Addis Ababa University School of Graduate Studies

Food Science and Nutrition Program

Indigenous Processing Methods, Nutritional and Alcoholic Contents of Cheka: A Traditional Fermented Beverage in Southwestern Ethiopia.

By: Belay Binitu

Advisor: Dr. Ashagrie Zewdu

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirement for the Degree of Masters in Food Science and Nutrition

June, 2015

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MSc Thesis

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DEDICATION

This thesis is dedicated to my parents and best friends particularly Mr. Afrashu Beyene and Mr. Zinabu Seyoum with whom I had been grown up and who had been encouraging me during my study times. They all showed me true and persistent love than anyone I met in my life time and hence, I gave them the highest position in my heart.

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LIST OF ABBREVIATIONS

AAS-Atomic Absorption Spectroscope

ADH-Alcohol Dehydrogenase Enzyme

ALDH2-Acetaldehyde Dehydrogenase Enzyme 2

ANOVA- Analysis of Variance

AOAC- Association of Official Analytical Chemists

ATP- Adenosine Triphosphate

CSA-Central Statistical Agency of Ethiopia

EFMHACA- Food, Medicine and Health Care Administration And Control Authority of Ethiopia

ESA-Ethiopian Standards Agency

FAS-Fetal Alcohol Syndrome

FDRE-Federal Democratic Republic of Ethiopia

GC-Gas Chromatograph

LAB-Lactic Acid Bacteria

LDL-Low Density Lipoprotein

LSD- Least Significant Difference

NAD^+- Nicotinamide Adenine Dinucleotide

SNNPR-Southern Nations, Nationalities and People's Region

LSD- Least Significant Difference

NAD^+- Nicotinamide Adenine Dinucleotide

ABSTRACT

Cheka is a cereal and vegetable-based beverage which is commonly consumed in Southwestern parts of Ethiopia. A study of indigenous processing techniques and raw materials used for the production of cheka was carried out using an open-ended interview questionnaire. In this study, the traditional processing methods, types and proportions of ingredients, equipments, sources of energy, economic, socio-cultural and nutritional importance of cheka were described. Moreover, nine cheka samples were collected purposively from vending houses in Konso and Dirashe districts for the analysis of their nutritional and alcohol contents. Three of samples (coded K1, K2, and K3) were collected from Karat in Konso which were prepared mainly from yellow maize and were fermented for $3^{1/2}$ days. The remaining six samples were collected from Gidole and Shelele villages in Dirashe district. These samples were prepared from a mixture of maize, sorghum and leafy vegetables such as moringa and leaf cabbage. Samples from Gidole (coded G1, G2, and G3) were fermented for about 7 days, whereas samples from Shelele were fermented at least for a month. One sample was prepared in the laboratory by the investigator following the Konso cheka preparation method.

In the study areas, maize, sorghum and vegetables such as cabbage, moringa, decne and taro were reported to be utilized for cheka preparation. Informants described the characteristics of quality cheka as thick, smooth, effervescent, foamy, and bitter in taste. The processing methods as well as the raw materials utilized and their proportions seem to vary between localities. Since the present study was the first of its kind, flow charts which shows the processing operations involved in cheka fermentation were constructed that might be used by those who want to scale-up the cheka processing in the future.

The pH and titratable acidity of the samples ranged from 3.53-3.99 and 0.80-1.11%, respectively with samples from Karat being the lowest in pH and the highest in titratable acidity. The total solids content of cheka samples varied between 21.05% (G2) and 26.87% (S3). The crude protein, crude fat, crude fibre, total ash, carbohydrate, and gross energy contents of the samples ranged from 3.12-4.44g/100g, 1.17-1.81g/100g, 0.94-1.27g/100g, 0.65-0.93g/100g, 14.16-19.03g/100g, and 82.04-107.17Kcal, respectively. Samples from Karat had better fat, carbohydrate, and energy content, whereas samples from Dirashe had high protein and crude fiber. The dietary Ca, Fe, and Zn content of the samples were ranged from 8.31-19.60mg/100g, *13.94-27.59mg/100g and 0.82-1.07mg/100g, respectively. Samples from Konso were relatively good in their zinc content; however, they were lower in their Ca and Fe contents than samples from Dirashe. The methanol and ethanol contents of the cheka samples ranged from 0.0163.1-0.2380% and 3.04-8.96%v/v. One of the samples from Shelele (S1) had considerably high methanol (0.2385%v/v) content and was followed by sample K1 (0.163%v/v) from Karat and sample S2(0.1361%v/v) from Shelele. Samples from Karat had relatively high ethanol content (up to 8.96%v/v) followed by samples from Shelele (up to 8.02%v/v). The cheka sample prepared in the laboratory contained nutrient and alcohol contents comparable with some of the collected samples. The findings of this study indicated that cheka has low nutrient content and thus, suggests that people in Konso and Dirashe should not rely on it without eating solid foods as it is almost always diluted with significant amount of water. In conclusion, the longer fermentation time of cheka resulted in high methanol levels that can present adverse health effects to consumers.*

Key Words: *Cheka, Konso, Dirashe, fermented beverage, indigenous processing techniques*

1. INTRODUCTION

1.1 Background of the Study

Fermented foods are among the oldest processed foods and have formed a traditional part of the human diet in almost all countries for millennia (Fellows, 2000). Among fermented foods, alcoholic beverages have been widely consumed since prehistoric times by people around the world. Traditional fermented beverages are those that have been indigenous to a particular area and are usually prepared from locally available raw materials using age-old techniques (Rose, 1997). In the world, there are a large variety of fermented foods and beverages with economic and sociocultural value. The diversity of such fermented products derives from the heterogeneity of traditions found in the world, cultural preference, different geographical areas where they are produced and the raw materials used for fermentation. Over the years in many instances it is highly likely that people learned to control and optimize theses fermentations through trial and error. Additionally, the art has passed down by cultural and traditional values to subsequent generations. In spite of being produced via traditional kitchen fermentation these fermented food and beverages are extremely important in contributing to household nutrition security and in preserving important socio-cultural practices. The tradition of fermented beverages is long embedded in many cultures (FAO, 2012).

Many papers have been published on various aspects of Ethiopian traditional fermented beverages. Some of these beverages include *tella*, *tej*, *areki (*Sahle & Gashe, 1991, Yohannes *et al*. 2013*)*, *borde* and *shamita (*Ashenafi & Mehari, 1995; Abegaz *et al*., 2002a). In Ethiopia, *tella*, *tej* and *arake* are popular traditional drinks particularly in northern part of the country whereas *borde, shamita* and *cheka* are mainly consumed in central and southern Ethiopia (Fite *et al.*, 1992).

Traditional fermentation serves many purposes. It can alter the texture of foods, enhance the digestibility of a food, preserve foods by production of acids or alcohol, or produce subtle flavours and aromas which increase the quality and value of raw materials (Fellows, 2000; Kohajdova & Karovicova, 2007). Fermentation which is often considered as a low-input enterprise provides individuals with limited purchasing power, access to safe, inexpensive and nutritious foods (FAO, 2012).

Cheka is a traditional fermented beverage made from cereals mainly sorghum and maize. Leafy vegetables such as moringa, cabbage and decne (*Leptadenia hastata)* and some root crops like taro can also be used for its preparation. It is produced by spontaneous fermentation using rudimentary equipment. This beverage is commonly consumed in southern Ethiopia particularly in areas such as Dirashe, Konso, and to some extent in Ale, Arba Minch and South Omo. For instance, people in Dirashe district start drinking this beverage early in the morning on an empty stomach and from observation an adult man on average drinks up to 8 litres of *cheka* per day and in addition (sometimes) adds few cups of arake. Especially, they consume it in larger quantities during crop harvesting and threshing seasons. In addition, those who eat solid foods are considered as childish among adults and for this reason, most of them usually rely on *cheka* without eating other foods.

In the villages it is common for the rural neighbouring households to call one another early in the morning, be gathered, drink *cheka* and talk together once on-farm work has been finished. *Cheka* drinking is the most important social function among adults in a village and is sometimes seen as part of their culture. People of all ages including infants, pregnant and lactating women drink *cheka* though the amount they drink varies. Some mothers and care-givers often dilute this beverage and give it to their infant (s) even before the recommended time for introducing complementary food. Currently, children including those in secondary and high schools are abusing this beverage. School children who are going long way to school essentially would like to drink *cheka* wherever they find it as it is cheap and deemed to serve as a food substitute. They use it without being aware of the actual health benefits and side effects of drinking it. Therefore, it is worthwhile to study the indigenous processing methods, nutritional and alcoholic content of *cheka.*

1.2. Statement of the Problem

Indigenous fermented foods are relatively cheap to prepare and are therefore can be easily affordable in meeting the demands of low-income consumers. The greatest drawback in the development of fermented food products is that many products are produced under primitive conditions and as such can result in low yield and poor quality, including short shelf-life (FAO, 2012). In addition, the processes of most traditional fermented beverages are often laborious and time-consuming (Abegaz *et al*., 2002a; Achi, 2005). For instance, *cheka* fermentation takes place under natural and unhygienic condition using a mixture of raw materials with no standardized formulations and also usually in the absence of back-slopping. As a result, the beverage becomes of poor quality with inconsistency and failure in most cases. Understanding the traditional processing methods and physicochemical properties of raw materials and fermented beverages will help in subsequent optimization of the process (FAO, 2012). Cheka had been mentioned in Abegaz *et al.* (2002b) along with other Ethiopian traditional beverages, but no one has documented about it yet.

While considering advancing the processing of traditional beverages, it is equally important to think of the negative health consequences that can result due to their utilization particularly for alcoholic beverages which are being prepared under uncontrolled conditions. Though fermented alcoholic drinks contribute a substantial portion of the energy in a person's diet and help to reduce the risk of developing and dying from heart diseases and other chronic, the harm they present may sometimes far exceed the possible benefits. Alcohol in beverages when consumed in excess can be converted to body fat and stored (Whitney & Rolfes, 2008) and thus can present chronic diseases associated with fat accumulation. Alcohol is reported to be the third highest risk for disease and disability, after childhood underweight and unsafe sex (WHO, 2014). Chronic alcohol consumption is associated with a risk of developing health problems such as mental and behavioural disorders, alcohol dependence, and non-communicable diseases such as liver cirrhosis, cardiovascular diseases, some cancers, acute respiratory failures and possible death. Alcohol consumption can also cause social harms such as crime, economic trouble, unemployment, accidents and marital problems. It also increases the chances of people to take risks, including with their sexual health (Bhargav *et al.*, 2008; Coleman & Cater, 2005; Sue *et al.*, 2009; WHO, 2014). To further decrease health complications and avoid other social problems with alcohol consumption, it is important to accurately quantify the amount of ethanol present in unrecorded beverages (Sarah & Matthew, 2012).

Production of traditional beverages often takes place under insanitary conditions and most frequently by uncontrolled fermentations and hence, the presence of toxic substances such as methanol and fusel oils are inevitable. Methanol (also known as methyl alcohol or wood alcohol) is a potent toxicant in humans and occurs naturally in alcoholic beverages at levels not harmful. However, it may present in significant amounts that can cause serious damage to human health especially in the case of fermented beverages and other illicit drinks (Paine and Dayan, 2001). In the human liver, methanol is converted to formaldehyde and formic acid through the action of the enzyme alcohol dehydrogenase and when the formic acid builds up in the body after excessive methanol intake, it causes severe toxicity and even death. Outbreaks of methanol poisoning arise from the consumption of counterfeit or informally-produced alcoholic beverages. There have been numerous outbreaks in recent years throughout the world, including in Cambodia, Czech Republic, Ecuador, Estonia, India, Indonesia, Kenya, Libya, Nicaragua, Norway, Pakistan, Turkey, and Uganda. The size of these outbreaks has ranged from 20 to over 800 victims, with case fatality rates of over 30% in some instances (WHO, 2014).

Several works have been done on traditional fermented alcoholic beverage. The ethanol, methanol and fusel oil contents of Ethiopian alcoholic beverages such as *tella*, *tej* and *arake* were determined by different researchers (Desta, 1977; Urga, 1997; Bahiru, *et al*., 2001; Yohannes *et al*., 2013) using pycnometer, hydrometer, refractometery and other distillation methods. The indigenous processing methods and raw materials for the preparation of most Ethiopian fermented beverages had been well documented by many investigators. However, no information has been recorded on the processing methods, microbial dynamics, nutritional values, sensory properties and safety concerns of *cheka* drink until present. Therefore, this study was intended to (a) document the indigenous processing methods (b) determine the nutritional content of *cheka* and (c) detect and quantify the alcoholic contents of *cheka* using a gas chromatographic technique.

1.3. Significance of the Study

Traditional fermented foods and beverages are produced through inexpensive technology and have improved nutritional values and sensory properties. As they are produced at the household level, they are easily accessible and enable increased food security through contribution to household income. However, routine household preparation of fermented beverages is too arduous and time consuming and often result in small production and short shelf life. This necessitates scaling up of craft-based fermentations to high technology production systems for consistent quality. Therefore, the findings of this paper will help researchers interested to optimize the processing conditions and raw materials of cheka production to achieve good and stable product quality.

The *cheka* consuming rural communities could benefit from this study as it also aims at identifying the challenges associated with small-scale fermentation activities as well as opportunities related with the marketing options and at the same time at suggesting possible solutions, if any. In addition, public health and nutrition policy makers who wish to promote healthy food and small-scale agro-industrial development may also benefit from the results of this research. Generally, the findings of this study will be very useful for people and organizations that provide advisory, business and technical support services to resource poor small-scale producers and local communities in *cheka* consuming areas.

1.4. Research Questions

- How do people in Konso and Dirashe produce *cheka* and what raw materials do they use?
- Do people get enough nutrients and energy from *cheka* as many adults in Dirashe and Konso depend on cheka as a food?
- Does *cheka* have high methanol and ethanol levels that can pose adverse health effects?

1.5. Objectives of the Study

1.5.1. General Objective

This study was generally intended to assess the indigenous processing methods and to determine the nutritional and alcoholic contents of *cheka* drink.

1.5.2. Specific Objectives

The specific objectives of this study was:

- To document the traditional processing methods and identify constraints in the production, marketing and consumption of *cheka*.
- To determine the pH and titratable acidity of *cheka.*
- To analyze the total solids, crude fat, crude protein, crude fibre, total ash, carbohydrate and total energy content of *cheka*.
- To analyze the mineral content of *cheka* beverage.
- To detect and quantify the amount of ethanol and methanol present in *cheka*.

2. LITERATURE REVIEW

2.1. History of Fermentation and Advances in the Technology

Throughout history and around the world, human societies at every level of complexity discovered how to make fermented beverages from sugar sources available in their local habitats (McGovern, 2003). Fermentation has been used since ancient times to preserve and alter foods. It has enabled our ancestors to survive drought periods and winter season by improving the shelf-life and safety of foods and beverages. Although utilization of fermented products had old history, most scientists speculate that ancient ancestors possibly discovered fermentation by accident than by guided efforts and continued to use the process out of presence or necessity. For thousands of years fermentation processes were carried out without understanding microbial mechanisms until 19^{th} century (Fellows & Hampton, 1992; Achi, 2005).

The term ‘fermentation’ comes from a Latin word *fermentum,* meaning to ferment. The historical definition describes fermentation as the process in which chemical changes in an organic substrate occur as the result of action of microbial enzymes. Historically, the science of fermentation is called zymology and the first zymologist was Louis Pasteur, who as the first made yeast responsible for fermentation. Nowadays, it is a metabolic process in which carbohydrates and related compounds are partially oxidized with the release of energy in the absence of any external electron acceptors; instead organic compounds such as pyruvate that are produced by breakdown of carbohydrates are utilized as final electron acceptors. Fermentation products contain chemical energy, which means that are not fully oxidized and their complete oxidation requires oxygen. Few ATP molecules are produced during fermentation process and therefore, it is considered less efficient than cellular respiration. Energy (ATP) is not generated during the transformation of pyruvate into end products; instead NAD^+ which is required for glycolysis is produced (Fellows, 2000; Steinkraus, 1996).

Fermentation in food processing is basically the conversion of carbohydrates to alcohols and carbon dioxide or organic acids using yeasts, bacteria or combination of thereof, under primitive anaerobic conditions. The first fermentation included the production of beer (Babylonia), soy sauce (Japan, China), fermented milk beverages (Balkans and Central Asia). Fermented beverages appeared in 5000 B.C. in Babylon, 3150 B.C. in Ancient Egypt, 2000 B.C. in Mexico and 1500 B.C. in Sudan (FAO, 2009).

Fermentation processes are believed to have been developed over the years by women, in order to preserve food for times of scarcity, to impart desirable flavour to foods, and to reduce toxicity (Rolle and Satin, 2002). Though fermentation products were mainly food products in ancient times, recently an increased interest has been observed in the production of bulk chemicals (ethanol and other solvents), specialty chemicals (vitamins, pharmaceuticals, and industrial enzymes), biofuels and food additives (Fellows, 2000; FAO, 2012).

2.2. Types of Fermentation and Fermentation Microorganisms

Microbial fermentation can be either homofermentative or heterofermentative. Micro-organisms that produce a single main by-product are termed *homofermentative* whereas those that produce mixed products are referred to as *heterofermentative*. Fermentations can be classified into those in which the main products are organic acids and those in which ethanol and carbon dioxide are the primary products. Lactic acid and ethanolic fermentations are among the most important commercial fermentations (Streissguth *et al.*, 1991; Fellows, 2000).

Lactic acid fermentation is used in fermentation of milk, vegetables (cucumber, cabbage, cassava, etc.), cereals (wheat, maize, sorghum, etc.), meat and fish. Alcoholic fermentation is one of the most important and the oldest processes. It is used in the production of alcoholic beverages, chemical and automotive industry, solvents and starting materials for the manufacture of cosmetics and pharmaceuticals, as well as disinfectants in medicine. Many fermentations involve complex mixtures of microorganisms or sequences of microbial populations which develop as changes take place in the pH, redox potential or substrate availability (FAO, 2000).These result in the presence of mixture of fermentation products.

Fermented foods are generally produced from plant or animal-based raw materials in combination with fungi or bacteria, which are either present in the natural environment (spontaneous), or added intentionally by human (induced or controlled) to obtain the desirable end products. The most important microorganisms in desirable food fermentations are bacteria (*Streptococcus*, *Lactic acid bacteria*, *acetobacter*, etc.), yeasts (*Saccharomyces spp.*) and molds (*Aspergillus*, *pencillium*, *Mucor*, etc.). Yeasts are frequently minority companions of LAB and are also used to produce CO_2 (in beer and bread making) and ethanol (alcoholic beverages). Molds are used in the production of enzymes which degrade polymeric components such as cell wall polysaccharides, proteins, lipids, which is significant for texture, flavor and nutritional value of mold fermented foods (Pederson, 1997; Fellows, 2000). Some studies have been done to isolate and characterize microorganisms responsible for fermenting the traditionally fermented Ethiopian foods and beverages. The reports from Abegaz *et al*. (2002a) and other researchers, as cited in Ashenafi (2002) showed that yeasts and lactic acid bacteria are the most important microbes responsible for the fermentation of traditional Ethiopian foods and beverages.

2.3. Ethiopian Traditional Alcoholic Beverages

Ethiopia differs in many respects from the remainder of tropical Africa, both in natural scenery and in cultural diversity and hence, many different types of indigenous fermented beverages are processed and consumed among the various ethnic groups in the country. A wide variety of traditional fermented beverages exist in the country, from low alcohol content (borde, shamita, kerebo) to relatively high alcohol content (arake) beverages. As reported by Kebede *et al*. (2002a), villagers prepare a wide range of traditional fermented foods and beverages from different raw materials such as cereals, ensete (false banana), honey, milk, etc. Many households in the country, especially women engage in the production and sale of these drinks as their main source of income to support themselves and their families. Some of the commonly consumed Ethiopian indigenous fermented beverages are discussed in detail in the next sections.

2.3.1. Tella

Tella is one of the malt-based traditional beverages in Ethiopia which is made of various cereals such as barley, wheat, sorghum and in rare cases from teff and maize (Fite *et al.*, 1991). Although the basic processing steps are similar, the recipe for tell preparation seem to vary between households, regions and ethnic groups depending on the tradition and economic situation of the brewers. During *tella* preparation, the clay pots used for *tella* production are thoroughly cleaned with water and fresh leaves of *girawa* (*Vernonia amygdalina*). In addition, the fermentation container is smoked with splinters of *weyra* (*Olea europaea*) in order to impart good fragrance or flavor. The preparation of *tella* has four major phases. In the first phase, powdered leaves of gesho (*Rhamnus prenoide*) are mixed with water in a small clay pot and allowed to ferment for four days to produce *tinsis*. In the next phase, the 'tinsis' is mixed with barley malt, pounded stems of gesho and pieces of 'kitta' (pan-cake like bread) in a large clay pot and left to ferment for two days. During the third phase, a thick slurry called 'difdif' is produced by adding more carbohydrate source and water. After fermenting for extra two days, the contents are thoroughly mixed with much water and the container is sealed tightly and allowed to ferment for extra two days. At this stage, most of the suspended materials settle to the bottom of the container and yellow to dark brown coloured *tella* is obtained by decanting the product (Sahle & Gashe, 1991).

