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DETERMINATION OF MINERAL CONTENTS AND PROXIMATE ANALYSIS OF "TELLA" RESIDUE COLLECTED FROM TRADITIONAL "TELLA" BREWERS IN JIMMA CITY

BY TESFAYE SHIFAREW

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DETERMINATION OF MINERAL CONTENTS AND PROXIMATE ANALYSIS OF "TELLA" RESIDUE COLLECTED FROM TRADITIONAL "TELLA" BREWERS IN JIMMA CITY

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By

TESFAYE SHIFAREW

ADVISORS: TSEGAYE GIRMA (PhD)

MENBERU YITIBAREK (Ass. Prof.)

APRIL, 2022

JIMMA, ETHIOPIA

Declaration

I hereby declare that, this thesis entitled "DETERMINATION OF MINERAL CONTENTS AND PROXIMATE ANALYSIS OF "TELLA" RESIDUE COLLECTED FROM TRADITIONAL "TELLA" BREWERS IN JIMMA CITY" and the work presented in it are my original work and has not been presented for a degree in any other university and that all sources have been appropriately acknowledged.

Student's Name: Tesfaye Shiferaw

Signature:______________________

Date: ______________________

Name of adviser: Tsegaye Girma (PhD)

Signature: ______________________

Date: ______________________

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COLLEGE OF NATURAL SCIENCES
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Mr. Kassim Kedir	______________________	______________________
Name of the Chairperson	Signature	Date
_Dr. Tsegaye Girma____	______________________	______________________
Name of Major Advisor	Signature	Date
_Dr. Shimelis Addisu___	______________________	______________________
Name of the Internal Examiner	Signature	Date
Dr. Alemayehu Pawlos	______________________	______________________
Name of the External Examiner	Signature	Date

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ACRONYMS AND ABBREVIATION

AAS	Atomic Absorption Spectrophotometer
ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
CP	Crude Protein
DM	Dry Matter
LOD	Limit of Detection
LOQ	Limit of Quantification
LSD	Least significant difference
SPSS	Statistical package of Social Science
VFA	Volatile of Fatty Acids

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ABSTRACT

There are different byproducts of local brewery in Ethiopia. Among these "Tella"residue is one of the byproduct of local brewery beverage which people used as feed for animals like cattle, sheep for fatten up, growth get energy as well as for increase milk productions. The objective of this research was to analyze the physico-chemical, nutrients content and mineral content of Tella residue available in Jimma city. Tella residue samples were collected purposively from five different sites of Jimma city: Ajip Sefer, Kochi Sefer, Sar Sefer, Mentina Sefer, and Dawro Ber. 200 mL of Tella residue was randomly collected from each neighbor Tella vender's houses of Ajip Sefer, Kochi Sefer, Sar Sefer, Mentina Sefer, and Dawro Ber and totally sampled from 25 Tella venders' houses. Then composited in one liter polyethylene bag and recorded as Ajip Sefer, Kochi Sefer, Sar Sefer, Mentina Sefer, and Dawro Ber separately on polyethylene bag contain Tella residue. The physico-chemical properties were determined by using Digital pH meter and conductivity meter. Proximate analysis were determined by using the Association of Official Analytical Chemists (AOAC) methods. The proximate analysis of Tella residues were performed in analytical chemistry laboratory, Jimma University. The mineral contents (Ca, Mg, Fe, Cu, Cr, Pb, etc) of the Tella residue were investigated by using atomic absorption spectrometry (AAS). All analysis were made in replicates. The pH and Temperature (ºC) values of sample obtained from Kochi Sefer, Sar Sefer, Dawro Ber, Mentina and Ajip Sefer were (3.36 and 20.20), (3.86 and 19.83), (4.13 and 19.63), (3.94 and 19.7),(4.23 and 19.26), respectively. The conductivity value obtained from Kochi Sefer, Sar Sefer, Dawro Ber, Mentina Sefer and Ajip Sefer was (124.1, 130.66, 153.5, 138 and 130.66) µs/cm respectively. The obtained results were reported in (g/100g) for proximate value and (mg/Kg) for mineral analysis. The Tella residue samples from Kochi Sefer, Sar Sefer, Dawro Ber, Mentina Sefer and Ajip Sefer was (20.16, 18.83, 18.72, 19.50, and 15.75) Moisture content, (20.16, 18.83, 18.72, 19.50, and 15.75) crude protein, (5.43, 3.93, 3.73, 4.30 and 4.73) Crude fat ,(17.83, 15.51, 19.73, 19.20, and 16.73) crude fiber, (3.58, 3.71, 4.21, 3.88, and 4.46) Total ash, (36.51, 40.50, 35.46, 35.01, and 39.14) g/100g carbohydrate content, (255.44, 267.40, 247.98, 247.41,and 271.13) Kcal/g gross energy contents, respectively. While the mineral content of Tella residue samples contained of Calcium, Magnesium, Iron, Copper, Chromium and Lead was (656.70, 274.74,79.16, 7.73,1.55, and 0.40) mg/Kg respectively. One way of ANOVA ($P< 0.05$) showed the presence of significant variation among Tella residue samples collected from different sites.

