) size c) shaped) length e) other, specify------------------------
14. What are other morphological characteristics of improved Cassava vary from local cultivar? Please specify --

Thank you for your cooperation!

Compiler: Name ___________________________________ Signature ___________________

Date__________ Duration: Starting time ________________ ending time ________________

7.2. Appendix II: Sensory Evaluation sheet

The panelists should not consume any beverages like (tea, coffee, macchiato, alcohol, soft drinks etc) at the time when they would evaluate the *injera*. The *injera* has to be tasted and in between two samples they have to rinse their mouth thoroughly using distilled water, no residues of the previous sample should adhere to their mouth, they have to fill the format as soon as they evaluate a particular sample and not later. Here are the samples, which are evaluated for sensory attributes. Look at the coded sample in sequential order of codes. From each coded samples placed in front of you in the plates; observe color, texture, sticking, sour character, aroma, taste, even eyes, bottom eye and overall acceptability. And decide your fillings you feel. Write corresponding number of your feeling of hedonic scores (where 1- extremely dislike, 2- dislike very much, 3- dislike moderately, 4- dislike slightly, 5- neither like nor dislike, 6- like slightly, 7- like moderately, 8- like very much, and 9– extremely like) on the table below.

Codes	Acceptance	Scale	Sensory Attributes								
			Color	Texture(roll ability, spring softness, sponginess)	Sticking	Sourness	Aroma	Taste	Appearance (even eyes)	Bottom eyes	Overall acceptability
	Extremely like	9									
	Like very much	8									
	Like moderately	7									
	Like slightly	6									
	Neither like nor dislike	5									
	Dislike slightly	4									
	Dislike moderately	3									
	Dislike very much	2									
	Extremely dislike	1									

7.3. Appendix III: Tables

Appendix Table 1: **Analysis of variance for moisture, protein, ash, fiber, fat, carbohydrate and hydrogen cyanide for blending ratio of cassava with teff in two-way ANOVA**

Moisture	**F-value**	**P-value**
Variety	1.79	0.1954
BR	55.66	<.0001
Var*BR	1.28	0.3112
Protein	**F-value**	**P-value**
Variety	5.80	0.0258
BR	80.85	<.0001
Var*BR	3.27	0.0324
Ash	**F-value**	**P-value**
Variety	228.38	<.0001
BR	18.37	<.0001
Var*BR	17.69	<.0001
Fiber	**F-value**	**P-value**
Variety	67.31	<.0001
BR	34.73	<.0001
Var*BR	19.49	<.0001
Fat	**F-value**	**P-value**
Variety	0.1333	14.61
BR	<.0001	27.11
Var*BR	0.0212	10.15
Carbohydrate	**F-value**	**P-value**
Variety	97.79	<.0001
BR	2.05	0.1261
Var*BR	0.56	0.4641
Hydrogen cyanide	**F-value**	**P-value**
Variety	14.61	0.0011
BR	27.11	<.0001
Var*BR	10.15	0.0001

Appendix Table 2: Analysis of variance for protein, ash, fiber, fat and hydrogen cyanide analyzed as simple CRD by including 100% teff injera

Treatment	**F-value**	**P-value**
Protein	66.66	<.0001
Ash	129.36	<.0001
Fiber	163.66	<.0001
Fat	37.97	<.0001
Hydrogen cyanide	32.39	<.0001

Appendix Table 3: Analysis of variance for moisture and carbohydrate contents of the blending ratio, analyzed as simple CRD by including 100% teff injera

	Moisture		Carbohydrate	
Blending ratio	**F-value**	**P-value**	**F-value**	**P-value**
	201.08	<.0001	174.42	<.0001

Appendix Table 4: Analysis of variance for color, texture, sticking, sourness, aroma, taste, eyes and overall acceptability for blending ratio of cassava with teff as two-way simple CRD ANOVA

Color	**F-value**	**P-value**
Variety	0.07	0.7879
BR	249.73	<.0001
Var*BR	1.15	0.3331
Texture	**F-value**	**P-value**
Variety	39.26	<.0001
BR	208.92	<.0001
Var*BR	5.53	<.0002
Sticking		
	F-value	**P-value**
Variety	0.33	0.5652
BR	184.35	<.0001
Var*BR	1.50	0.2022
Sourness	**F-value**	**P-value**
Variety	26.46	<.0001
BR	410.56	<.0001
Var*BR	9.59	<.0001
Aroma	**F-value**	**P-value**
Variety	20.27	<.0001
BR	253.25	<.0001
Var*BR	4.56	0.0013
Taste	**F-value**	**P-value**
Variety	26.74	<.0001
BR	194.10	<.0001
Var*BR	4.80	0.0008
Appearance	**F-value**	**P-value**
Variety	0.30	0.58
BR	140.05	<.0001
Var*BR	1.23	0.2973
Bottom eyes	**F-value**	**P-value**
Variety	31.76	<.0001
BR	149.17	<.0001
Var*BR	14.36	<.0001
Over all acceptability	**F-value**	**P-value**
Variety	43.26	<.0001
BR	369.34	<.0001
Var*BR	18.63	<.0001

Appendix Table 5: Analysis of variance for texture, sourness, aroma, taste, bottom eyes and overall acceptability of cassava teff-blending ratio including 100% teff injera

Treatment	F-value	P-value
Color	111.51	<.0001
Texture	99.67	<.0001
Sticking	189.67	<.0001
Sourness	184.92	<.0001
Aroma	116.83	<.0001
Taste	91.37	<.0001
Appearance	62.82	<.0001
Bottom eyes	76.21	<.0001
Over all acceptability	177.24	<.0001

BIOGRAPHICAL SKETCH

The author was born in 1992 at Sidama regional State, Hula Woreda. He attended his Elementary Education (1-7) at Balcha and Aleta Wondo Primary School (8). After completion of his primary class, he joined Aleta Wondo (9-11) and Hawassa tabor primary and secondary school (12). After successfully completion of Ethiopian higher education entrance exam, he joined Wolaita Sodo University College of Agriculture in 2011 and graduated with Bachelor of Science Degree in Horticulture in June 2014. After graduation, he was employed as crop expert from 2015-2017 in Hula Woreda Youth and Sport Sector under the department of rural job opportunity creation. Starting from October 2018 he joined Hawassa University, school of Graduate studies to pursue his Master of Science in Horticulture.