Tella is usually prepared and consumed at different social events and religious celebrations. It is by far the most commonly consumed alcoholic beverage in the country and assumed that over two million hectolitres of it is brewed yearly in households and vending houses in Addis Ababa. The pH of *tella* ranges from 4.0-4.99 and the alcohol content varies between 3.84 and 13.74 %v/v, with filtered *tella* having higher alcohol content (Yohannes *et al.*, 2013). According to Gizaw (2006), *tella* is reported to have mean pH of 4.51, with the range of 3.87-5.03 and also alcohol content of 5.21-8.03%v/v.

2.3.2. Tej

Tej is a home processed and commercially available honey wine. Honey wines such as *tej* are cloudy and effervescent containing residues of substrates and fermenting yeasts and other microorganisms (Steinkraus, 1983; Desta, 1977). It is usually prepared from a mixture of bee honey, water and leaves of hop shrub. Some brewers may also use sugar and in addition, colouring agents in order to attain a yellow coloured similar to that made from honey. During the preparation of *tej*, the fermentation pot is smoked over smoldering *gesho* (*Rhamnus prenoides*). The mixture of the *tej* ingredients are then added into the pot and allowed to ferment for 5 to 20 days depending on weather conditions of the region. The mixture is stirred daily and the final product filtered served after filtering through cloth to remove sediment and fragments of hop (Bahiru *et al.*, 2001; Vogel & Gobezie, 1983). According to Yohannes *et al.* (2013), the pH of *tej* ranges from 3.56-4.45 and Gizaw (2006) reported pH value of 3.74-3.79 for *tej*. The alcohol content of *tej* varies from 8.94-13.16%v/v (Yohannes *et al.*, 2013) and Gizaw (2006) reported alcohol content of 8.91-13.75%v/v.

2.3.3. Arake

Arake or *katikala* is a home-distilled beverage with alcohol content ranging from 22-46.6% (Desta, 1977). This beverage is more expensive than the other drinks and is popularly viewed as very strong and dangerous to consume. During araqe preparation, ground *gesho* leaves and water are fermented for 3-4 days. Then, a pancake-like bread (*kitta*) which is made from teff or other cereals and barley or wheat are added. The mixture is allowed to ferment for 5 to 6 days and finally distilled using primitive equipments made of gourds and woods such as bamboo. *Arake* is brewed in rural and semi-urban areas and is used more commonly by farmers and semi-urban dwellers than by people who live in the cities. And in cities, people who drink *arake* are predominantly from lower class or those who have become dependent on alcohol and cannot afford to buy industrially produced alcohol beverages (Selinus, 1971; Desta, 1977). *Arake* contains high alcohol content that ranges from 33.95-39.90%v/v (Yohannes, 203). However, *dagim arake* (double distilled *arake*) have higher alcohol content up to 48%v/v (Gizaw, 2006).

2.3.4. Borde

Borde is a local beer which is considered as a low alcohol drink and is mostly consumed by people in southern and western parts of the country. *Borde* serves as a substitute for meals during long trips and is also used by consumers for medical and ritual purposes. Consumers believe that it enhances lactation and mothers are encouraged to drink substantial amounts of it after giving birth (Abegaz, *et al.*, 2002a).

Borde is prepared by women from fermented maize, sorghum, barley, or a mixture of the three. The traditional fermentation of *borde* has four major phases marked by the addition of fresh ingredients into the fermentation container at different time. In the first phase, maize grits are mixed with water in a clean earthenware pot and allowed to ferment for 44 to 72 hours. The content is apportioned into three parts at different times which are cooked with other non-fermented ingredients and used at the later three phases of fermentation. In the next phase, *enkuro* is prepared by roasting a portion of the fermented maize grits taken after 44 to 48 hours of primary fermentation. After the *enkuro* is cooled, it is thoroughly mixed by hand with fresh malt and water to prepare *tinsis* which is left to ferment for 24 hours. In the third phase, the second portion of fermented maize grits taken after 68 hours of initial fermentation is roasted, cooled and kneaded with fresh flour and water. The mixture is then moulded into stiff dough balls, steam cooked (*gafuma*) and broken into pieces. The *gafuma* is blended with *tinsis* in the same insira to a thick brown mash called *difdif* and is allowed to ferment for 24 hours. In the fourth phase of *borde* fermentation, the remaining portion of fermented maize grits from phase I (72 hours old) is added into a pan containing a boiling mixture of sorghum and water. The mixture is further boiled into a very thick porridge with continuous stirring. The porridge is well mixed with *difdif* and malt and sieved through a mesh (*wonfit*). The residues are also milled using traditional stones and sieved about two times. The filtered product becomes ready for consumption after extra 6 hours of fermentation (Abegaz et al., 2002a; Abegaz, *et al.*, 2002b). According to Abegaz *et al*., (2002b), the pH of *borde* ranges from 3.68-4.26 and the titratable acidity can be up to 0.98% lactic acid, continuously varying between the phases of *borde* fermentation with the introduction of fresh ingredients which result in the dilution of the product. Total protein, soluble protein, fat and ash content of *borde* are 9.55%, 3.31%, 6.88%, and 3.66%, respectively. The high carbohydrate content coupled with the small amount of alcohol makes *borde* to serve as meal replacement beverage (Ashenafi and Mehari, 1995).

2.3.5. Keribo

Keribo is an indigenous traditional fermented beverage which is mainly prepared from barely and sugar and consumed in different parts of Ethiopia. *Keribo* constitutes a major part of the beverages being served on holidays and marriage ceremony. It is considered as a non- or low alcoholic beverage and thus becomes a popular drink among some religious groups and those who do not like alcoholic drinks. During *keribo* preparation, barley is intensely roasted and added into boiling water. Then, boiling is continued for 10-20 minutes at 65-70^{o}C until the ungrounded grain seems to be dissolved and the dissolved matter is sieved after cooling. Lastly, sugar and yeast are added into the filtrate and allowed to ferment overnight in sealed container. Sugar can also be added during consumption to make the product sweet enough. The average time required for *keribo* preparation from roasting to consumption is about 8 hours. *Keribo* has pH and titratable acidity of 3.84 and 12%, respectively (Rashid, 2013a).

2.3.6. Shamita

Shamita is an indigenous fermented low alcohol beverage with a thick consistency. *Shamita* is mainly prepared from roasted barely and it is used by most people as a meal replacement. During *shamita* preparation, barley is lightly roasted and ground into flour. Then, the flour is mixed with water and allowed to ferment overnight. The beverage is ready to serve the next day when salt and spices are added to it. Malt is not commonly used in *shamita* fermentation, but some brewers may use it frequently. Fermentation is often achieved by using a small amount of *shamita* from a previous fermentation. Ready to consume *shamita* has a pH of 4.2 and high total protein (10.37%), fat (3.46%), and ash (6.85%) contents compared to the major ingredient, barley (Ashenafi and Mehari, 1995).

2.4. Nutritional Importance of Fermented Beverages

Extending the shelf-life of foods is one of the major objectives of fermentation, with aspects such as wholesomeness, acceptability and overall quality. Fermented foods and beverages make a major contribution to dietary staples in numerous countries across Africa, Asia and Latin America and small-scale fermentation technologies contribute substantially to food security and nutrition, particularly in regions that are vulnerable to food shortages (FAO, 1998).

Fermentation is a cheap and energy efficient means of preserving perishable raw materials, which is accessible to even the most marginalized, landless, physically incapacitated rural, peri-urban and urban poor (Nout, 1980; Pederson, 1979). There are several options for preserving fresh fruit and vegetables including drying, freezing, canning and pickling, but many of these are inappropriate for use on the small-scale: for example, small-scale canning of vegetables can have serious food safety implications given contamination with botulism is a possibility; and freezing fruit and vegetables is not economically viable at the small-scale (FAO, 1998; Holzapfel, 2002). Fermentation however, requires very little sophisticated equipment, either to undertake or subsequently store the fermented product, and has had a major impact on nutritional habits, traditions, and culture. As such, traditional fermentation still serves as a substitute for refrigeration or otherwise safekeeping of food, and is also directly utilized to make good of edible leftovers.

The importance of fermentation in modern-day life is underlined by the wide spectrum of foods marketed both in developing and industrialized countries, not only for the benefit of preservation and safety, but also for their highly appreciated sensory attributes. Fermented foods are prized as major dietary constituents in numerous developing countries because of their keeping quality under ambient conditions thereby contributing to food security and because they add value, enhance nutritional quality and digestibility, improve food safety, and are traditionally acceptable and accessible (Rolle & Satin, 2002; Holzapfel, 2002). Fermentation results in increased protein, fat and ash contents than found in raw materials (Ashenafi and Mehari, 1995).

Fermented foods are described as palatable and wholesome and are generally appreciated for attributes, their pleasant flavours, aromas, textures, and improved cooking and processing properties (Van Veen & Steinkraus, 1970; Holzapfel, 2002). During fermentation food is softened as the result of complex changes in proteins and carbohydrates and hence its texture is improved. Sugars are fermented to acids, which reduce sweetness and increase acidity. In some cases bitterness is reduced by enzymatic activity. The production of volatile compounds such as amines, fatty acids, aldehydes, esters and ketones result in good aromas. Products of fermentation such as ethanol are very important for the mouth-feel and flavor of alcoholic beverages. Desirable food colours may result due to proteolytic activity, degradation of chlorophyll and enzymatic browning (Fellows, 2000).

Fermentation improves food safety quality through the presence of probiotics that protect from *E.coli* and other pathogens and have hypocholesterolemic and anticarcinogenic effects, which is of particular significance in lactose intolerance and gastrointestinal disorders. Most foods and beverages are fermented by lactic acid fermentation, during which pH is lowered to 4.0. In addition, bacteriocins, hydrogen peroxide, ethanol and diacetyl are produced. This inhibits the growth of pathogenic microorganisms and prevents spoilage of food.

Lactic acid fermentation also may reduce the content of natural toxins in food; e.g. cyanogenic glycosides in cassava (major staple food in Africa) and soften plant tissues. Cereal based diets, including maize, sorghum and millet, contain a number of anti-nutritive factors, including reduced availability of minerals, including calcium, iron, magnesium and zinc, as well as deficiencies in essential amino acids including lysine, tryptophan and methionine, which serve as building blocks for proteins (Holzapfel, 2002). Other anti-nutritive components typical of cereal and legume foods include acids and tannins which can further reduce mineral availability, and further exacerbate malnutrition. Fermentation enhances the digestibility and nutritional value of foods, as well as reduces anti-nutritive effects. For example, fermentation of plant cereal-based foods favors transformation of phytate by phytase. This increases several fold bioavailability of iron. The consequence of lactic acid fermentation is decreased tannin content in cereals, which increases mineral absorption and protein digestibility of grains. Microorganisms improve digestibility by hydrolysis of polymeric compounds, mainly polysaccharides and proteins (Fellows, 2000; Nout, 1980; Van Veen & Steinkraus, 1980). Most beverages typically contain a lot of water and while not necessarily adding nutrients to the diet, they importantly help prevent dehydration. Many fermented fruit drinks contain significant sugar adding energy to the diet, and in some cases, provide vitamins and minerals (Fellows and Hampton, 1992).

In Ethiopia, diverse fermented beverage are produced with inexpensive ingredients and simple techniques. These fermented beverages make significant contributions to the diets of rural households and village communities throughout the country. For instance, some beverages with thick consistency such as *borde* are consumed as cheap source of nutrients and alternative meal replacement foods particularly for low-income groups of consumers (Abegaz *et al*., 2002b). The nutrient contents and physiochemical properties of some indigenous beverages produced in Ethiopia are presented in the following table.

Table 1. Nutrient contents and chemical properties of some fermented beverages and foods in Ethiopia

Beverage	Protein (g/100g)	Fat (g/100g)	Total ash (g/100g)	pH	Titratable acidity (% lactic acid)
Borde	9.55[b]	6.88[b]	3.66[b]	3.68-4.26[a]	0.98%[a]
Shamita	10.37[b]	3.46[b]	6.85[b]	4.20[b]	-
Kerebo	-	-	-	3.20-5.17[d]	12.0[d]
Tej			-	3.56-4.45[c]	-
Tella	-	-	-	4.00-4.99[c]	-
Arake	-	-	-	4.30-4.51[c]	-
Ayib	13.4-16.0[e]	1.9-2.0[e]	0.75-0.87[e]	3.3-4.6[e]	
Ergo	7.17[e]	9.05[e]	-	3.65[e]	1.92[e]

Sources:

- a-Abegaz *et al*. (2002b)
- b- Ashenafi and Mehari (1995)
- c- Yohannes *et al*. (2013)
- d- Rashid (2013a)
- e- cited in Ashenafi (2002)

2.5. Pitfalls of Fermented Foods and Beverages

Fermentation technologies are complex and sensitive and require careful control of quality and safety of raw materials, environmental hygiene and sanitation and safety of metabolites, as well as processing conditions and degree of acidity achieved (Abegaz *et al*., 2002a). If the fermentation is not properly conducted, spoilage may appear which causes annoying odor and bad taste because of the undesirable products such as butyric acid, hydrogen sulfide, and aromatic amines. In addition, there is a danger of contamination by pathogenic organisms. For instance, fermentation under anaerobic conditions may encourage the development of toxins such as botulin in foods. The use of uncontrolled conditions, especially temperature, may also result in the proliferation of undesirable microorganisms which convert desirable fermentation products such as ethanol to unpleasant end products like acetic acid which unfavorably affect the taste, texture and stability of the products (Holzapfel, 1991). The production of acids in fermented beverages reduce the pH of the drink and therefore, the increased intake of this beverages is an issue of concern because of the potential of low pH to erode teeth and bones. The low pH of beverages can rob calcium in skeletal systems and lead to dental caries and osteoporosis (Cairns *et al*., 2002; Mettler *et al*., 2006).

Fermentation of traditionally fermented alcoholic beverages relies on the microorganisms present in the substrates, fermentation vats or equipment. As these fermentations are natural and, thus, uncontrolled, alcohol and fusel oils produced during the fermentation can be hazardous to health if produced beyond acceptable levels (Bahiru *et al*., 2001). Alcoholic beverages may also contain a variety of carcinogenic contaminants that are introduced during fermentation and production, such as nitrosamines, asbestos fibres, phenols, and hydrocarbons. According to some studies carried out in some African countries there is considerable evidence that home produced alcohol drinks are known to have toxic components (Fite *et al*., 1991). Some of the compounds present in alcoholic beverages which have potential to cause serious health problems are discussed in the next sections.

2.5.1. Methanol

Methanol is ubiquitously present in the human body and it appears in human blood and breath. Studies carried out so far shown that methanol is the common contaminants of traditional alcoholic beverages. It is a potent toxicant in humans and occurs naturally at a low level in most alcoholic beverages, but it may occasionally reach concentrations up to 18g/l ethanol (equal to 0.72% v/v methanol at 40% ethanol). It is produced by bacterial fermentation or by decomposition of pectins by moulds such as *Mucor.* These microorganisms secrete pectinase enzyme, the enzyme that breaks down pectins to release methanol (Bindler *et al.*, 1988; Lindinger *et al.,* 1997).

The presence of methanol mainly in traditional alcoholic beverages is a well known problem. Methanol can be present in both distilled and non-distilled beverages. It is often distilled together with ethanol due to their similar physiochemical properties (Bindler *et al.*, 1988). Low levels of methanol are not considered toxic, but higher ingestion of this substance may lead to serious health hazards, the most commonly known is blindness. In the human body, methanol is converted to a metabolite called formaldehyde by the enzyme alcohol dehydrogenase and then to formic acid which seriously damages the retina, optic nerves and central nervous system (Tephly, 1991; Eells *et al*., 2000). Therefore, the sensitivity of humans to methanol toxicity depends on individuals ability to oxidize and detoxify formic acid. The diuretic effect of alcoholic beverages can also determine the toxicity of methanol. Methanol in order to cause toxicity, it must first be metabolised by alcohol dehydrogenase to formaldehyde and thereafter to formic acid. The toxicity evolves from a combination of the metabolic acidosis (H^+ production) and intrinsic toxicity from the formate anion itself (Paine and Davan, 2001).

Alcohol dehydrogenase has a greater affinity (a 20 fold) for ethanol than methanol. So simultaneous consumption of these alcohols considerably reduces the conversion of the methanol to its toxic metabolites. Administering ethanol intravenously for treating methanol poisoning can be an effective treatment because it increases blood ethanol level and circulation as well. If ethanol is found in sufficient concentrations in the person ingested the methanol, its potential to become toxic will be reduced as long as ethanol is there. However, when the ethanol is continually being metabolised by the enzyme alcohol dehydrogenase, its protective effect would decline gradually (Jacobson *et al*., 1988; Haffner *et al*., 1992; Eells *et al*., 2000). Treatment involves the use of buffer such as sodium bicarbonate and if necessary haemodialysis to correct metabolic acidosis, mechanical ventilation, fomepizole, and antidote to inhibit metabolism of its toxic metabolite, formic acid (Jacobsen and McMartin, 1986; Brent, 2001).

The initial symptoms of methanol poisoning consists of weakness, dizziness, headache, nausea, vomiting and blurred vision. In severe cases of accidental or reckless ingestion, methanol may lead to permanent blindness or death (Eells *et al*., 2000, Tephly, 1991). The consequences of toxic effects of methanol in humans can be exhibit by formic acidaemia, metabolic acidosis, blindness or serious visual impairment and even fatal illness (Conor *et al*., 1979; Eells *et al*., 2000). The current EU general limit for naturally occurring methanol is about 10g methanol/L ethanol which equates to 0.4% (v/v) methanol in alcoholic drink containing 40% alcohol (cited in Paine and Davan, 2001). According to the East African standards (EAS, 2013), gin shall contain a maximum methanol content of 50mg/L and 37.5±0.5%v/v ethanol. On the other hand, wines in Ethiopia shall contain maximum of 250mg/L (white wine)-400mg/L(red wine) (ESA, 2013). The acceptable intake of methanol is higher when alcohol is present, since alcohol is an antidote of methanol poisoning. The potential for widespread human exposure to methanol is by increased consumption of illicit alcoholic beverages. Common traditional Ethiopian beverages like a*rake*, *tella* and *tej* were reported to have methanol content of 320.87 ppm, 32.37 ppm, and 45.67 ppm, respectively (Fite *et al.,* 1991). However, in the studies conducted by Gizaw (2006) and Abel (2013), methanol was not detected in *arake* and *tella* samples.

2.5.2. Ethanol

Ethanol (ethyl alcohol) is the only type of alcohol that can be consumed. Commercial ethanol for consumption is prepared from various forms of starch and sugars by yeast fermentations **(**Whitney and Rolfes, 2008). Ethanol might have some benefit for coronary heart disease for those with high blood low density lipoprotein (LDL) cholesterol. But the benefit can usually be achieved more safely by other means of lowering LDL cholesterol. The consumption of alcohol carries a risk of adverse health and social consequences related to its intoxicating, toxic and dependence-producing properties. There are reported cases of danger associated with the consumption of alcoholic beverages throughout the world (WHO, 2014). It has often been observed that alcoholism is a more significant problem than all other forms of drug abuse combined (Desta, 1977). In 2012, about 3.3 million deaths, or 5.9% of all global deaths, were attributable to alcohol consumption, as measured in disability-adjusted life years (WHO, 2014).

Ethanol affects the central nervous system, gastro-intestinal tract, cardiovascular system, endocrine, liver, lipid metabolism, fetal development, and has immune suppression activities.

Alcohol is rapidly absorbed via stomach and/or small intestine into the bloodstream depending on the amount of alcohol consumed. Alcohol in the liver is metabolised into a blood through the activities of two enzymes; *viz*. alcohol dehydrogenase which converts alcohol to acetaldehyde (ADH) and acetaldehyde dehydrogenase 2 (ALDH2) which metabolises toxic acetaldehyde to non-toxic substances. About 90-98% is metabolised in the liver into acetic acid and 2-10% is excreted unchanged. However, the liver can only metabolise a small amount of alcohol at a time, leaving the excess alcohol to circulate throughout the body. The intensity of the effect of alcohol on the body is directly related to the amount consumed **(**Whitney and Rolfes, 2008).