Keywords: Tella Residue, proximate analysis, mineral content

1. INTRODUCTION

1.1 BACKGROUND

Tella is an Ethiopian traditional fermented beer-like beverage made from varieties of cereals and a herb locally called Gesho (*Rhamnus prinoides*). Tella resembles commercial beer in that it is made of malted barley and other grains, with the addition of Gesho as a traditional beer **[1]**. Tella is a predominant traditional alcoholic drink consumed in almost every region of Ethiopia, but more popular in the central and northern parts of the country **[2]**. A variant of Tella known as Karibo, which is made without the addition of the herb Gesho and brief fermentation, is also common among the Muslim families in Ethiopia **[3]**.

Tella is known by different names among the Ethnic groups in Ethiopia, which includes ጠላ (Tella) in Amharic, Farsoo in Afaan Oromoo and Siwa in Tigrigna. There are also variations in the ingredients and processes of Tella making among the different ethnic cultures in Ethiopia **[4]**. Tella is a low alcoholic beverage with a maximum alcoholic level of ~4.0% g/100 mL **[5]**, which makes nutritionally important in the rural community. Tella also makes up a livelihood of significant number of poor women in a minor trade setting **[5]**. It is important to investigate the processes, properties and ingredients of such traditional products to improve it and scale to a mechanized commercial processing level. There are recent reports of some positive outcomes of the Ethiopian traditionally fermented foods and beverages **[6,7]**. There is an obvious need to improve the nutritional properties of the traditional beverages relation with commercialization in the local and international markets. Looking more nutritious and cheaper ingredients that can serve multiple purposes is of great importance.

1.1.2 Raw material and Preparation phase of Tella

Tella" is an alcoholic drink made from many different raw materials, including barley (*Hordeum vulgare*), maize (Zea *mays*), wheat (*Triticum aestivum*), sorghum (*Sorghum bicolor*) or teff (*Eragrostis tef*) etc. Tella is made in a clay pots (*Gan* or *Insira*), plastic containers or metal barrels (whose capacity varies from 50 liters to 200 liters) that is washed using a plant called Grawa (*Vernonia amygdalina*) and then rinsed and smoked with Weyra (*Olea europea sub sp .cuspidate*) for around 10 minutes.

The preparation consists of 3 basic fermentation phases **[8]**. The first (called-*Teje*t) is dedicated to the preparation of the malt (bikil). The cereals are soaked in water, left for at least 3 days to germinate, and then dried in the sun. Finally it's milled as well as a leave and stem of Gesho

(*Rhamnus prenoide*) is milled. In the second phase (**-***Tenses*), powdered leaves of Gesho *(Rhamnus prenoide)* are mixed with water in a small clay pot and allowed to ferment for four days to produce *tenses* then tenses is transferred in to large clay pots (*Gan* or *Insira*), plastic containers or metal barrels and mixed with either a barley flour called *Enkuro* or a non-leavened bread (Kita) which is broken into pieces and left to ferment for a 96 hours. In the third or last phase (*Difdif)*, water is added and a new fermentation takes place and lasts 96 hours. After that Tella is filtered and drink. A byproduct of Tella residue is known as Tella Atella which is used for animal feed**.** The by-product of Tella production, is a kind of brewer's grains that has a high moisture content, and relatively high protein content than most brewer's grains **[9]**. It's widely used by livestock rearing farmers, because of their low cost and accessibility in most household localities **[10]**. Therefore, the purpose of this study was to increase the economic profitability of treatment diets, to assess the important nutritional profiles of Tella residues and locally available supplementary feeds for animals.

1.2 Statement of the problem

'Tella'' residues is one of supplementation of dairy cattle in the urban and peri-urban. Smallholder dairy production systems in the highlands of the country is mainly based on individual feed ingredients produced as by-products of different locally available. Various research reports have been documented on nutritional profiles of different locally available supplementary feed resources in the country [**11-16]**. However, no information has been recorded on the nutritional values and minerals contents present in the byproduct of Tella residue in Jimma city until present. There is also a problem of handling and storage of Tella residues especially in rural area. It is deposited by people in the environment washed off by rain to the river and contaminates the environment as well as risk on human health. Therefore, this study was intended to fill the gap of awareness of handling and storing as well as to determine the nutritional composition, detect and quantify the minerals contents in Tella residue.

1.3 Significance of study

Tella-Atella is an important nutritional feed for animals. Atella can be also used in rural and urban area for fattening cattle as well as sheep even though the amount of uses, availability Tella residue, raw material prepared from Tella are different. The study can enable Tella residue producers and consumers to know the physico-chemical properties nutritional, selected minerals contents composition of different Tella residue sampled. It's essential to develop animal performance when insufficient amount of natural pasture and crop residues are available.

Additionally the result of the study will be used as the source of information for further study who went to conduct research on by product of traditional local beverage.

1.4 Objective

1.4.1 General objective

The general objective of this study is to assess the feed quality of Tella residue (Tella-Atella) collected from different Tella vender's available in Jimma city.