Based on extensive reviews of research studies, there is a strong scientific consensus of an association between alcohol drinking and several types of cancer. Human Services lists consumption of alcoholic beverages as a known human carcinogen. The research evidence indicates that the more alcohol a person drinks, particularly the more alcohol a person drinks regularly over time the higher his or her risk of developing an alcohol-associated cancer. Brain and liver are one of the most affected organs because of alcohol consumption. A meta-analysis of various findings indicated associations between alcohol consumption and the development of head and neck cancer, esophageal cancer, liver cancer, breast cancer and colorectal cancer (Longnecker, 1994).

Chronic alcohol consumption may also result in severe nutrient deficiencies such as thiamin deficiency that results in the development of serious brain disorders, a condition known as Wernicke-Korsakoffs syndrome. The symptoms of Wernicke's encephalopathy include mental confusion, paralysis of the muscles that move the eyes (i.e., oculomotor disturbances), and difficulty with muscle coordination. Heavy drinking has extensive and far-reaching effects on the brain, ranging from simple slips in memory to permanent and debilitating conditions that require life time custodial care and even moderate drinking leads to short-term impairment (Martin *et al*., 2003; Victor *et al*., 1989). Large quantities of alcohol, especially when consumed quickly and on an empty stomach, can produce a blackout, or an interval of time for which the intoxicated person cannot recall key details of events, or even entire events (White, 2003; White *et al*., 2002).

A number of factors influence how and to what extent alcohol affects people. These include the quantity and frequency of drinking (volume and patterns), age, gender, genetic background, family history of alcoholism, prenatal alcohol exposure and general health status of the person (WHO, 2014). Mumenthaler *et al.*(1999) reported that women are more vulnerable than men to many of the consequences of alcohol use. Therefore, those who choose to drink alcoholic beverages should do so sensibly and in moderation; up to one drink per day for woman and two drinks per day for men. However, alcoholic beverages should not be consumed by some individuals, including those who cannot restrict their alcohol intake, women of childbearing age who become pregnant, pregnant and lactating women, children and adolescents, individuals taking medications that can interact with alcohol and those with specific medical conditions. Those individuals engaging in activities that need attention, skill, or coordination such as driving or operating machinery should not drink alcoholic beverages (Whitney and Rolfes, 2008)**.**

Drinking alcohol by pregnant women often results in fetal alcohol syndrome in infants that can impair the motor performance of children, or even adults. Maternal alcohol use during pregnancy contributes to a range of effects in exposed children, including hyperactivity and attention problems, learning and memory deficits, and problems with social and emotional development. Prenatal alcohol exposure is associated with increased levels of irritability during infancy (Coles *et al*., 1991), a temperamental variable known to contribute to poorer maternal attachment and behavioural problems in childhood (Kelly *et al*., 2000). Two studies have found that children exposed prenatally to alcohol were rated by their teachers as less socially competent and more aggressive in the classroom (Brown *et al*., 1991; Jacobson *et al*., 1998). Because these effects remained significant after controlling for current maternal drinking and measures of quality of parenting, these studies suggest that prenatal alcohol exposure may have effects on socio-emotional development that are independent of the social environment in which the child is raised.

Scientific evidences indicated that prenatal alcohol exposure is associated with a distinctive pattern of intellectual deficits, particularly in arithmetic and certain aspects of attention, including planning, cognitive flexibility, and the utilization of feedback to modify a previously learned response. With respect to learning, the acquisition of new information is more likely to be impaired than retention and retrieval of previously learned information. Fetal alcoholic syndrome (FAS) children were more likely to exhibit antisocial behaviours, lack consideration for the rights and feelings of others, and resist limits and requests by authority figures. It is also reported in some findings that adults with FAS are more likely to get into trouble with the law and to exhibit sexually inappropriate behaviour (Streissguth *et al*, 1991).

Different fermented beverages are found in Ethiopia ranging from non-alcoholic to highly alcoholic beverages. *Borde*, *shamita*, *korefe*, *kerebo* are generally considered as low or non-alcoholic, whereas *tej*, *arake* and *tella* are deemed to be high in their alcohol content (Abegaz, 2002b). Consumers particularly those in rural areas usually choose these drinks because of their low cost compared to taxed alcohol. The ethanol content of some Ethiopian fermented beverages is presented in the following table.

Table 2. Ethanol contents of some traditional beverages in Ethiopia

Beverage	Ethanol (%v/v)
Filtered *tella*	3.84-6.48
Unfiltered *tella*	3.50-4.52
Arake	33.95-39.90
Tej	8.94-13.16

Sources: Yohannes *et al*. (2013)

2.6. Unrecorded Alcohol Consumption and Its Effect

Unrecorded alcohol refers to alcohol that is not taxed, because it is produced, distributed and sold outside formal channels and therefore, it is outside the usual systems of government control. These may include the consumption of homemade or informally produced alcohol (illicit or traditionally brewed alcoholic beverages), smuggled alcohol, alcohol intended for industrial or medicinal uses, and alcohol obtained through cross-border shopping (Rehm *et al*., 2010). According to the 2014 WHO global status report on alcohol and health, the consumption of unrecorded alcohol accounts for 25% of the worldwide total consumption.

Since the government has no control over the production of locally brewed alcoholic drinks, it is difficult to estimate the amount of alcohol production and consumption in Ethiopia. However, the unrecorded alcohol consumption from 2003-2010 is estimated to be 3.5 litres of pure alcohol per capita for population older than 15 years of age (WHO, 2014). Traditionally prepared beverages remain to be the most widely consumed alcohol as they are inexpensive and easily accessible than factory produced beverages. For this reason, factory produced drinks tend to be mainly consumed by people who can afford the more expensive price and by urban dwellers while locally produced and home-brewed alcoholic beverages are predominantly used in the rural areas and by people living in the urban areas who cannot afford factory made drinks. Due to health and safety risks in over-consumption, many regulations have been initiated to control the availability and enforce an acceptable level of alcohol consumption. To further decrease health complications with alcohol consumption, it is important to accurately quantify the amount of ethanol present in unrecorded beverages (Sarah & Matthew, 2012).

3. MATERIALS AND METHODS

3.1. Description of the Study Areas

The survey data and *cheka* samples collection were carried out in two districts, namely Konso and Dirashe. Dirashe and Konso are one of the five districts in Segen and its Surrounding Peoples Zone and are located in the South-western part of the SNNPR at a distance of about 550 and 590 kilometers from Addis Ababa, respectively. According to the 2008 census, the total population of Konso and Dirashe is 234, 987 and 142, 678, respectively (FDRE Population and Census Commission, 2008). Konso district is organized into 50 kebeles whereas Dirashe is organized into 28 kebeles. In Konso, the dominant and major ethnic group in all 50 kebeles is Konso and their language is called Afan Konso. On the other hand, Dirashe has four major ethnic groups (Dirashe, Mashole, Mosiye and Kusume) which have their own language. The two communities are highly inter-dependent and bound up together through the *Jala* (meaning friend) system and can understand each other and communicate with one another without an interpreter since their major languages (Afan Konso and Dirashita) belongs to the same language family, Cushitic. The administrative map of the study area is shown in Figure 1.

Peoples of Konso and Dirashe are famous for their sustainable environmentally friendly agricultural system and their livelihood is majorly depends on agriculture and livestock. The most important crops grown in the two districts include maize, sorghum, coffee, cassava and chat. Their nutritional habit is dependent on *kurkufa* (balls made from maize, sorghum and wheat flour and cooked with vegetables such moringa and leaf cabbage), *nufiro or nufit* (boiled maize, haricot bean or combination of these) and *cheka* (cereal-based fermented beverage) (SNNPR Nationalities Council, 2009).

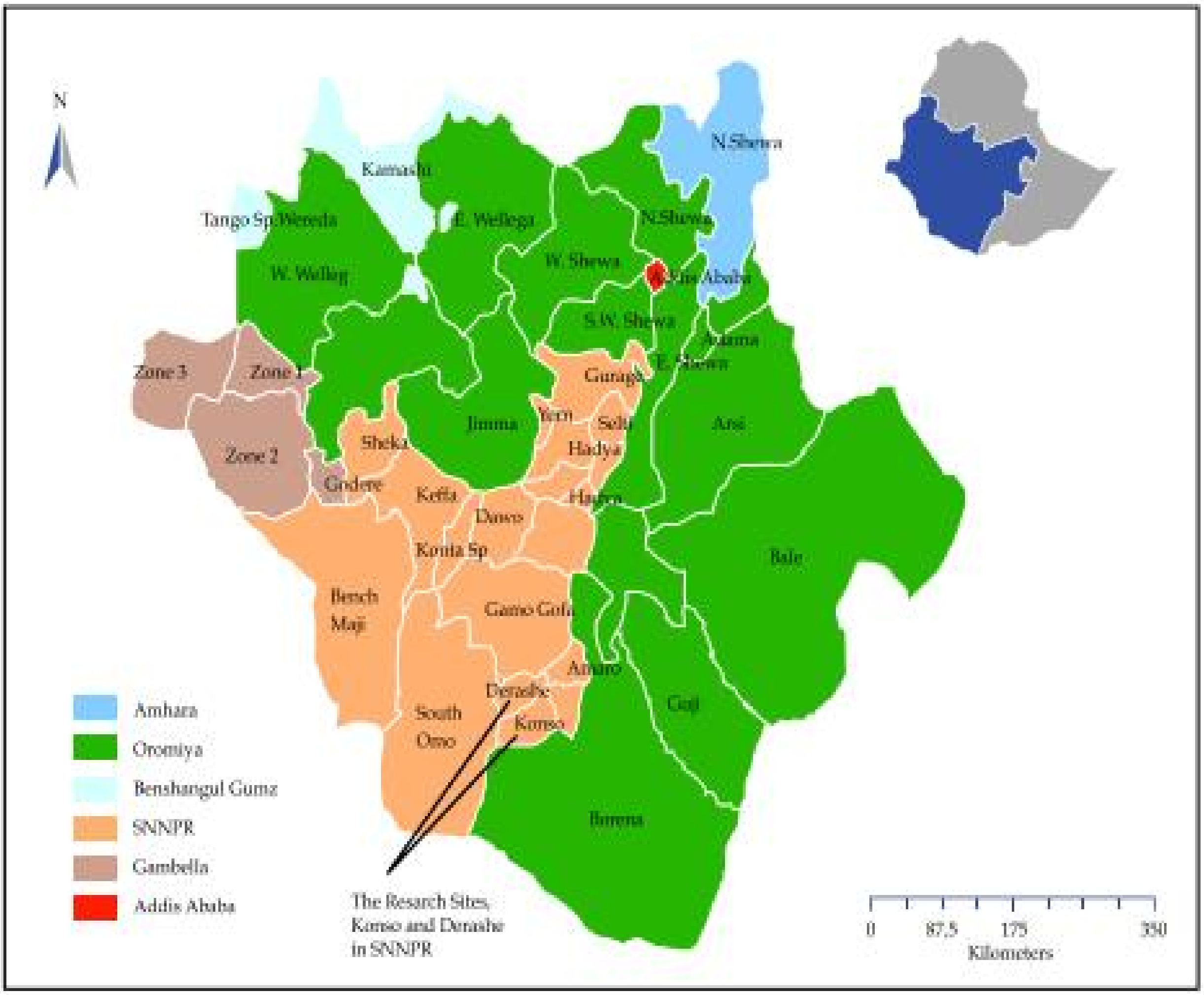

Figure 1. The Administrative Map of the Southwestern Ethiopia (including the SNNPR)

Source : CSA (2008)

3.2. Survey data collection

A survey of traditional processing methods and raw materials used for the production of *cheka* was conducted using in-depth interviews and focus group discussions with 90 cheka producers at two districts in southwestern Ethiopia, namely Konso and Dirashe. The interview was administered in Amharic language in the villages of each locality. Three kebeles which are known for consumption and vending of cheka were selected from each locality. A total of 60 brewers (10 women from each kebele) were selected randomly for interview after preliminary screening. In order to obtain an insight into the processing operations, ingredient proportions, consumption patterns and undisclosed things, focus group discussions were carried out in three kebeles with 30 women who were selected based on availability. Data were collected on the preparation techniques, types and proportions of ingredients, sources of energy, types of equipment, sensory properties, shelf-life and economic importance of *cheka* as well as constraints in its production, marketing and consumption. Cooking temperatures were recorded during on the spot interviews at Karat, Gato and Gidole where people use warm water for diluting *cheka*.

3.3. Sample Size and Sample Collection

Nine *cheka* samples were collected using screw-cap plastic containers (1 litre each) from vending houses at three localities for analysis of their chemical properties, nutritional and alcohol contents. All the samples were collected purposively while considering the processing techniques. The samples were coded with the first letter of the site and numbers in the order they were collected. The samples coded as K3, K2, and K3 were collected from Karat (Konso) and were prepared mainly from maize and had been fermented for about $3^{1/2}$ days following the Konso method of cheka preparation. The samples group coded as S1, S2, and S3 and G1, G2, and G3 were collected from Dirashe (specifically from Shelele and Gidole). The former group of samples were fermented for at least one month and the latter group were fermented for about a week. The samples collected from Dirashe were mainly prepared from a mixture of sorghum, maize and vegetables such as cabbage. The collected samples were transported by plane to the laboratory of the Centre for Food Science and Nutrition at Addis Ababa University using an icebox.

3.4. Sample preparation for analysis

After transportation of the samples, moisture analysis and determinations of pH and titratable acidity were immediately carried out in the laboratory and the samples were stored in a deep freezer and then were lyophilised. The dried samples of cheka were packed in polyethylene plastic bags and were stored in dry place.

3.5. Preparation of *Cheka* in the Laboratory

One sample of *cheka* was prepared by the investigator in the laboratory following the Konso preparation method using yellow maize, sorghum grains and barley obtained from local markets of Addis Ababa. For this purpose, 200 grams of Maize was milled into flour. The flour was kneaded with 150ml of water in a dish and allowed to ferment for 38 hours. After the maize flour was fermented for 38 hours, dough balls was prepared. Some pieces of hop sticks were placed at the bottom of a metal pot and about 200ml of water was added. The dough balls were added after the temperature of the boiling water become 94^{o}C and was cooked for about 30 minutes. The cooked balls was broken down into pieces and cooled for about 1 hour. The cooled product was mixed with 45g of milled malt and be kneaded with 50ml of water. 5g of malt was spread on the surface of the kneaded product and allowed to ferment overnight. In the next day morning, the fermented product was transferred from the dish into a bath and about 50ml of water was added. Then, a thick porridge was prepared from 250 grams of milled sorghum by mixing with about 300ml of boiling water (94^{o}C). After cooling for 1 hour, the porridge was mixed and properly kneaded with 50g malt. Finally, about 100ml of water was added, well mixed together and allowed to ferment overnight.

3.6. Materials, Reagents and Apparatus

All chemicals utilized for the analysis were of analytical and HPLC grade. Prior to some analysis, crucibles and glassware were cleaned using distilled water, 6N HCl and 10% HNO_3 solutions in order to avoid contamination. Chemicals used during analysis are found in the experimental procedures section. The main instruments and equipments utilized during analysis are listed as follows.

- Drying oven (DHG-9055A, Memment, Germany)
- Refrigerator, deep freezer, and lyophilizer
- Analytical balance
- Protein digester and Kjeldahl apparatus
- Muffle furnace
- Flame Atomic Absorption Spectrophotometer
- Gas Chromatography (GC 2010 plus, SHIMADZU, Japan)
- Soxhlet fat extraction apparatus
- Fibretech fibre analyzer

3.7. pH and Titratable Acidity

The pH of the samples was measured by dipping the glass electrode of a digital pH meter into 10 ml of the sample after blending with distilled water at a 1:1 ratio into thick slurry as described in Abegaz *et al*. (2002b). Prior to measuring the pH, the meter was calibrated with buffer solution at pH 4.0 and 7.0. For the determination of total titratable acidity, about 10ml of *cheka* samples were added into beakers (50ml) and titrated against 0.1 N standard solution of NaOH after adding 3 drops of 1% phenolphthalein indicator (Byaruhanga, 1998; cited in Rashid, 2013b). The results were expressed in terms of percentage of lactic acid. The assumption made here was that the fermentation of cereal-based beverages like *borde* and *shamita* which are similar to *cheka* is predominantly mediated by activities of lactic acid bacteria (Bacha *et al.,* 1998; Bacha *et al* 1999).The percent of lactic acid present in the sample was calculated using the following formula.

$$\%Lactic\ acid\ (wt/v) = \frac{N\ \times VNaOH\ \times Eq.wt \times 100}{Vs\ (mL) \times 1000}$$

Where; N = normality of titrant (mEq/ml), V_{NaOH} = Volume of titrant (ml), Eq. wt = Equivalent weight of predominant acid (mg/mEq which is 90.08 for lactic acid), V_s = Volume of sample (ml) and 1000 = factor relating mg to grams

3.8. Nutritional Content

3.8.1. Total Solids

Total solids of the samples was determined by hot air drying method according to the official method 925.09 of AOAC (2000) and ASEAN manual of food analysis (2011). Steel crucible were dried in a drying oven at 105^{o}C. The crucibles were taken out from the oven, cooled in a desiccator for 30 minutes and then their weight was measured (W_1). About 8g of *cheka* sample was weighed in the crucible and dried in drying oven at 105^{o}C for 3 hours. Similarly, the moisture content for lyophilised cheka samples were also determined by using 5 grams of the samples. Then, the weight of the crucible containing the sample was measured (W_2). After drying, the crucible containing the dried sample was cooled in a desiccator to room temperature and weighed until constant weight was obtained (W_3). The amount of total solids was calculated by using the following formula.

$$\%\ Total\ solids = 100 - \%\ Moisture\ \text{(W/W)}$$

3.8.2. Crude Protein

Protein content was analysed by the micro Kjeldahl method according to the official method 979.09 of the AOAC (2000).The general procedure included the following steps of digestion: 0.5g of freeze dried sample was weighed in a cleaned Kjeldahl flask and 6 ml of concentrated sulfuric acid was added for digestion. 3.5ml of hydrogen peroxide was added in drop wise manner and 3g of catalytic mixture of potassium sulfate and copper sulfate was also added and the reaction was left for 15 minutes. The mixture was digested in a digest stove initially at low temperature to prevent frothing and then at 370^{o}C for 4hours until a clear digest was obtained. After digestion, it was cooled in the hood on the rack. 25ml of distilled water was added to prevent precipitation of the sulfate. 25ml of 35% NaOH was added to neutralize sulfuric acid and thus, ensure complete release of ammonia. A 250ml Erlenmeyer flask containing, 25ml of 4% H_3BO_3, 25ml of distilled water and 3 drops of methyl red indicator was placed as receiver on the distillation unit. The distillation process continued until the volume of the distillate reached 150ml or more. The distillation was continued for 1-2 minutes after the receiver flask is lowered such a way that the delivery tube is above the liquid surface. Then, the delivery tube was rinsed with distilled water and the washings was allowed to drain into the flask. Finally, the distillate was titrated with standardized 0.1 N HCl until the appearance of the first pink colour and the amount of HCl consumed was recorded. Moreover, reagent blank was run to subtract reagent nitrogen from the sample nitrogen. The amount of protein was calculated by using the following formula.

$$\%\,Crude\ protein = \frac{(V2 - V1) \times N \times 14.01 \times 6.25}{10 \times W}$$

Where; V1= volume (ml) of hydrochloric acid solution required for the blank test, V2= volume (ml) of hydrochloric acid solution required for the test sample, N= normality of hydrochloric acid, V= volume of the sample, 10 = factor relating mg to grams, 14.01= equivalent weight of nitrogen**,** 6.25= protein conversion factor for foods

3.8.3. Crude Fat

The crude fat was extracted using Soxhlet apparatus according to AOAC (2000) official method 4.5.01. About 2 gram of the freeze dried sample was weighed in thimble containing fat free cotton (W_1). The extraction cylinder was washed with distilled water and detergent and then dried. The cylinder was cooled in a desiccator for 30 minutes and weighed (W_2). 50ml of diethyl ether with boiling point of 34.6^oC was added into the cylinder and the thimble was immersed into the cylinder containing diethyl ether for 2 hours. Fat extraction was done for extra 2 hours, while the temperature was set at 55^oC. After that the cylinder containing the extracted fat was dried in drying oven to a constant weight at 70^oC for 30 minutes. Finally, the cylinder containing the extract was cooled in a desiccator for 20 minutes and weighed (W_3). The amount of extractable fat was calculated by using the following formula.

$$\%\, Crude\ fat = \frac{W3 - W2}{W1}$$

Where; W1= Weight of sample, W2= weight of cylinder, W3= weight of cylinder + fat, W3-W2= weight of fat

3.8.4. Crude Fibre Content

Crude fibre content of the *cheka* samples was determined according to the method 962.09 of the AOAC (2000). The analysis involved the steps of digestion, filtration, washing, drying, and combustion. First, about 1g of celite sand was measured in pre-dried crucible for the purpose of preventing the pores from being blocked and 1g of cheka sample (W_3) was weight. Next, the crucible with its content was placed in the Fibertec and the sample was digested with 1.25% of sulfuric acid solution for 37 minutes and it was washed with distilled water. Then, the sample was digested by 1.25% of NaOH solution for 37 minutes and was filtered in coarse porosity crucible in the apparatus at a vacuum of about 25mm. The residue was dried in an oven at 130°C for 2 hrs, cooled in a desiccator, and weighed (M_1). Finally, the crucible was placed in a muffle furnace and the sample was ashed at 525°C for 3 hours, cooled in a desiccator and weighed again (M_2). The crude fibre was calculated using the following formula.

$$\%Crude\ fiber = \frac{(W1 - W2) \times 100}{W3}$$

Where; W_1 = crucible weight after drying, W_2 = Crucible weight after ashing, W_3 = Weight of sample

3.8.5. Carbohydrate and Gross Energy

The carbohydrate content of the *cheka* samples was determined by difference method that is by subtracting the sum of the percentages crude protein, crude fat, fibre and ash content from 100%. Gross energy contents of the samples were determined by calculation from fat, carbohydrate and protein contents using the Atwater's conversion factors; 4 kcal/g for protein, 9 kcal/g for fat and 4 kcal/g for carbohydrates and were expressed in kilocalories (Guyot *et al.*, 2007).

3.8.6. Total Ash Content

The ash content was determined according to the official method 923.03 of the AOAC (2000)**.** Clean porcelain crucible was dried at 105^{o}C in hot air oven and in addition was ignited at 550^{o}C for about 3 hours in a muffle furnace. Next, the crucible was cooled in a desiccator for about 30 minutes to room temperature and weighed until constant weight using analytical balance (W_1). About 2.5 g of freeze dried *cheka* sample was weighed into the cleaned crucible (W_2). Then, it was charred on a hot plate at low temperature to avoid spattering until the smoke disappeared. The charred sample was incinerated in a muffle furnace at 550^{o}C for 5 hours until the residue became white in appearance. The residue was moistened with few drops of deionized water and the water was allowed to evaporate on a hot plate. The sample was ashed for 30 minutes at 500^{o}C and some drops of deionized water and 5 drops of concentrated HNO_3 was added after cooling in a desiccator. The water and HNO_3 were caused to evaporate on a hot plate as above starting from low temperature. The sample was again ashed as above for 30 minutes at the same temperature as previously described and it was weighed after cooling for 1 hour (W_3). The amount of total ash present in the sample was calculated by using the following formula.

$$\%\,ASh = \frac{W3 - W1}{W2 - W1} \times 100$$

Where, W_1= weight of crucible, W_2= weight of crucible + sample, W_3= weight of crucible + ash, W_2-W_1= weight of sample, W_3-W_1= weight of ash

3.9. Mineral Analysis

Mineral composition of the samples was determined according to methods recommended by Association of Official Analytical Chemists (AOAC, 2000) and ASEAN manual of food

Analysis (ASEANFOODS, 2011). Ca, Fe, and Zn contents of the cheka samples were determined by atomic absorption spectrophotometer (AAS) following standard procedures.

3.9.1. Dry ashing and sample solution preparation for mineral analysis

The *cheka* samples were ashed following the procedure described above in the total ash analysis section. 7ml of 6N HCl solution was added to the ash of each sample and heated on a low temperature hot plate until it dried. Then, 15ml of 3N HCl solution was added and the mixture was heated on the hot plate till it just boils. After the solution cooled down, it was filtered through a filter paper into a volumetric flask (50ml). 10ml of 3N HCl was added and the crucible was heated until the solution boiled. The solution was allowed to cool and filtered through a filter paper into the volumetric flask. The crucible and filter paper was washed thoroughly and the washings were collected into the flask. Finally, 2.5ml of 10% lanthanum chloride was added into the solution and the volume was made up to the 50ml mark with deionized water. Blank sample was also run by taking the same amount of reagents. The solutions were transferred to polyethylene bottles and stored in cool place until analysis.

3.9.2. Mineral Analysis and Calibration of AAS

In order to fit calibration curves, a series of standard solutions (0, 0.5, 2.0, 4.0 and 6.0ppm for Ca, 1.25, 2.5, 5 and 10ppm for Fe and 0.0, 0.5, 1.0, 2.0, 3.0 and 4.0 ppm for Zn) of the minerals were prepared from stock solutions of 10 ppm. 5 ml of 10% lanthanum chloride was added when preparing Ca stock solution in 100 ml volumetric flask. The flame atomic absorption spectroscope was calibrated with the prepared standards for the respective minerals (Appendices 5, 6 and 7) and the sample solutions and also the blank were run to correct the obtained values. Finally, the mineral content of the samples were calculated by using the following formula.

$$Mineral\ content\ \left({}^{mg}/_{100g}\right) = \frac{[(Cs - Cb) \times V \times D]}{10 \times W}$$

Where, Cs = Concentration of the sample, Cb = Concentration of the blank, V = Volume (ml) of the extract, W = Weight of samples, D = Dilution factor

3.10. Alcohol analysis

The ethanol and methanol contents of the *cheka* samples were determined by a gas chromatography method. The samples were prepared according to the method developed by Tangerman (1997). The gas chromatographic conditions were set following the method developed by Wang *et al* (2003).

3.10.1. Sample Preparations

10ml of *cheka* was measured in a plastic test tube and ultracentrifuged for 2 hours at 4°C and 30,000g. About 5ml of the *cheka* supernatant was carefully removed and transferred into a conical polypropylene tube and centrifuged for 1 minute at 10,000g (Tangerman, 1997). The clear supernatants were stored in a refrigerator and later used for the chromatographic analysis. For analysis, the supernatant was filtered through micro filter (0.45m PTFE membrane) into vial (1.8ml).

3.10.2. Standard Preparation and Calibration of GC

An external calibration method was utilized to determine the methanol and ethanol contents of the *cheka* samples. Therefore, series of solutions ranging from 0.1-15% and 0.005-2% were prepared to make a standard calibration curves for ethanol and methanol (Figure 2 & 3), respectively. The solutions were stored in a refrigerator at 4°C. The limit of detection (LOD) and limit of quantitation (LOQ) were determined by multiplying the standard deviation obtained from 10 repeated injections of solutions with low concentrations of 0.005% (methanol) and 0.1% (ethanol) by 3 and 10, respectively. The recovery test was done by spiking a known amount of methanol (0.5ml and 5ml of 1% solution which were equivalent to 5µl and 50µl, respectively) and ethanol (0.5ml and 5ml of 5% solutions which were equivalent to 25µl and 250µl) into 10ml of *cheka* (Wang *et al.*, 2003).

3.10.3. GC Conditions

Ethanol and methanol analysis were performed using Shimadzu GC 2010 Plus gas chromatograph which was equipped with an FID detector, AOC-20i+S autosampler and with a GC solution software for data handling system. The length, inner diameter and film thickness of the column were 30m, 0.25mm and 0.25µm, respectively. The flow rates of H_2 and N_2 gas were set at 30 and 300ml/min, respectively. The temperatures of the FID detector and the injection port were set at 300°C and 225°C, respectively. The column temperature was set initially at 45°C for two minutes and then ramped at a rate of 45°C/min to the final 245°C. The injection volume was limited to 1.0µl using split injection mode (Wang *et al*., 2003).

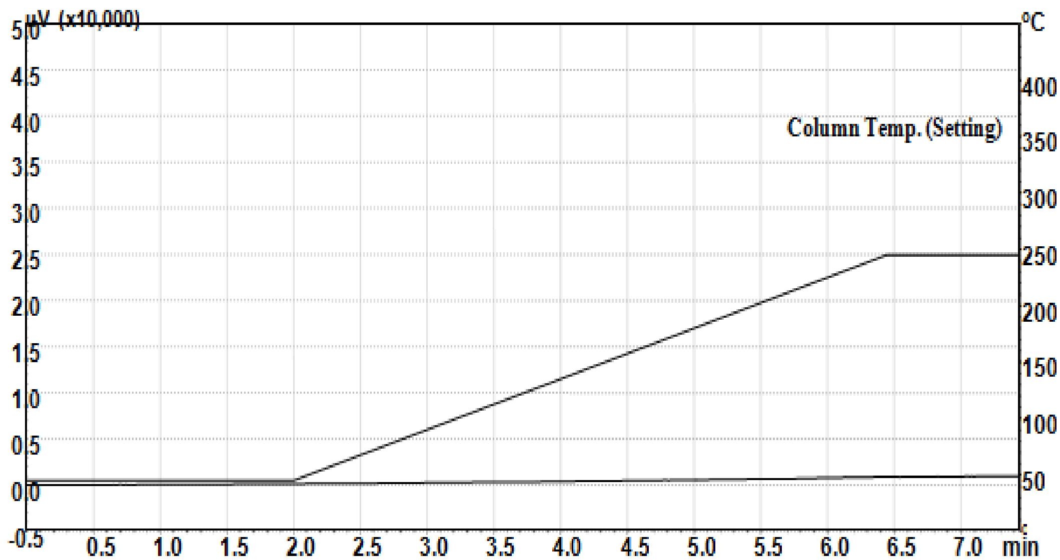

Figure 2. Column Temperature Setting

3.11. Data analysis

Determinations were done in duplicates for the need of statistical analysis. Data were computed using SPSS (version 20) statistical software packages. Data were expressed as mean ± standard deviations of the replicate determinations. One way analysis of variance (ANOVA) was used to study the significant difference between the samples with respect to the studied parameters. Least significant difference (LSD) at $P < 0.05$ was used to determine which means were significantly different.

4. RESULTS AND DISCUSSION

4.1. Indigenous processing methods

4.1.1. Respondents' Personal Information

All participants of this study were women, because both in Konso and Dirashe, *cheka* production is considered to be the art and responsibility of women and almost all processing operations are carried out by them. The respondents consisted of housewives (13.3%), *cheka* sellers (43.3%), merchants (31.1%) and government employees (12.2%) and the majority of them were Orthodox (39.0%) and evangelical Christians (42.0%). Almost all informants in Konso districts were Afan Konso speakers whereas Dirashigna (26.7%) followed by Amharic (16.0%) and Kusumita (10.0%) were spoken by the respondents in Dirashe. With respect to education, they were majorly illiterate (49.6%) and below grade 7 (Table 3).

Table 3. Socio-demographic characteristics of the respondents

Demographic characteristics	No. of respondents	Percentage
Age		
≤ 25	13	14.4%
26-35	23	25.6%
36-45	29	32.2%
46-55	16	17.8%
>55	9	10.0%
Language	90	100%
Afan Konso (Konsigna)	40	44.4%
Dirashigna	24	26.7%
Kusumita	9	10.0%
Amharic	17	18.9%
Religion	90	100%
Orthodox	39	43.0%
Protestant	42	48.0%
No religion/traditional belief	9	8.0%
Occupation	90	100%

Housewives (do not sell cheka)	12	13.3%
Cheka sellers	39	43.3%
Merchants	28	31.1%
Government employees	11	12.2%
Level of educational	90	100%
Illiterate	41	49.6%
Grade 1-6	25	25.6%
Grade 7-12	18	16.0%
Certificate/Diploma	6	8.8%
Total	90	100%

4.1.2. Raw Materials Utilized for the Preparation of *Cheka*

Cheka is a cereal-based fermented beverage mainly prepared from sorghum (*Sorghum bicolor*) and maize (*Zea mays*). People in Dirashe district use leafy vegetables such as cabbage (*Brassica spp*.), moringa (*Moringa stenoptella*) and decne (*Leptadenia hastata*) for preparing *cheka*. In addition brewers in some localities utilize root part of taro (Table 6). But people in Konso district only use the leaf part of taro in addition to cereal crops. In some localities, few households also use dried edible leftovers of *injera*, *kitta* or *kurkufa*. This mean cheka fermentation can salvage waste food which otherwise would not be usable as food and increases the range of raw materials available as food. During focus group discussion, the informants disclosed that few brewers use hop to make *cheka* taste bitterer as consumers judge bitter *cheka* as of good quality. White sorghum was the most preferred cereal in both localities. However, most *cheka* producers at Konso and in some kebeles in Dirashe tend to use maize due to low production and relatively higher market prices of sorghum. During this survey, the market price of maize was 4 birr/Kg at Dirashe and 6 birr/Kg at Konso, White sorghum 5-5.6 birr/Kg at Dirashe and 6-9 birr/Kg at Konso, red sorghum 5 birr/Kg at Dirashe and 6 birr/Kg at Konso and barley 20-26 birr/Kg at both localities.

Table 4. Raw materials utilized for *cheka* preparation

Unmalted ingredients		
Types of ingredient	No. of Respondents	Percentage
Maize	25	27.8%
Sorghum	21	23.3.2%
Mixed (maize and sorghum)	44	48.9%
Total	90	100%
Malt		
Maize	38	42.2%
Sorghum	22	24.4%
Mixed (including barley and millet)	30	33.3%
Total	90	100%
Vegetables utilized		
Not use vegetables	10	11.1%
Leaf cabbage	34	37.8%
Moringa	14	15.6%
Decne	7	7.8%
Taro leaf part	15	16.7%
Taro root part	10	11.1%
Total	90	100%

In fact, most *cheka* producers (48.9%) use a mixture of cereals for *cheka* preparation since they have more than one farm and therefore, can produce different cereal crops during one production season. In addition, they use a mixture of cereals because they believe that the quality and sensory properties of good cheka is determined by the type and combination of cereals utilized. For instance, brewers in most localities reported that if maize is exclusively utilized, the prepared *cheka* become sour before expected time and on the other hand, if only red sorghum is used, the *cheka* took much time to become mature. For this reason, even when utilizing maize as a main ingredient they mix some amount of red sorghum. However, maize is frequently utilized for producing Konso *cheka* which needs short fermentation period (usually 2-4 days). Focus group discussion revealed that people used to use grain grits during early stages of *cheka* preparation to facilitate fermentation of leafy vegetables and prevent the development of unpleasant odor. But now only flour is being utilized at all phases of fermentation.

Malt for the production of *cheka* is prepared from maize, sorghum, barley (*Hordeum vulgare*) and finger millet (*Eleusine coracana*) or a mixture of these cereals. The latter two cereals always are not utilized alone and barley could be utilized as malted or unmalted ingredient. About 38% (Table 4) of the respondents reported maize was the most appropriate raw materials for malt. According to the brewers barley is utilized to make the *cheka* more alcoholic and taste strong and it is often used in small quantities. The ingredients utilized and their possible combinations were found to vary within and between households regardless of localities and processing methods employed. The proportion of malt to unmalted ingredients varies with the processing method, climatic conditions and strength of the product of second phase of *cheka* fermentation. The proportion of the malt used during the whole phases of *cheka* fermentation varies between 20 and 25% of the total unmalted ingredients. The raw materials utilized for *cheka* preparation are selected based on availability, price, purpose of production (e.g. for home consumption, social events, etc.), processing method to be employed and preferences of the brewers. Seasonal variations in the price of various cereals also affect the choice of ingredients in both localities.

4.1.3. Preparation of Malt

Malt used for *cheka* preparation can be prepared from a single or mixture of cereals (Table 4). Cereals stored in silos if not damaged by pests such as weevils are appropriate for malt preparation. Some cheka producers also use grains stored underground for few weeks to a year after harvesting. However, the latter greatly depends on the initial quality of the grains and quality of the soil where the pit is dug. As the cereal crops are threshed manually by beating harvested grain heads with thick wood rods on the soil, they are more likely to contain broken seeds and extraneous materials. So brewers usually start malt preparation by separating these foreign materials including broken and pest damaged grains through winnowing and flotation method during soaking. After cleaning, the grains are steeped in water overnight for sorghum, barley and finger millet but it requires 24 hours for maize. In case, maize is mixed with other cereals for malt preparation, the soaking time is reduced from the usual 24 hours. This is because other cereals absorb excess water and become spoiled instead of sprouting.

The steep water is poured out and/or drained off when storing in a sack. Historically, the swollen grains were allowed to germinate in a basket while covered with leafs of castor oil or ensete. The duration of germination varies with the type of cereal used and the interest of the brewer. In most areas, the germination takes 2-3 days for all cereals. However, some producers in Konso allow the grains to germinate for more than 4 days at ambient temperatures so that mold could develop which is desired for foam formation. In this case, the sack is tightly wrapped in order not to allow excess air to enter into the sack. After four days, the sack is opened for about 2 minute and again wrapped for extra 3-4 days. The germinated grains are then spread out on an animal hide, a sheet of plastic material or mat made of leaves of *Phoenix reclinata* and let to dry in the sun for 2-5 days depending on weather conditions and stored in a dry place until required.

Depending on the volume of cheka to be produced, the entire malt or its portion can be milled for immediate use. Some brewers mix the malt with unmalted barley when they need to mill it. In few villages and under some situations like scarcity of modern flour mills, grinding stones are still utilized for this purpose. According to the informants opinion, well milled flour is highly desired for *cheka* preparation since it results in less *atella* (sedimented solid residue being left at the bottom of the container after a person drinks the *cheka*) which is usually given to domestic animals. None of the respondents utilize wet malt that was reported to be used in borde preparation (Abegaz, 2002a).

4.1.4. Source of fuel and Equipment Utilized for *Cheka* Preparation

Cheka producers depend on firewood and dry crop residues such as maize or sorghum stalks, straw and corncob. Locally available rudimentary equipment is used by producers for traditional preparation of *cheka*. Large clay pots (*gan or insira*), plastic containers or metal barrels (whose capacity varies from 50 litres to 200 litres), plates, bowls made from woods (*Gebete*) and car tires, plastic, gourd and metal bottles, grinding stones, baskets of varying shapes and sizes made from bamboo and sieves made from leafs of *Phoenix reclinata* (*Yezembaba kitel*) and circular flat metal mesh, traditional pestle and mortar made from wood and plastic buckets are used. Traditional circular flat trays made by interweaving bamboo splints are utilized when cleaning grains. Modern flour mills are available for milling purpose but grinding stones are still used for milling fermented vegetables and malt in some villages. Metal and clay pots of different size are used for cooking fermented products and boiling water during cheka preparation and consumption. Large gourd bottles with long necks (10-15 litres), plastic jars and clay pots (10-25 litres) are used for transporting *cheka* to farm for workers as well as in case of social events such as wedding and funeral ceremonies. Depending on age a single person may use small screw-cap plastic bottles and gourd bottles or jars (2-5 litres) when going to farm or looking after livestock. At villages and market places *cheka* is served in plastic or metal containers (cans) and gourd bottles (not long necked) whose capacity is approximately 1 litre. The following table shows list of equipment and their uses in *cheka* processing operations.

Table 5. Cheka processing operations and equipment utilized for the purpose

Operations	Equipment
Drying of grains and malt	Plastic sheets, animal hide, mats, mosquito net, blanket
Malt preparation	Metal pots, bucket, bowl, sack, baskets
Cleaning of grains	Traditional flat trays (*sefed*), mortar and pestle
Milling	Flour mill, grinding stones
Filtering and sieving	Traditional sieve (*wonfit*)
Fermentation of leafy vegetables	Small traditional bowl, buckets, plastic plates, broken clay pots or jars
Cooking and boiling	Metal pots, barrel, insira
Crashing of dough balls	Beer bottle, cylindrical stone, pestle-like wood (*tomambyta* or *korya kabotat*)
Main fermentation and storage of cheka	Large bowl, plastic container, barrel
Serving utensils	Small metal or plastic containers, gourd bottles

4.1.5. Description of the Methods and Steps in Cheka Preparation

Three methods of *cheka* preparation were identified in the study areas depending on the duration of fermentation and sensory properties of the final drinkable product. The methods of preparation are very complex and varied within household and among households, villages and localities. The duration of fermentation varies from 12 hours (½ day) for *menna* to months for *parshota or hiba*. Methods with short duration of fermentation are mostly used by brewers who produce *cheka* for sale. In some instances, *cheka* prepared for home consumption might be quite different from *cheka* prepared for sale. Most respondents informed that *cheka* prepared for home consumption differs in some ingredients from the one produced for sale. In all study areas, *cheka* fermentation occurs under ambient temperature (25-37^{o}C) with the microbial flora of the raw materials and the product of the third phase is consumed after standing for about 5 to 12 hours. There was a variation among respondents opinion concerning proportions of raw materials utilized for *cheka* preparation. This made the estimation of the amount of the ingredients and water used problematic. The type and proportion of ingredients depend on the volume of *cheka* to be produced, the availability of the ingredient and type of the *cheka* being produced. The amount of malt added during phase III of *cheka* fermentation is highly dependent on the power of the product of the second phase.

4.1.6. Proportion of the Ingredients and Steps Involved in the Preparation of Konso Cheka

This method of *cheka* preparation is commonly used by almost all producers in Konso and Gato kebele from Dirashe. In Konso language, it is named '*Chaqa*', but Dirashe people call it '*Fasha'*. Most women in Dirashe who sale *cheka* are currently shifting to this processing method because it is simple and requires short preparation time (about four days). *Cheka* prepared in this way tastes relatively less bitter than Dirashe *cheka* and usually forms yellowish foam when diluted with warm water. Besides, it very often becomes sour within two days. The relative proportions of the ingredients in preparing Konso cheka are presented in Table 6.

(a) **(b)**

Figure 3. (a) Konso *cheka* when diluted with warm water and (b) Konso *cheka* when diluted with cold water (Photos taken by the investigator)

Phase I

At the beginning, grain flour is thoroughly kneaded with water in *gebete* and allowed to ferment for 36-40 hours. For home consumption and occasionally for sale, brewers in Konso use the leaves of taro to produce *cheka*. In this case, taro leaves are chopped and cooked in a metal or clay pot. The overcooked taro leaves are allowed to ferment for about 6 days in a gebete. The fourth day, the fermented product is mixed with a handful of malt and left to ferment for extra 2 days. Brewers believe that the added malt facilitate the decomposition of the leaves. After that the fermented taro is mixed with fresh flour as usual and is kneaded with water which also ferments for 36-40 hours. This fermenting material is commonly referred to as *pulota*.

Table 6.The proportion of ingredient during each phase of Konso *cheka* fermentation

Ingredients	Proportion (w/w or w/v)	Involved phases
Chopped cooked taro leaves (cooked) : malt : water	0.5 : 0.2 : 0.2	Phase I
Grain four: Fermented taro leaf : water	5 : 0.6 : 4	Phase I
Pulota : kneading water : cooking water	7 : 0.5: 4	Phase I
Cooled smashed dough balls : malt : kneading water	9 : 1.4: 1	Phase I
Sokatet: diluting water	9 : 2.5	Phase II
Grain flour : boiling water for porridge preparation	5 : 3.5	Phase II
Sokatet : porridge : Malt: Water for mixing	9 : 1.4 : 1: 2	Phase II

Phase II

Approximately after 36 hours, the fermented product (*pulota*) is kneaded with little or no water and then made into dough balls (*qabot*). The dough balls shouldn't be less or much moistened. If the balls are less moistened, they become uncooked at the centre and if too moistened they are too tiresome for kneading. During cooking, pieces of dried hop wood are placed at the bottom of the pot or barrel and excess water is added to prevent the dough balls from burning. If a lot of balls are prepared, most brewers add the dough balls thrice at an interval of 10-15 minutes. The balls are added when the water is boiled (93-95.5 ^{o}C) and the barrel or pot is covered with a lid or a gourd that fits the pot. The dough balls are cooked for about 45 minutes to 1 ½ hours depending on the amount of balls and intensity of the fire. Cooking of the dough balls in water would be expected to gelatinize cereal starch granules and thereby increase the efficiency of starch degradation by amylase. The process of gelatinization occurs over a temperature range depending on the type and size of granules and starch to water ratio. Leaching of amylose occurs during gelatinization and thus create available carbohydrate for the proliferation of fermentation microorganisms. (Liu *et al*., 1999; Fennema, 1996). Brewers often insert stick into the balls to check whether they are cooked well or not.

When the dough balls are cooked well producers take one ball at a time and dip their hands quickly into water in a container handled by the other hand to avoid damage to them. Then, the *qabot* is smashed in *gebete* using a beer bottle or a round-headed (pestle-like) material made from wood called *tomambayt*. Once the dough balls are broken down into pieces, they are kneaded with little water and spread on a plastic sheet, large sized gebete or a bed made from wood to cool for few minutes to 7 hours. However, the time of cooling not only depends on the amount of the product, but also the thickness of the product spread on the plastic sheet or gebete. After cooling, it is mixed with adequate milled malt, thoroughly kneaded and allowed to ferment overnight in a *gebete.* Most brewers also spread a handful of malt on the surface of the kneaded product. The proportion of malt added during this phase can be as high as 25% of the unmalted ingredient. Next day early in the morning, the product is transferred into large fermentation vessel (barrel or *rotto*); water is added and then well mixed together.

Phase III

On the same day the *Sokatet* is transferred into large containers and mixed with water, a very thick porridge (*koldhumat*) is prepared by pouring boiling water (94.5-97^{O}C) on to flour in *gebete* and thorough mixing using a material made from wood for this purpose or a flat cattle bone (Scapula). The porridge is allowed to cool to room temperature for 5-7 hours and malt is kneaded with the cooled porridge. The respondents indicated that the amount of malt added at this stage depends on the strength of the *sokatet* and amount of *cheka* being produced. If the *sokatet* tastes much bitter, small quantity of malt is added or otherwise it would increase. Then, the *koldhumat* is added into the vessel containing the *sokatet*; sufficient water is added and is thoroughly mixed together using a thick stick with flat end. In some cases, brewers use their hands to mix the two products and also to adjust the consistency of the mixed product. The *cheka* is ready for consumption after 4-12 hours of fermentation. *Sokatet* can be stored for more than a week and so brewers may utilize a portion of it for preparing *cheka* for home consumption.

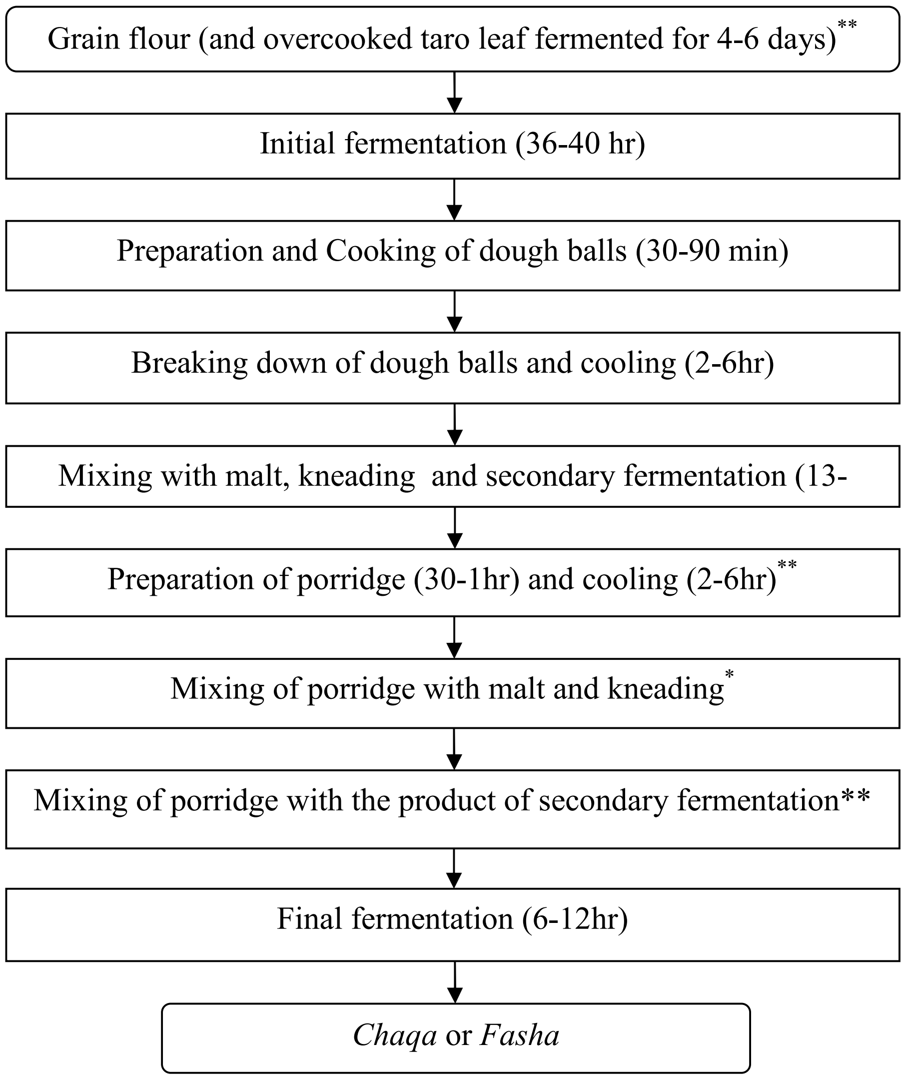

Figure 4. Flow chart for traditional preparation of Konso *cheka*

*Some water is used   **Much water is use

4.1.7. Proportion of the Ingredients and Steps in the Preparation of Dirashe *Cheka*

This type of *cheka* is commonly produced in most villages of Dirashe district and has very complex and time-consuming operations (Figure 6). The methods of preparing this type of *cheka* greatly vary between villages. *Cheka* prepared following this preparation method tastes a little bitter than Konso cheka and have whitish to greenish foam depending on the type of cereals used and the presence or absence of green leafy vegetables. People in Dirashe districts call this type of *cheka parshota* or *hiba*. The relative proportion of the ingredients is presented in Table 7.

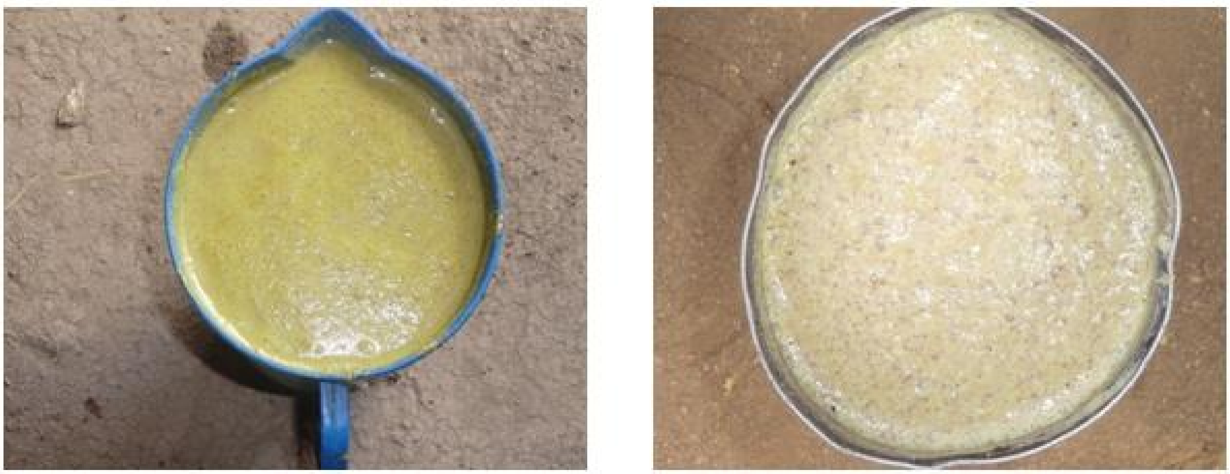

Figure 5. Dirashe cheka (Photos taken by the investigator)

Phase I

In phase I, leaf cabbage is chopped into pieces with traditional double-bladed knife prepared only for this purpose. The chopped cabbage is put in a bowl or bath and little quantity of water is sprayed on it. Then, it is tightly covered with leaves of ensete or plastic sheet. Some producers spread small quantity of flour on the surface of cabbage. These prevent the entry of air that otherwise causes the fermenting cabbage develop bad odor which could be sensed by consumers during consumption. The cabbage is allowed to ferment for 4 to 6 days and is then blended with small quantity of flour. In the past, people used to use grain grits for the same purpose. After fermenting for additional 2-3 days, the fermented cabbage is milled with a grinding stone. The milled product is blended with excess water in a bath and is sieved through *wonfit* (traditional sieve). The filtrate is mixed with fresh flour, exhaustively kneaded and is allowed to ferment overnight. Some brewers may blend cooked and smashed taro roots kneaded with little flour and the fermented product.

However, several brewers in the low land areas of Dirashe allow the chopped cabbage, leaves of moringa or decne to dry and then mill them with few kilograms of grains and dried food leftovers, if any. Then, the flour is kneaded with water and allowed to ferment for at least 1 month while being uncovered. But the fermenting product should be kneaded with little amount of water with an interval of 2-3 days. Respondents reported that if it is neglected even for about five days, larvae appears on the product because after four days insects including flies start to settle on it and lay their eggs in the cracks formed as it is dehydrating. In addition, the product may develop undesirable odor. When leafy vegetables are unavailable, only flour can be used and the fermentation time is relatively short. The fermented product is then blended with fresh flour one day earlier before the day it is desired to cook.

Table 7.The proportion of ingredient during each phase of Dirashe *cheka* fermentation

Ingredients	Proportion (w/w or w/v)	Involved phases
Chopped cabbage or cooked taro roots or decne (flour of dried moringa leaf + grain flour) : water	0.6 (1.4*) : 0.2 (1*)	Phase I
Grain four: Fermented vegetable : kneading water	5 : 0.8 (2.4*) : 4	Phase I
Pulota : kneading water : cooking water	9 (10.4*) : 0.5: 4	Phase I
Cooled smashed dough balls : malt : kneading water	9 : 1.4: 1	Phase I
Sokatet: diluting water	9 : 2.5	Phase II
Grain flour : boiling water for porridge preparation	5 : 3.5	Phase II
Sokatet : porridge : Malt: Water for mixing	9 : 0.9 : 1: 2	Phase II

*When using dried vegetables

<u>Phase II</u>

In this stage, pieces of dried hop wood or peeled barks of some plants are placed at the bottom of clay pot or barrel and excess water (over 20 litres) is added to prevent the dough balls from burning. The fermented product is moulded into dough balls and added into the boiling water. The cooked dough balls are then smashed with a stone, beer bottle or a wood whose one end is made into ball shaped to easily crash the balls. After cooling, it is mixed with adequate malt, thoroughly kneaded and allowed to ferment overnight in a *gebete.* Next day early in the morning the product is transferred into large fermentation vessel; water is added and well mixed. Some people in Dirashe district would also like to consume this product and it is usually given to respectable people such as hard-workers and close relatives.

Phase III

In phase III of fermentation, *hanshalt* (which is an equivalent word to koldhumat) is prepared on the same or very often in the next day the *sokatet* is transferred to large fermentation vessel. Most brewers tend to prepare the thick porridge on the second day after cooking the *kabot* because they believe that doing so reduces the likelihood of failure as there is enough time for the *sokatet* to become mature which is recognized by bitterness. Similar to Konso *cheka* the amount of malt being added depends on the strength of the product of the second phase and the amount of *cheka* being produced. As the duration of fermentation in the preparation of *hiba* is too long, the *sokatet* becomes much bitter and as a result the amount of malt added into *hanshalt* in the preparation of *fasha* is slightly larger than for *hiba* and also the proportion of the *sokatet* in the final product is much greater than *hanshalt* in *fasha*.

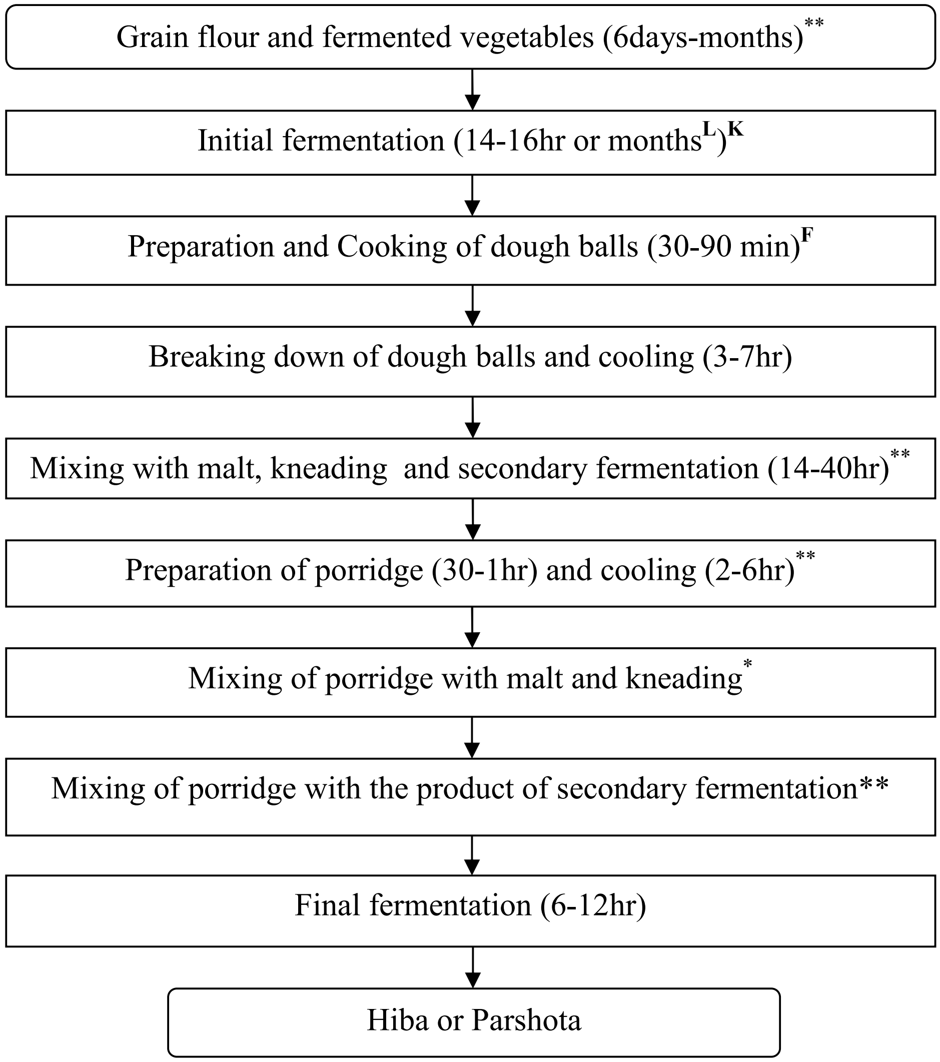

Figure 6. Flow chart for traditional preparation of Dirashe *Cheka*

*Little water is added **Much water is added

F-Introduction of fresh flour one day earlier when it is desired to cook the dough balls in the case of *cheka* preparation in the lowland areas of Dirashe

K-Kneading the fermenting product every 2 to 3 days to avoid dehydration of *pulota* and the development of unpleasant odor in the case of *cheka* preparation in the lowland areas of Dirashe

L-Duration of flour fermentation in the case of *cheka* preparation in the lowland areas of Dirashe

4.1.8. Steps in Preparation of Menna

Menna is being prepared by majority of the brewers in both localities and especially on a regular basis during times of shortage. Consumers derived its name from the biblical word 'Manna' to mean safe to drink for Christians. This type of cheka is simple to prepare (Figure 7)and is considered to be low in alcohol content and hence, it is commonly consumed by children and followers of some religions such as evangelical Christians. However, it is utilized by people of all ages whenever there is no *hiba* or *fasha*. In Konso *menna* is called '*madhot*' but in Dirashe it is named as '*Poh-kedha*'. The relative proportion of the ingredients in preparing this type of cheka is presented in the following table.

Table 8. Proportion of ingredients during menna preparations

Ingredients	Proportion (w/w or w/v)
Grain Flour : boiled water	5 : 3.5
Porridge : malt : diluting water	5 : 0.1 : 2.5

During *mena* preparation, a very thick porridge (*muqe*) is prepared from flour in a similar way as done in the third phase of *hiba* or *fasha* fermentation. However, some households may prepare *muqe* with a relatively thin consistency. After cooling, it is mixed and kneaded with relatively small quantity of malt. Water is added as necessary to ensure that the product has desired consistency. The cheka prepared in this way becomes ready for consumption after fermenting overnight. This type of cheka has no foam, sweet-sour taste and short shelf-life (1-2 days).

However, the preparation of *menna* by some brewers slightly varied from the previous method. In this case, flour is kneaded with water and is fermented overnight. The fermented product is then made into dough balls and cooked. The balls are broken down, kneaded and allowed to cool as usual. After cooling it is kneaded with adequate malt and allowed to ferment overnight. Porridge is prepared in the next day and is kneaded with additional malt after cooling. After that it is mixed with the product of the prior phase in the main fermentation vessel and fermented overnight similar to *fasha* or *hiba*. This results in *menna* with relatively high alcohol content comparable with that of fasha and thus, people literally call it '*false menna'*.

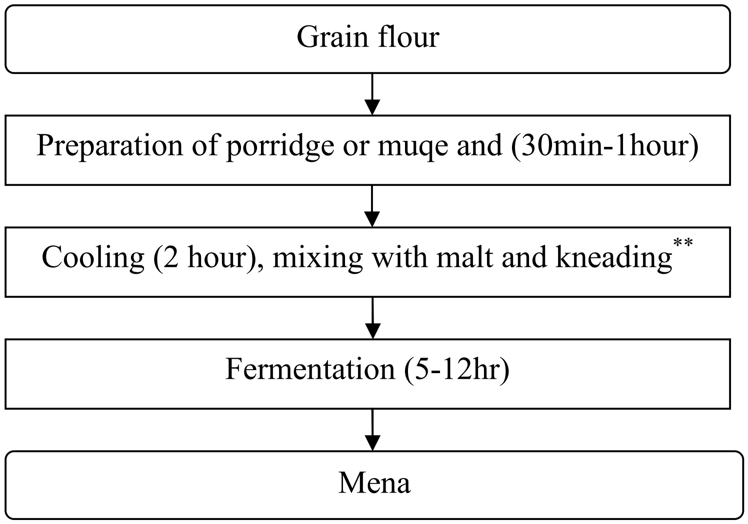

Figure 7. Flow chart for traditional preparation of mena

4.1.9. Sensory Properties and Consumption Pattern of *Cheka*

Cheka is produced in both rural and urban communities of Dirashe and Konso for household consumption, income generation and also for special occasions like *debo*, *waleta* (a group of affluent people who have good contact so that they invite one another to drink cheka together), mahiber, wedding and funeral. The way of preparing *cheka* differs as between households, ethnic groups and depends on tradition, economic situation and consumer preferences. According to the respondents the sensory properties of cheka varies with the type of *cheka* and raw materials utilized. However, the *cheka* which is often produced for sale and at special occasions should have a bitter taste, yellowish to green foam, refreshing aroma, consistent texture, a very small residue (*atela* which is given to animals) and a fairly longer shelf-life. In addition, it shouldn't contain excess foreign materials such as chaff, dead weevils or other else even though it is consumed unfiltered. Brewers in Konso villages and Gato kebele who produce *fasha* indicated that increasing the proportion of malt during the third phase of fermentation adds to the bitterness and overall quality of *cheka* whereas producers in Dirashe believe that addition of excess malt makes the cheka sourer within a day.

Unlike *borde* which must be consumed within a day (Abegaz, 2002a), *cheka* has a shelf-life of 2 to 4 days. But it is usually produced on a small-scale basis to avoid loss and if it is produced following Konso's processing method, it should preferably be sold within one day because consumers usually wouldn't like to drink *cheka* on the next day once it is ready for consumption.

Quality deterioration starts when the active fermentation slows down and the sparkling foam doesn't appear on the surface of *cheka*. In both districts, *cheka* is retailed only at vendors' house and is often consumed locally. At times of scarcity people also consume a very sour *cheka* either by diluting with excess water or mixing it with fine ash separated through sieve. But, some people currently use orange powder to make cheka less sour. Up on addition in both cases (ash and orange powder) the *cheka* starts to form foam and tastes less acidic. The neutralising effect of ash on sour *cheka* would be because wood ashes to some extent may contain the oxides and carbonates which serve as liming agents, raising pH and thereby helping to neutralize acidic *cheka*. Most people in Dirashe like to drink sour cheka and are often suffer from stomach ache and other health problems. Smooth and reddish lower lips and skin lesions which are common among Konso people and some Dirashe people were attributed to sour *cheka* and *arake*.

Cheka drawn from fermentation vessel is very thick and is normally diluted with cold or warm water (boiled at 65-80^{o}C; especially in Konso and some villages in Dirashe like Gato and Gidole) during serving. It is consumed daily by both adults and children as a drink and meal replacement. In the study areas, solid foods are not available during day time at most households and as a result it is *cheka* that is consumed all day long. Most people particularly adults start drinking it early on an empty stomach and people in Konso on average drink 3-5 litres of *cheka* per day but, in Dirashe adults can drink up to 8 litres per day. Since it can be obtained for free in most villages of Dirashe district, the amount a single individual drinks per day may go beyond 8 litres.

Although most mothers do not give cheka for their under 1 year's infants due to its high alcohol contents, children die due to *cheka* as few caregivers try to give it to infants even less than 8 months and usually not on demand. Based on the informants' opinion, what matters is not only giving *cheka* for infants but also the feeding practice. Care givers hold one of their hands beneath the lower lip of the child to contain the cheka and after adding the *cheka*, they close the nose of the child with the other hand in order to prevent the entry of *cheka* via nose. During this moment, the child is struggling to breath and this increases the likelihood of the child being choked. Even during this survey, a child of about 8 months old has lost his live due to this practice in one of the survey areas called *Shelele* kebele.

Both in Dirashe and Konso, drinking *cheka* is a common feature of social gatherings. Brewers and consumers reported that *cheka* is consumed in large quantities at collective work gatherings (*debo*), on market days and possibly on weekends and at special occasions. In rural communities of Dirashe, it is common that parents of a marrying man write letters to their close relatives to help them with *cheka* to be served for the invited people on the wedding and accordingly every requested household provides up to 6 jerry cans or clay pots (20-25 litres each) of *cheka*. Some people also willingly supply 1-2 jerry cans of *cheka* on other occasions like funerals. These indicate that cheka plays a vital role in building the social interaction of the society.

Cheka is considered as a low-cost meal (about ETB 2 per litre) for low-income people including government employees who cannot afford factory produced beverages and restaurant foods. *Cheka* and *kurkufa* (a dish prepared by cooking leafy vegetables particularly moringa and rounded balls of maize, sorghum or wheat flour) are believed to enhance lactation and thus, lactating women are encouraged to use them. Those consumers who drink excess *cheka* and additionally use other alcoholic beverages such as *arake* do not eat other solid foods. These indicates that dependence on *cheka* alone can affect the nutritional well-being and general health of individuals. However, most *cheka* consumers eat other foods like *nufro* or *nufiti* (salted boiled maize and/or haricot bean), *kurkufa, kitta* (unleavened bread) and *kollo* (roasted maize, chickpea, sunflower or their combination). Ground chili pepper spiced with ginger, garlic, coriander, rue, basil and salt and sometimes mixed with raw tomato or cooked vegetables is served with *cheka* as appetizers and to reduce satiation. Usually people in the study areas eat the cooked dough balls and also drink the product of phase II (*sokatet*).

4.1.10. Economic Importance of Cheka and Constraints in Its Production, Utilization and Marketing

Cheka is a good source of economic opportunity in particular for the women as its preparation is not physically demanding. The cost of entry to *cheka* vending is minimal and generally uses local raw materials from the farm and local markets. By just selling cheka, rural women earn income for their family and basically for themselves. Some producers in Karat, town in Konso, sell *cheka* on a daily basis and most producers in both district sell *cheka* twice per week or every other day. On a single day a given woman can produce up to 1000 litres of *cheka* which can generate a profit over ETB. 400. By virtue of *cheka*, she can also sell other foods such as *kollo*, tomato and cooked leafy vegetables and boiled haricot bean (separately or mixed) which help her to get extra income. Since the cost of raw materials and fuel in the study areas is fluctuating with seasons, the profit a brewer gets from cheka sale can be variable. Most informants in rural communities of Dirashe reported that they usually do not get a fair profit from cheka if their labour and cost of fuel is considered.

Atella (residue of *cheka*) is used to enhance the livestock nutrition and is believed to improve their health particularly in times of feed shortage, thereby strengthening the livelihood system. As *cheka* fermentation involves labour intensive activities such as milling fermented vegetables and kneading, it serves as source of both direct and indirect employment for women. In Karat and Gidole (town in Dirashe), two or more women are employed per household that cover the major complex tasks of *cheka* fermentation. These women get paid and besides obtain their daily meal from there. In some cases, if the brewer cannot provide solid foods that consumers take while drinking, neighbouring women may help with it and indirectly generate money for herself. Moreover, *cheka* fermentation has played a huge role in gender development. In rural communities of Dirashe and Konso, women who produce quality *cheka* are given more status and have a greater say in a family and community.

Although *cheka* serves as source of cash for households, the short keeping quality of *cheka*, lack of clean water, electricity and fire wood, seasonality of *cheka* marketing (particularly in rural communities), inconsistency in the product quality and lack of encouragement from masculine family members are the major challenges which reduce the profitability of *cheka*. In most rural communities of Dirashe especially during harvesting and threshing seasons, people can get *cheka* for free. Consequently, brewers who depend on *cheka* vending cannot get enough customers during such times and become non-profitable. For this reason and others, most women in Dirashe do not engage in *cheka* marketing.

4.2. pH and Titratable Acidity

pH and titratable acidity are one of the most important parameters that determine the flavor and shelf-life of a food product. While total acidity is a better predictor of acids impact on flavor, pH affects the growth of microorganisms present in the product and other properties of food such as chemical reactivity (Sadler, 2010). In this study, the pH and titratable acidity of the *cheka* samples ranged from 3.53-3.99 and 0.77-1.11%, respectively (Table 9). Although the samples coded as, K2 (3.53) and K3 (3.55) had the lowest pH value, they did not significantly differ from samples coded as K1 (3.58) and G3 (3.68). The samples S2 (3.99), S3 (3.89) and G1 (3.95) had the highest pH value and no significant difference (P>0.05) was observed among them. K1(1.11%) had the highest percent titratable acidity followed by K2 (1.07%) and K3 (1.01%). No significant difference was found between S1 (0.91%), S2 (0.91), S3 (0.89), G2 (0.90%) and G3 (0.86). The *cheka* produced in the laboratory had pH of 3.91 which was comparable with the pH of the samples S2, G1, and S3, but it had significantly (P<0.05) lower percent titratable acidity (0.77%) than most of the collected samples. The pH and titratable acidity of *cheka* samples are presented in the table below.

Table 9.The pH and Titratable Acidity of *Cheka* Samples

Sample code	pH value	% Titratable acidity
K1	3.58 ± 0.08^{cd}	1.11 ± 0.03^{a}
K2	3.53 ± 0.05^{d}	1.07 ± 0.01^{a}
K3	3.55 ± 002^{d}	1.01 ± 0.01^{b}
S1	3.76 ± 0.08^{b}	0.91 ± 0.03^{c}
S2	3.99 ± 0.04^{a}	0.91 ± 0.01^{c}
S3	3.89 ± 0.03^{a}	0.89 ± 0.02^{c}
G1	3.95 ± 0.06^{a}	0.80 ± 0.03^{d}
G2	3.72 ± 0.05^{b}	0.90 ± 0.03^{c}
G3	3.68 ± 0.02^{bc}	0.86 ± 0.01^{c}
CL	3.91 ± 0.17^{a}	0.77 ± 011^{d}

- K1, K2 and K3 are samples collected from Karat
- S1, S2 and S3 are samples collected from Shelele
- G1, G2 and G3 are samples collected from Gidole
- CL-*Cheka* prepared in the laboratory
- Values in each cell are mean ± standard deviation of duplicate determinations
- Means in the same column with different letter superscripts indicate significant differences (p<0.05).

Generally, samples from Konso had low pH values and samples from Shelele had the highest pH values. The variation observed between the samples in their pH value could be due to the differences in fermentation time and type of cereals utilized. Based on the finding of this study, *cheka* had low mean pH value of 3.75 than other Ethiopian traditional beverages such as *tella* (Yohannes *et al*., 2013), *tej* (Gizaw, 2006; Yohannes *et al.*, 2013), *borde* (Abegaz, 2002b), *shamita* (Ashenafi and Mehari, 1995), *kerebo* (Rashid, 2013) and arake (Yohannes *et al.*, 2013). On the other hand, ready to consume *cheka* had titratable acidity comparable to *borde* (Abegaz, 2002b) but lower titratable acidity than *kerebo* (Rashid, 2013). Since the pH of the samples where measured once immediately after they had been brought to the laboratory, the investigator believes that the pH of *cheka* can even be lower than the reported values in this study if determined over a period of time until it turns not safe to consume. Evidences point out that the low pH of beverages can rob calcium in skeletal systems and lead to dental caries and osteoporosis (Cairns *et al*., 2002; Mettler *et al*., 2006). Therefore, if the pH of *cheka* drops below the reported values (especially after 2 days of consumption), it can cause harms to the skeletal system of the consumers.

4.3. Nutrient Content

4.3.1. Total Solids Content

The dry matter that remains after moisture removal is referred to as total solids (Sadler, 2010). The total solids content of *cheka* varied between 21.05% (G2) and 26.87% (S3). There were no significant differences (P>0.05) in the total solids contents of K1 (25.47%), K2 (22.44%), K3 (22.67%), S1 (23.83%), S2 (22.81), G2 (23.48%) and G3 (23.11%). The cheka sample prepared in the laboratory (CL) had a total solids content of 22.57% and it did not significantly differ from most collected samples in this parameter. The reason for the variation might be due to the use of different amount of water during any phase of *cheka* fermentation which dilutes the product. As people in the study areas use *cheka* after diluting with sufficient water due to its thick consistency, alcohol content and low acidity, the total solids content of the *cheka* that is being actually consumed by an individual can be lower than the values reported in this study. Depending on the thickness of the *cheka* being served and the desire of an individual, *cheka* can be diluted by 20 to 50% water. For this reason, the amount of nutrients a given person can get per a given amount of *cheka* could greatly vary with the extent to which the *cheka* is being diluted. The total solids content of the *cheka* samples is presented in Table 10.

4.3.2. Crude Protein Content

In this study, it was found that the crude protein contents of the cheka samples ranged from 3.02 to 4.44 g/100g (Table 10). Two of the samples collected from Gidole town (G1 and G3) had significantly ($P<0.05$) high protein content of 4.44g/100g and 4.40 g/100g, in that order and were followed by the sample coded as S3 (4.19) which was collected from Shelele kebele. However, the remaining samples did not significantly ($P>0.05$) differ from one another. The sample produced in the laboratory had lower protein content (3.02g/100g) since no vegetables were utilized. The observed variation among the collected samples from the study areas could be resulted because people in Dirashe oftentimes utilize leafy vegetables which add to the protein content of *cheka*.

Based on the result of this study, one can conclude that the *cheka* samples had high mean protein content (15.68g/100g on dry matter basis) when compared to *borde* and *shamita* which have about 9.55g/100g and 10.37g/100g protein on dry basis, respectively (Ashenafi and Mehari, 1995). Proteins serve vital roles in catalytic and hormonal activities, immune system, oxygen transport, and many other functions in our body (Vaclavik and Christian, 2008). The protein RDA for adults is about 0.8 grams per kilogram of healthy body weight per day (Whitney and Rolfes, 2008). That means if an average adult weighs about 60 kilograms, s/he should get about 48 grams of protein per day from the meal s/he eats. On the other hand, the protein adequate intake ranges from 34g/day for adolescents (9-13 years) to 46g/day for adults (≥19 years). The low protein values (on fresh matter basis) reported in this research indicate that *cheka* can contribute to the daily protein intake of consumers in Konso and Dirashe but should not be exclusively relied on.

4.3.3. Crude Fat Content

Cheka samples had the crude fat contents of 1.17 to 1.81g/100g with samples from Karat having good crude fat content (Table 10). Sample K1(1.81g/100g) had the highest fat content than all other samples whereas samples G1 (1.35g/100g), G2 (1.17g/100g), and G3 (1.37g/100g) had the least fat contents. But statistical analysis of the result showed no significant ($P>0.05$) variation between the samples coded as K2 (1.44g/100g), K3 (1.42g/100g), and S1 (1.42g/100g). The *cheka* sample prepared in the laboratory had a fat (1.49g/100g) content comparable with most of the collected samples. The high fat content of the samples collected from vending houses in Konso might be due to the increased use of maize during *cheka* preparation which is relatively a good source of fat. Fats play many essential roles by yielding energy, enhancing the absorption and storage of vitamins (particularly lipid soluble ones) and along with carbohydrates and proteins constitute the chief structural components of all living cells (Whitney and Rolfes, 2008).

Cheka samples had a mean fat content of 6.11g/100g on dry matter basis which is comparable with the fat content of *borde* (6.88g/100g), but more fat content than *shamita* (3.46g/100g) (Ashenafi and Mehari, 1995). According to the 2005 dietary guidelines (cited in Whitney and Rolfes, 2008), fat should provide 20 to 35 percent Kcalories to the person's daily energy intake. Therefore, the result of this study suggests that consumers cannot meet their daily fat requirement by drinking cheka with no solid foods intake.

4.3.4. Crude Fibre, Total Carbohydrate and Gross Energy Content

The total carbohydrate and fibre content of the *cheka* samples ranged from 14.16 to 19.03g/100g and 0.94 to 1.27g/100g. The results of this study showed that sample K3 (19.03g/100g) had high amount of carbohydrate followed by K1 (18.24g/100g), K (17.57 g/100g), and S1(17.19 g/100g) in that order and no significant difference (P>0.05) existed between these four samples. Even though there were no significant variations between the samples in their fat content, samples from Gidole and Shelele kebele had relatively higher fibre contents than samples collected from Konso. The considerable difference observed between the samples in their carbohydrate and dietary fibre content might be attributed to the differences in the raw materials utilized and/or their proportion in the *cheka* samples.

It should come as no surprise that samples from Gidole had high fibre content as people in Gidole always use leaf cabbage for preparing cheka. On the other hand, the gross energy content of *cheka* samples varied from 82.04 Kcal/100g for G2 to 107.17 Kcal/100g for K3. Significant variation were observed among the samples and generally samples from Gidole (G1, G2 and G3) had low gross energy (Table 10). The *cheka* sample prepared in the laboratory had low fiber but comparable carbohydrate and energy content with most of the collected samples.

Table 10.Proximate composition of the *cheka* samples (g/100g)

Sample code	% Total solids	Crude protein	Crude fat	Crude fibre	Total ash	Carbohydrate	Gross energy (Kcal)
K1	25.47 ± 0.35^{ab}	$3.53{\pm}0.02^{c}$	$1.81{\pm}0.08^{a}$	$1.07{\pm}0.02^{a}$	$0.82{\pm}0.07^{ab}$	$18.24{\pm}0.33^{ab}$	95.59 ± 2.17^{abc}
K2	22.44 ± 1.68^{bc}	$3.38{\pm}0.19^{c}$	$1.44{\pm}0.12^{bc}$	$0.94{\pm}0.09^{a}$	$0.65{\pm}0.03^{b}$	$16.02{\pm}1.24^{bcd}$	$90.60{\pm}5.23^{bc}$
K3	22.67 ± 1.28^{abc}	$3.12{\pm}0.14^{c}$	$1.42{\pm}0.05^{bc}$	$1.00{\pm}0.04^{a}$	$0.76{\pm}0.03^{ab}$	$17.57{\pm}1.08^{abc}$	$107.17{\pm}1.03^{a}$
S1	23.83 ± 0.55^{abc}	$3.51{\pm}0.14^{c}$	$1.42{\pm}0.01^{bc}$	$1.00{\pm}0.02^{a}$	$0.71{\pm}0.01^{b}$	$17.19{\pm}0.36^{abc}$	$103.17{\pm}2.00^{ab}$
S2	22.81 ± 1.33^{bc}	$3.53{\pm}0.15^{c}$	$1.36{\pm}0.11^{cd}$	$1.19{\pm}0.05^{a}$	$0.68{\pm}0.04^{b}$	$16.05{\pm}0.98^{bcd}$	$90.60{\pm}6.85^{bc}$
S3	26.87 ± 0.31^{a}	$4.19{\pm}0.09^{ab}$	$1.59{\pm}0.01^{b}$	$1.14{\pm}0.01^{a}$	$0.93{\pm}0.04^{a}$	$19.03{\pm}0.37^{a}$	$95.60{\pm}5.34^{abc}$
G1	23.48 ± 2.37^{abc}	$4.44{\pm}0.51^{a}$	$1.35{\pm}0.09^{cd}$	$1.24{\pm}0.13^{a}$	$0.76{\pm}0.15^{ab}$	$15.70{\pm}1.48^{cd}$	$92.69{\pm}8.81^{bc}$
G2	21.05 ± 2.40^{bc}	$3.71{\pm}0.34^{bc}$	$1.17{\pm}0.16^{d}$	$1.27{\pm}0.35^{a}$	$0.73{\pm}0.06^{b}$	$14.16{\pm}1.50^{d}$	$82.04{\pm}8.75^{c}$
G3	23.11 ± 1.26^{abc}	$4.40{\pm}0.18^{a}$	$1.37{\pm}0.04^{cd}$	$1.24{\pm}0.07^{a}$	$0.74{\pm}0.11^{b}$	$15.36{\pm}0.86^{cd}$	$91.38{\pm}4.50^{bc}$
CL	$22.57{\pm}2.78^{bc}$	$3.02{\pm}0.43^{c}$	$1.49{\pm}0.10^{bc}$	$1.19{\pm}0.16^{a}$	$0.67{\pm}0.08^{b}$	$16.21{\pm}2.02^{bcd}$	$90.28{\pm}10.68^{bc}$

- All the values are mean ± standard deviation of duplicate determinations
- Means within the same column with different letter superscripts indicate significant differences ($p<0.05$)

Dietary energy is required to sustain the body's functions such as respiration, circulation, physical work and body temperature maintenance. The estimated energy requirement for adults males is about 3067 kcal/day and for adult females is about 2403 kcal per day. It is also recommended that carbohydrate intakes should contribute 45 to 65 percent of total food energy the person eat (Whitney and Rolfes, 2008). On the other hand, the recommended fiber adequate intake for adults varies from 25g/day to 38g/day (Whitney and Rolfes, 2008). The low fibre, total carbohydrate and gross energy of *cheka* necessarily indicates that adults who rely on cheka are still needy for the consumption of other solid foods in order to meet their daily nutrient and energy requirements

4.3.5. Total Ash Content

Ash content represents the total mineral content in foods and can serve as an indirect indicator of elemental content of food products (Suzanne, 2010). The ash content of *cheka* samples ranged from 0.65-0.93g/100g. The sample coded as S3 had the higher ash content (0.93g/100g) than samples K2 (0.65g/100g), S1 (0.71g/100g), S2 (0.68g/100g), G2 (0.73g/100) and G3 (0.74g/100g), but it did not significantly ($P>0.05$) differ from K1 (0.82), K3 (0.76g/100g), and G1 (0.76g/100g). The sample represented by K2 had the least ash content though it did not significantly differ from most of the samples except S3 (Table 7). The sample prepared in the laboratory had relatively low ash content than the collected samples (Table 10).

The *cheka* analyzed in this research had lower average ash content on dry matter basis (3.15g/100g dry basis) than *borde* and *shamita* which have mean ash contents of 6.85g/100g and 3.66g/100g, respectively (Ashenafi and Mehari, 1995). However, the *cheka* samples had total ash content comparable to *ayib,* 0.75-0.85g/100g (cited in Ashenafi, 2002). Based on this result, one can predict how the ash content of *cheka* will be reduced when diluted with much water.

4.4. Mineral Content

In the present study one of the most important mineral elements such as calcium, iron, and zinc were analysed. Cheka samples contained Ca, Fe, and Zn levels ranged from 8.31-19.60mg/100g, 13.94-27.59mg/100g, and 0.82-1.07mg/100g, respectively (Table 11). Statistical analysis of the result showed significant ($P<0.05$) variations in the contents of all the three minerals. Samples collected from Gidole (G1, G2, and G3) and Shelele (S1, S2, and S3) had significantly higher calcium than those collected from Karat. One of the samples from Karat, K1 (1.07mg/100g), had the highest zinc content followed by samples K3 and S1, and S3 all having about 0.95mg/100g. The *cheka* sample produced in the laboratory had comparatively low mineral content than most of the collected samples. The relatively low mineral contents of the *cheka* samples collected from Karat could be due to the fact that brewers in Konso are highly market oriented and utilize only grains because it helps them produce *cheka* frequently. The amount of the minerals analysed in this study are presented in the following table.

Table 11.Mineral composition of the *cheka* samples (mg/100g)

Sample code	Ca (mg/100g)	Fe	Zn
K1	10.90 ± 1.93^{e}	18.96 ± 0.73^{cd}	1.07 ± 0.09^{a}
K2	8.31 ± 1.45^{e}	13.94 ± 0.87^{e}	0.86 ± 0.09^{c}
K3	14.54 ± 0.25^{cd}	15.29 ± 1.43^{e}	0.95 ± 0.04^{abc}
S1	18.26 ± 0.70^{ab}	24.14 ± 0.93^{b}	0.95 ± 0.01^{abc}
S2	15.33 ± 0.04^{bc}	16.32 ± 2.57^{de}	0.86 ± 0.03^{c}
S3	18.31 ± 0.19^{ab}	27.59 ± 1.36^{a}	0.95 ± 0.04^{abc}
G1	16.52 ± 1.11^{abc}	16.49 ± 1.73^{de}	0.82 ± 0.08^{c}
G2	19.60 ± 3.33^{a}	21.22 ± 2.09^{bc}	0.90 ± 0.05^{bc}
G3	11.14 ± 0.44^{de}	14.41 ± 0.81^{e}	1.02 ± 0.04^{ab}
CL	14.38 ± 1.03^{e}	14.41 ± 0.81^{e}	0.79 ± 011^{c}

- All the values are mean ± standard deviation of duplicate determinations
- Means within the same column with different letter superscripts indicate significant differences ($p<0.05$)

Minerals are utilized by the human body for the proper composition of bone and blood, and maintenance of normal cell function. They also function along with vitamins as essential components in enzymes and hormones. Foods consumed on daily basis should provide sufficient quantities of dietary minerals to meet the requirement of individuals or otherwise enough diversity of foods would be required. The recommended dietary allowances (RDA) for calcium ranges from 1000mg/day for adults (19-50 years) to 1300mg/day (9-18 years) for adolescents and young children. On the other hand, the RDAs for iron ranges from 8mg/day for adolescents, adults and older people (19-50 years) to 11mg/day for young children (14-18 years) and for zinc ranges from 8mg/day for adolescent (9-13 years) to 11mg/day for the rest age groups (Whitney and Rolfes, 2008). Based on values reported for this minerals in this study, one can meet the his/her daily iron requirement by just drinking cheka if the antinutritional factors in *cheka* beverage are low. However, the daily requirement for iron might not meet if the *cheka* is highly diluted by water during serving. Therefore, the total dependence on *cheka* by adults in the study areas might be not good because they cannot meet their daily mineral requirements.

4.5. Alcohol Contents

4.5.1. Methanol Content

The methanol content of the cheka samples ranged from 0.0163-0.2385% (v/v) (Table 12). The sample S3 (2384.4ppm) had significantly ($P<0.05$) high methanol content than the remaining samples and was followed by K1(0.1630%v/v) and S2 (0.1361%v/v). The lowest methanol content was recorded for sample S1 (0.0163%v/v), but it did not significantly differ from other samples except K1, S2, and S3. Generally, samples from Shelele contained significantly high amount of methanol. The reason for high methanol content in Dirashe could be due to the longer fermentation time that allows more pectins in the product to be degraded by pectinase enzymes into methanol (Singkong *et al*., 2012).

The amount of methanol reported in this study for most samples is much higher than the methanol contents reported for *tella* (32.37ppm) and *tej* (45.67ppm), and *arake* (320.87ppm) (Fite *et al*., 1991). The toxic dose of methanol varies depending on the individual and on the provision of treatment. Blood methanol concentrations above 500mg/L are associated with severe toxicity, and concentrations above 1500-2000 mg/L will lead to death in untreated patients (WHO, 1997). The samples coded as K1, S2 and S3 had much higher methanol content than the specifications for maximum methanol and wine (ESA, 2013). All samples had methanol content higher than the maximum limit specified by East African Standards for gin (EAS, 2013) and also half of samples had more methanol content than the limit set by EU regulation (cited in Paine and Davan, 2001). This shows that there might be the possibility of methanol toxicity in the study localities where the fermentation time is longer.

Table 12.Methanol and Ethanol content of the *cheka* samples

Sample code	Methanol content (%v/v)	Ethanol content (%v/v)
K1	0.1630±0.042^{b}	8.96±0.35^{a}
K2	0.0178±0.006^{c}	5.65±3.2^{ab}
K3	0.0328±0.020^{c}	5.84±1.14^{ab}
S1	0.0163±0.005^{c}	3.05±0.29^{b}
S2	0.1361±0.022^{b}	7.38±1.39^{ab}
S3	0.2385±0.024^{a}	8.02±1.70^{a}
G1	0.0369±0.048^{c}	3.12±0.29^{b}
G2	0.0595±0.004^{c}	5.00±3.52^{ab}
G3	0.0288±0.001^{c}	5.63±1.47^{ab}
CL	0.0249±0.004^{c}	7.06±1.86^{ab}

- All the values are mean ± standard deviation of duplicate determinations
- Means within the same column with different letter superscripts indicate significant differences ($p<0.05$)

4.5.2. Ethanol Content

The alcohol content of the cheka samples analyzed varied between 3.05%v/v and 8.96%v/v (Table 12). One of the samples from Konso (K1) had the highest ethanol content (8.96%v/v) followed by the sample S3 (8.02%v/v), which was collected from Shelele. Significant variation was observed among some of the samples in their ethanol contents. Sample S1 (3.02%v/v) had the least ethanol content, but it did not significantly differed from most samples except samples K1(8.96%v/v) and S3 (8.02%v/v). These variation could be due to the differences in the duration of fermentation time and also the introduction of unequal amount of fresh flour during *cheka* production. Since cheka fermentation is mediated by natural microbes from raw materials and equipment, the yeast strains and their load may vary which contributes to the observed variation in ethanol content. In the case of Konso *cheka* preparation, there is almost no (except when using taro leaves) introduction of fresh flour once the fermentation started, but fresh flour must be added into Dirashe cheka one day in advance of cooking the dough balls. Based on this finding, the ethanol content of the *cheka* samples was comparable with that of *tella* (2.5-14.52%) and *tej* (6.2-14%) (Yohannes *et al.*, 2013; Desta, 1977; Gizaw, 2006; Sahle & Gashe, 1991). However, the alcohol content of the *cheka* samples was much lower than that of *arake* which has alcohol content as high as 48%v/v (Gizaw, 2006).

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Cheka is a cereal and vegetable-based beverage which serves as source of nutrients for hundreds of thousands of people in South-western Ethiopia. The preliminary survey showed that the preparation of *cheka* involves very complex and tedious operations such as repeated cooking and kneading of the fermentation products. Diverse methods of preparing *cheka* exist in Dirashe and Konso with differences in some ingredients utilized. In this study, it was found that the duration of *cheka* fermentation varies among localities (from 4 days to months); as a consequence, *cheka* with different sensory properties is produced. *Cheka* is being consumed while it is actively fermenting and has a short shelf-life of two to four days.

Samples collected from Konso (Karat) had significantly lower pH value but higher titratable acidity than samples from Dirashe. Samples from Gidole had better protein and fibre content; however, they had lower energy and carbohydrate values. Higher calcium and iron contents were found in samples from Dirashe, whereas samples from Konso were better in zinc contents. These variations in nutrient content greatly reflects the differences in some of the raw materials utilized for cheka preparation and the fermentation time as well. Although *cheka* contains higher amount of nutrients on dry matter basis than other traditional Ethiopian beverages such as *borde* and *shamita*, the actual amount of nutrients a person gets from *cheka* in its liquid form can be too lower than from *borde* and *shamita*. This is because *cheka* is almost always diluted with much water due to its high alcohol content which is comparable with *tella* and *tej*.

On the other hand, higher methanol content was found particularly in samples collected from Shelele. One of the possible reason is that brewers in Dirashe mostly utilize leafy vegetables such as cabbage which contains high fibre and the fermentation time is much longer than for Konso *cheka*. This longer fermentation time results in the degradation of one of the major fibre components, pectins into methanol. Therefore, one can conclude that longer fermentation time is not good for the *cheka* to be safe to consume. Cheka also had high ethanol levels that might be not safe for some individuals including pregnant and lactating women, children and adolescents.

5.2. Recommendations

Cheka is almost always diluted either with warm or cold water and therefore, the absolute dependence on *cheka* by some consumers particularly adults and older people in both study localities might not be reasonable. People in those areas should consume solid foods in addition to *cheka*. They should also keep it moderate since excess consumption may lead to social and health risks due to its high alcohol and methanol contents.

The fermentation of *cheka* is spontaneous and often takes place under non-sanitary conditions. This shows that besides methanol which had been detected and quantified in the present study, the presence of other toxic substances such as fusel oils are expected. Thus, from the public health point of view, investigation on the mechanism of *cheka* production and means to avoid unpleasant contents are necessary. Moreover, the use of ash for neutralising high acidity of sour *cheka* by consumers in some villages of Dirashe district and the use of mold contaminated malt by brewers in some Konso villages need awareness creation and support from the scientific community.

The researcher believes that *cheka* fermentation has not received the scientific attention that it deserves. Therefore, research has to be done to heighten community awareness about the potential of *cheka* as a commercially viable enterprise that can contribute to small-scale farmers' income and to preserving important socio-cultural values. In addition, technical support services and loans from credit unions are also essential for enabling women to produce *cheka* that can be reliably traded for income since majority of the women in the study areas are illiterate and also have no control over financial resources due to wrong cultural perceptions towards them. These also help women to carry out successful fermentation activities and to use more refined methods to operate more efficiently.

Future priorities and research in the area of *cheka* fermentation should lie in developing starter culture and modifying the processing steps in order to improve the small-scale fermentation and shelf-life of *cheka* and to enhance its sensory properties and nutritional values. The impact of cheka consumption on the nutritional well-being and largely on the health of consumers should also be assessed. Moreover, it might be worthwhile to study whether the longer fermentation time of *cheka* improves the nutrient content of the raw materials or not. In conclusion, the information obtained from this study may serve as a basis for further investigations on different aspects of *cheka* fermentation including the optimization of processing parameters.

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APPENDICES

Appendix 1. Interview Questionnaire in Amharic

መጠይቅ

<u>መግቢያ</u>

በመጀመሪያ የተከበረ ሰላምታዬን እያቀረብኩ በመቀጠልም የትብብር ጥሪ ለማቅረብ እሞክራለሁ ፡፡ እኔ በላይ ቢንቱ እባላለሁ፡፡ በአዲስ አበባ ዩኒቨርሲቲ የምግብ ሳይንስና ሥነ-ምግብ የድህረ-ምረቃ ተማሪ ሲሆን በአሁኑ ጊዜ በባህላዊ የጨቃ አሠራር እና በውስጡ ያሉ ንጥረ-ነገሮች ላይ ምርምር እያደረኩኝ ስለሆነ በዚህ ቃለ-መጠይቅ ላይ መረጃ እንድትሰጡልኝ በትህትና እጠይቃለሁ ፡፡

<u>የመጠይቁ ዓላማ</u>

የዚህ መጠይቅ ዓላማ ጨቃን ለመሥራት የሚትጠቀሙአቸውን አሠራርና እቃዎች ፣የጥረ እቃ አይነትና መጠን ፣የሃይል ምንጮች ፣ኢኮኖማዊ ጥቅሞችና በአጠቃላይ ያሉ ችግሮች ዙሪያ መረጃ ለመሰብሰብ ነው ፡፡ ይህ ጥናት ባህላዊ የጨቃን አሠራር ለዓለም ሁሉ ለማስተዋወቅ የሚረዳ ከመሆኑም በላይ ወደ ፊት የጨቃ አሠራርን ለማጠናከርና ወደ ተሻለ ደረጃ ለማሳደግ መሥራት ለሚፈልጉ ተመራማሪዎች እንደ ግብዓት የሚያገለግል ይሆናል ፡፡ በተጨማሪም ወደ ፊት አሠራሩንበማሻሻልጥቅሙን ለማሳደግና ጨቃ በሰዎች ጤናና ባጠቃላይ በህብረተሰቡ ላይ ሊያደርስ የሚችለውን ችግሮችን ለመቀነስ መሥራት ለሚፈልጉ ተመራማሪዎች እንደ ግብዓት የሚያገለግል መሆኑን ለመግለፅ እወዳለሁ ፡፡ ስለዚህ የእናንተ ምላሽ በጣም አስፈላጊና ለዚህ ዓላማ ብቻ የሚጠቀማቸው መሆኑን እየሳወቅኩ የሚቀጠሉትን ጥያቄዎችን በአግባቡ እንዲትመልሱልኝ አሁንም በድጋሜ እጠይቃለሁ ፡፡ ስለትብብራችሁ በጣም አመሰግናለሁ!

<u>የተሳታፊው የግል መረጃ</u>

ስም፡ ______________________ሃይማኖት፡ ___________________

ዕደሜ፡ __________________ የት/ት ደረጃ፡ ___________

የተሰማሩበት ሥራ፡ ______________

ክፍል 1. የጥረ እቃ አይነትና መጠን

1. ጨቃን ለመሥራት በዋናነት የሚትጠቀምው ጥረ እቃዎች ምን ምንድናቸው?

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2. ቢቅል ለማዘጋጀት የሚትጠቀምው ጥረ እቃዎች ምን ምንድናቸው?

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3. ጥረ እቃውን የሚታገኘው ከየት ነው ?

4. ጥረ እቃዋውን በምን ያህል መጠን ነው የሚትጠቀምው?

ክፍል 2. ባህላዊ የጨቃ አሠራርና ለዓላማዊ የሚያገለግሉ እቃዎች

1. ቢቅልን እንዴት ነው የሚታዘጋጅው ? የሚትጠቀምው እቃዎችስ ምን ምንድናቸው?

2. ጨቃን እንዴት ነው የሚታዘጋጅው ? የሚትጠቀምው እቃዎችስ ምን ምንድናቸው?

3. ጨቃን ለመሥራት ምን ያህል ቀን ያስፈልጋል?

ክፍል 3. የሃይል ምንጭ

1. የሚትጠቀምው የሃይል ምንጭ ምንድነው?

2. የሚትጠቀምውንየሃይል ምንጭ ከየት ነው የሚታገኝው?

ክፍል 4. የጨቃ ባህሪያትና ከተሰራ በኃላ ያለው ቆይታ

1. ጥራት ያለው ጨቃ ምን ዓይነት ባህሪያት አለው ብለህ ታስበለሽ?

2. ጨቃ አንዴ ከተዘጋጀ በኃላ ለምን የህል ጊዜ ይቆያል ?

3. የጨቃ ባህሪያት በምን አይነት ነገሮች የሚወሰኑ ይመስልሻል ?

ክፍል 5. ኢኮኖማዊና ሌሎች ጥቅሞች

1. ጨቃን ለገቢ ማመንጫነት ትጠቀማለሽ?ምን ያህል ጊዜ ነው የሚትሸጭው ?

2. የት ነው ጨቃን የሚትሸጭው ?

3. ጨቃን ስታዘጋጅህ ፣ስትሸጭ ወይንም ስትጠቀሚ ምን ችግር አጋጥሞሽ ያውቃል ?

4. ጨቃ የማትሸጭ ከሆነ ምክንያቱ ምንድነው ?

Appendix 2. Interview Questionnaire in English

Questionnaire

Introduction

Dear respondent,

Greetings! I am Food Science and Nutrition graduate student at Addis Ababa University and currently conducting my research on '**Indigenous Processing Methods, Nutritional and Alcoholic Contents of Cheka'**.

Objective of the Questionnaire

The objective of this survey questionnaire is to gather information regarding traditional processing methods, types and proportions of raw materials, energy sources, constraints in the production and marketing, consumption pattern as well as the economic importance of cheka. I need you to understand that while this study aims to document cheka preparation now, it also envisages initiating researchers who want to improve its processing for better quality and improved livelihood in the future. Your responses are very appreciated and only used for the above purpose. So please respond the questions as honestly as possible. Thank you very much for your time and valued responses.

Respondents Personal information

Sex: ___________________________ Age: ______

Education level: ____________________ Religion: ________________

Marital status: _________________ Job: ___________________

Part I. Types and proportions of ingredients

1. What raw materials do you use as main ingredients for cheka preparation?

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2. Which raw materials do you prefer for malt preparation?

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3. Where do you get the raw materials?

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4. In what proportions do you mix the ingredients during each phase of cheka fermentation?

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Part II. Indigenous processing techniques and types of equipment

1. How do you prepare malt and which equipment do you use during malting?

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2. How do you prepare cheka and which equipment do you use?

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3. How many days it requires to prepare cheka?

Part III. Sources of energy

1. Which type of energy source do you use during cheka preparation?

2. Where do you get the energy source?

Part IV. Sensory properties and shelf-life

1. What characteristics do quality cheka has?

2. How long cheka is fit to drink once it is prepared?

3. What factors do you think affect the quality of cheka?

Part V. Economic and Other importance

1. Do you sell cheka for generating cash and how often do you sell it?

2. Where do you sell cheka?

3. What problems do you encounter during cheka production, marketing and consumption?

4. In case you don't sell cheka, could you give reason, please?

Appendix 3. Topics Selected for Focus Group Discussions

The participants of the focus group discussion had provided their information on the following pre-selected topics.

- Methods of cheka preparation and most preferred raw materials
- Unnecessary raw materials used by some brewers during cheka preparation
- Reason for drinking or not drinking cheka
- Places where people get cheka
- Occasions on which people mostly drink cheka

- Amount of cheka an average adult drink
- Impact of cheka consumption on the nutritional well-being and general health of individuals in particular and the society at large
- Socio-cultural and economic importance of cheka
- Constraints in the production, marketing and consumption of cheka

Appendix 4. Photos depicting the steps involved in cheka preparation up to consumption

(a)

(b)

(c)

(d)

(e)

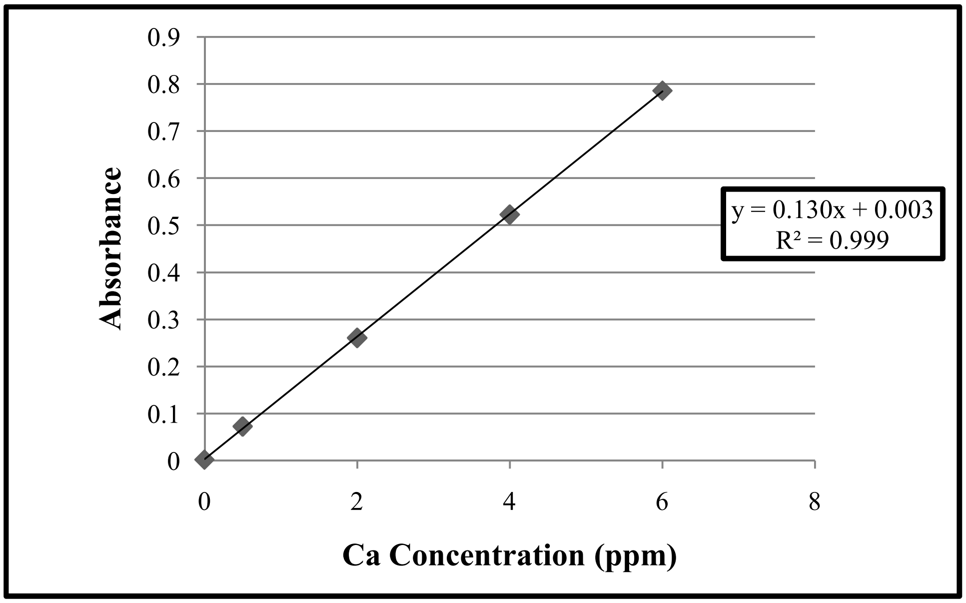
(f)

(g) (h)

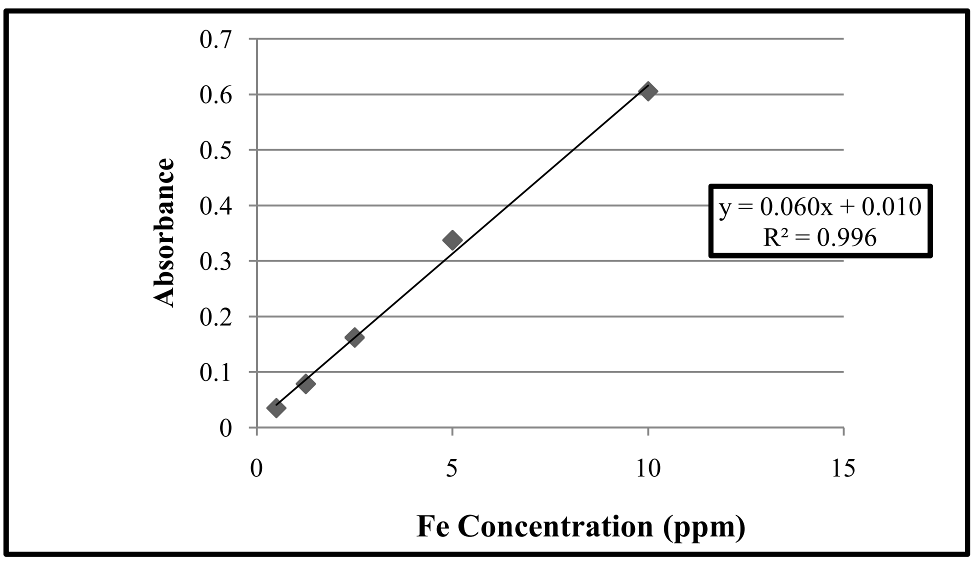
(i) (j)

(a) Fermented product of the initial phase (b) Kneading the fermented product to prepare dough balls (c) Dough balls (d) Dried hop stems and corn coverings placed at the bottom of the metal pot to prevent direct contact with dough balls (e) Cooking of the dough balls (f) Smashed dough balls (g) Porridge (h) Final fermentation of the mixed products (dough balls fermented overnight and porridge) (i) Cheka being served (j) Beans mixed with tomato and ground chili powder which are used as appetizers

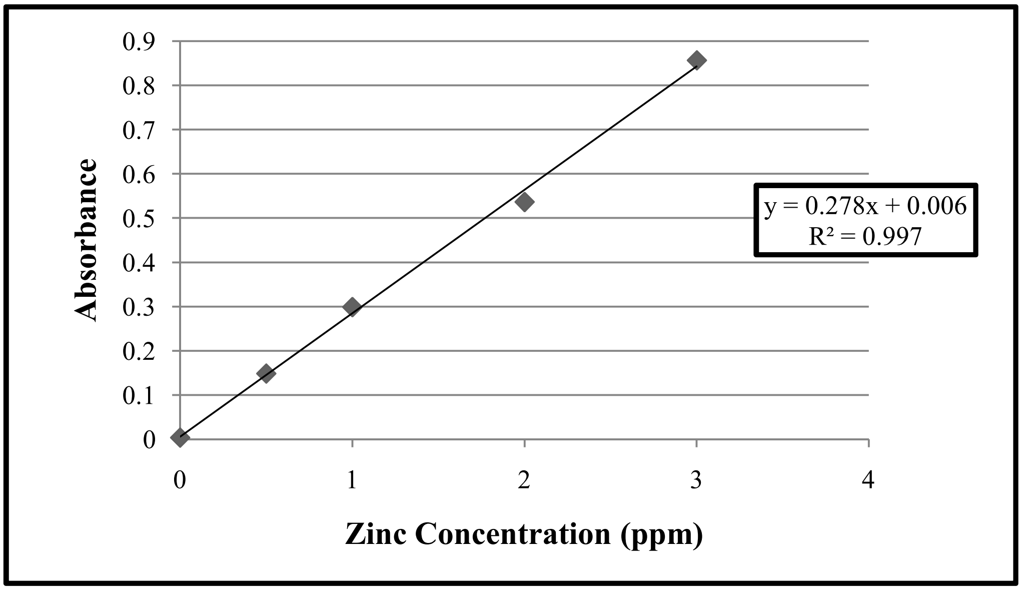
Appendix 5. Calibration Curve for Calcium



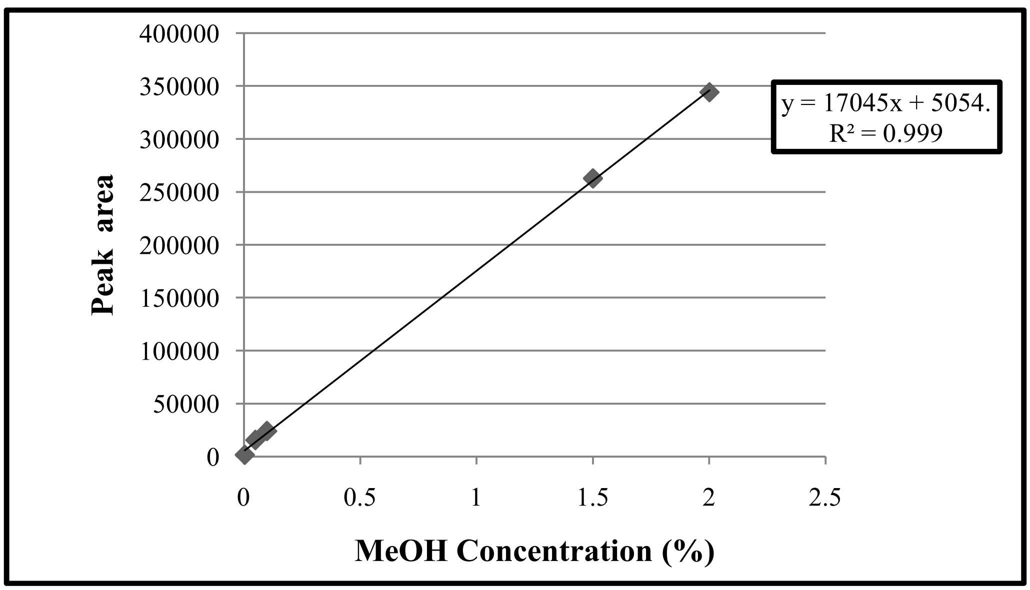
Appendix 6. Calibration Curve for Iron



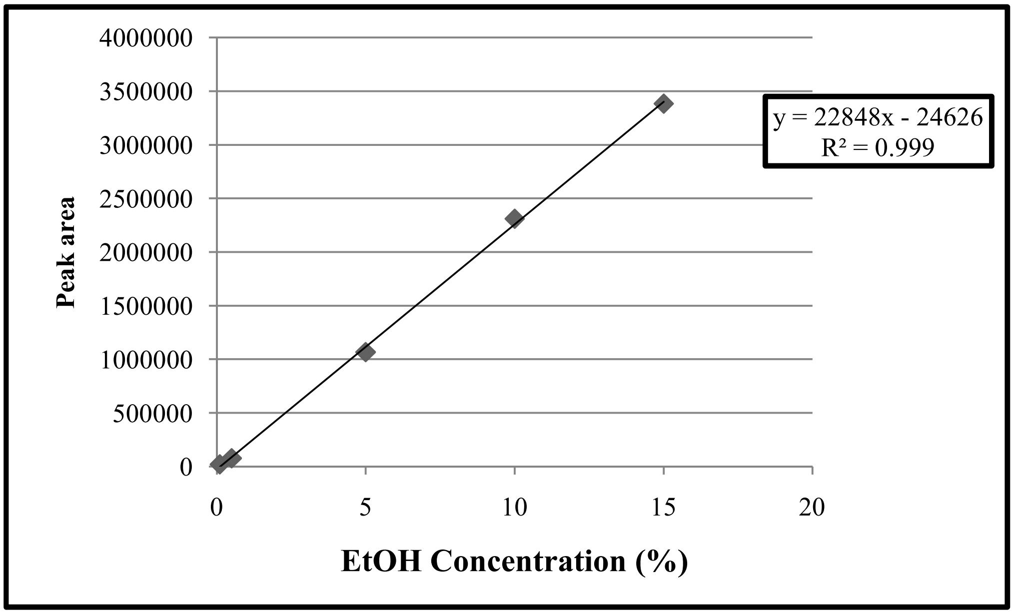
Appendix 7. Calibration Curve for Zinc



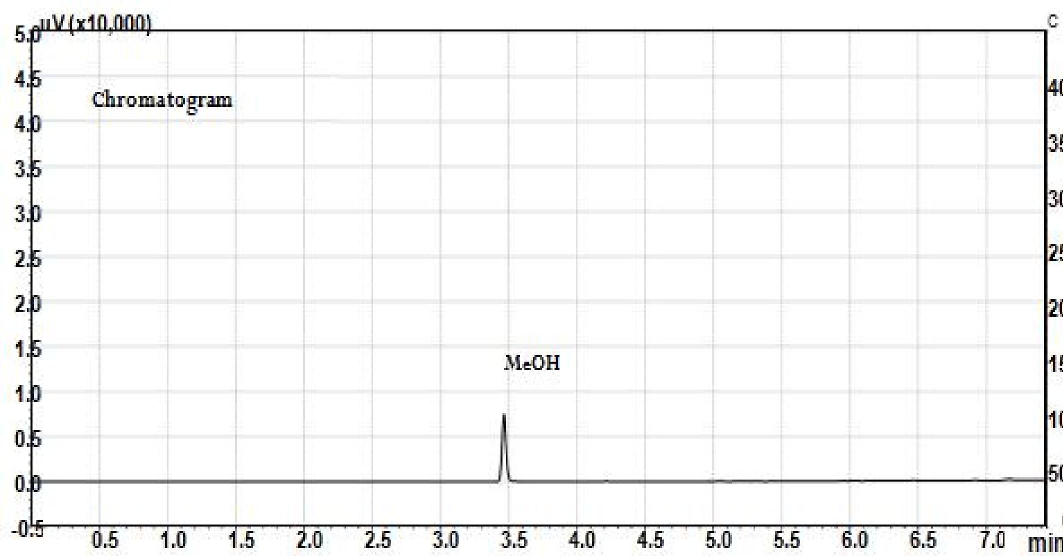
Appendix 8. Calibration Curve for Methanol



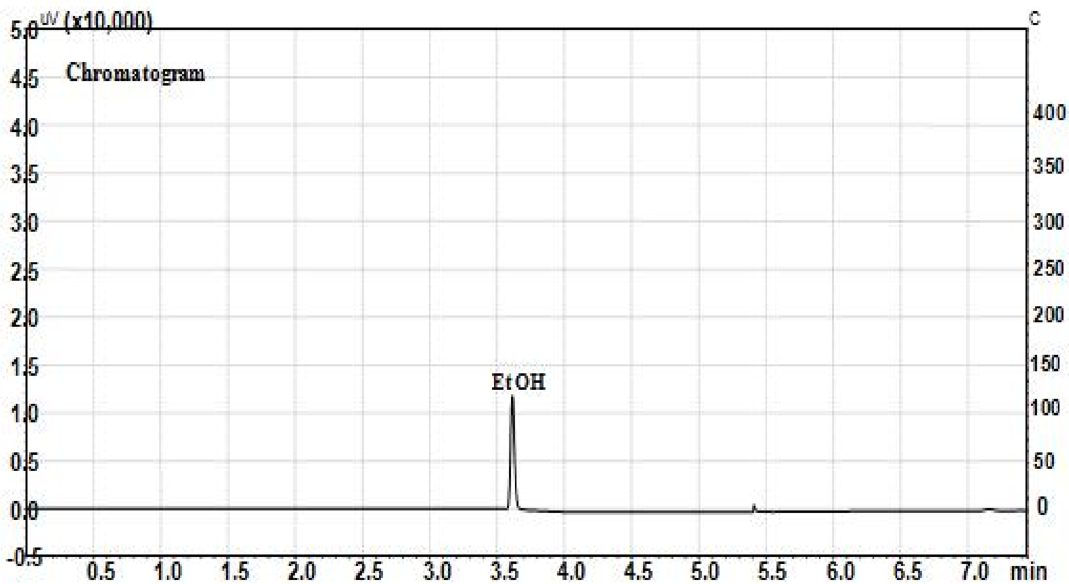
Appendix 9. Calibration Curve for Ethanol



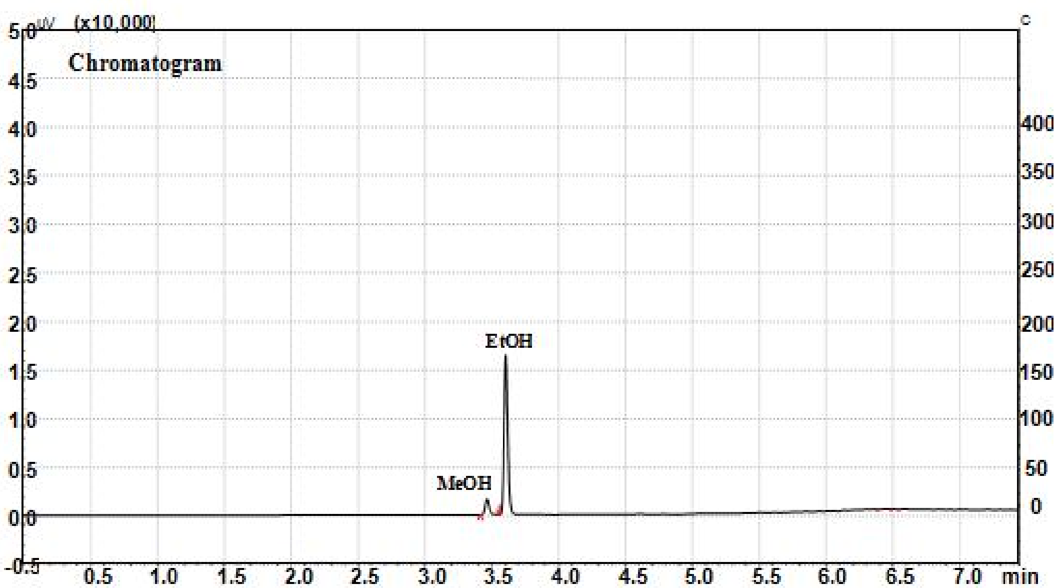
Appendix 10. Chromatogram of Methanol



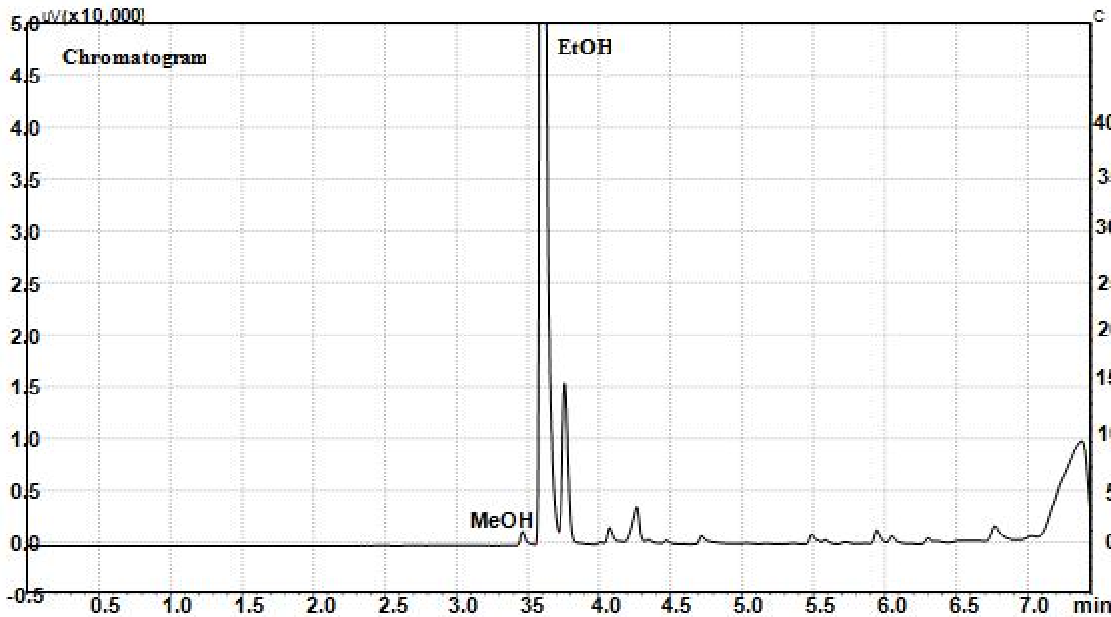
Appendix 11. Chromatogram of Ethanol



Appendix 12. Chromatogram of Methanol and Ethanol in Mixture



Appendix 13. Chromatogram of Methanol and Ethanol Detected from Cheka Sample



Appendix 14. Limit of detection (LOD) and limit of quantitation (LOQ) of the method

Compound	SD (µl/ml)	LOD (µl/ml)	LOQ (µl/ml)
Methanol	0.667	2.00	6.67
Ethanol	1.670	5.01	16.7

- n= 10

Appendix 15 . Recoveries of methanol and ethanol in spiked cheka samples

Sample [a] (µl/ml)	Amount [b] spiked (µl/ml)	Amount present [c] (µl/ml)	Recovery (%)	CV(%)
1.63	5*	6.42	95.80	2.30
1.63	50*	50.03	97.08	4.11
89.6	25**	112.71	92.44	4.34
89.6	250**	329.70	96.04	3.35

- *Methanol
- **Ethanol
- n = 3

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for any degree in this or any other institution and that all sources of materials used in this thesis have been duly acknowledged.

Candidate: **Belay Binitu** Signature ____________

This thesis has been submitted for examination with my approval as a University advisor. In addition, I declare that this thesis is the original work of my student and has been done under my supervision.

Advisor: **Dr. Ashagrie Zewdu** Signature_____________

APPROVAL

This thesis has been approved by the examining board:

	Signature	Date
1. Dr. Tetemke Mehari (External examiner)	____________	___________
2. Prof. Nigussie Retta (Internal examiner)	____________	___________
3.Mr. Aynadis Tamene (Chairperson)	____________	___________

Place and Date of Submission: Addis Ababa University School of Graduate Studies

Centre for Food Science and Nutrition

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