1.4.2 Specific objective

The specific objectives of this study are:

- To evaluate the proximate analysis of Tella residue samples collected from different sites of Tella vender's in Jimma city.
- To determine the physico-chemical properties of Tella residue samples collected from different Tella vender's in Jimma city.
- To evaluate the mineral contents (Ca, Mg, Fe, Cu, Cr, and Pb) of Tella residue samples collected from different Tella vender's in Jimma city.
- To compare the proximate analysis and the physico-chemical properties of Tella residues collected from different Tella vender's in Jimma city.

2.0 REVIEW OF RELATED LITERATURE

2.1 Tella Residue

Tella residue is a residue of home brewed beer in Ethiopia**.** It's a byproduct, resulting from the production of Tella **[9]**. Atella is a variable byproduct whose composition and nutritional value depend on the grain used and on the process (temperature, fermentation time, etc.). These processes yield the following byproducts:

A. Tella-Atella. It's the by-product of Tella production which is a kind of brewer's grains that has a high moisture content, and relatively high protein content but lower fiber content than most brewer's grains.

B. Katikala-Atella. It's the by-product of Katikala production, is close to distillers grains **[17]**. It has been less studied than Tella-Atella.

C. Brewers grains. It's a by-product of the brewing industry that makes up 85 percent of brewing by product **[18]**. Brewer's grains is obtained as a mostly solid residue after wort production in the brewing process. The product is initially wet, with a short shelf-life, but can be dried and processed in various ways to preserve it **[19].**

2.2 Cattle feeds and nutritional values

Feed resources are classified as natural pasture, crop residue, improved pasture and forage, agro industrial by- products and other by-products like food and vegetable refusal, of which the first two contribute the largest feed types **[20]**. In the mixed crop– livestock system of both cereal crop based and enset and coffee based systems, grazing is the major feed resource. The majority (53.7%) of the households use animal feeds from their own crop farm, while 23.7% use a combination of own farm and communal grazing, and 15.8% use own farm and purchased feed and about 7% use other sources. Contrary to this, 76% of dairy producers in the urban production system use purchased feeds from different sources. The rest 16 and 1.7% use road side grazing and own feed resources, respectively **[21]**. The major roughage feed resources for dairy animals across all the different production systems included natural pasture/grasslands, crop residues, non-conventional feed resources (e.g. leaf and stem of enset, banana and sugarcane). Teff, wheat and barley straw, and maize Stover are important feed resources in the rural highland system.The contribution of these feed resources, however, depends up on the agro-ecology, the types of crop produced, accessibility and production system **[22]**. Agro-industrial by-products include cereals flour mill by-products, such as wheat, maize, rice bran, wheat short, and wheat middling's, which are commonly used as energy supplements, and oil seed cakes such as noug, cottonseed, peanut, sesame cakes, which are mainly used as protein supplements. Agro-industrial by-products are characterized by high protein, digestible energy, and low fiber fraction, and when supplemented to dairy cows improve the use of low quality basal diet and thereby improve milk production **[22]**.

2.2.1 Crop Residues

Crop by-products are fibrous plant materials left behind after harvesting human food crops and are available in many areas where crop agriculture is practiced. They are generally high in fiber, low in digestibility and low in crude protein. On small farms in developing countries they form the principal feed of ruminant livestock during dry seasons.

Table 1. Some of Crop residues feed animals [23].

By-product	DM (%)	CP (%)	CF (%)
Sugar cane bagasse	95	3.0	43.1
Rice straw	92	4.2	42.3
Maize Stover	9	16.0	42.0
Cassava leaves (dried)	90	24.7	17.3
Wheat straw	86	4.0	42.0
Barley straw	86	4.0	42.0
Sugar cane tops	26	5.0	32.6
Sorghum Stover	25	6.0	28.1
Banana stem	5	3.2	19.1

Crop residues can be used for feeding dairy cattle but cannot supply adequate nutrients without supplementation. Because of their low digestibility they remain in the rumen for a long time, limiting intake. The other major limitation is they do not contain enough crude protein to support adequate microbial activity in the rumen. It is therefore advisable to feed them with a true protein source (as opposed to a non-protein source, e.g. urea) such as fodder legumes or commercial supplements such as cottonseed cake. Crop residues should not be fed in large amounts to growing animals. If used, they should make up no more than 25% of the diet with the remainder comprising high-quality feeds.

In the mixed cereal livestock farming systems of the Ethiopian highlands, crop residues provide on average about 50% of the total feed source for ruminant livestock. The contributions of crop residues reach up to 80% during the dry seasons of the year **[24]**.Further increased dependence on crop residues for livestock feed is expected, as more and more of the native grasslands are cultivated to satisfy the grain needs of the rapidly increasing human population. In spite of the rising dependence on fibrous crop residues as animal feeds, there are still certain constraints to their efficient utilization. Substantial efforts have been made so far to resolve the feed shortage problem in the Ethiopian highlands, aiming at improving feed availability and thereby improve livestock productivity. However, the impact was so little to manage with the problem that animals are still subjected to long periods of nutritional stress **[25]**.

2.2.2 Natural Pasture

Forages play varying role in different livestock production systems. In general, however, they are important as adjuncts to crop residues and natural pastures and may be used to fill the feed gaps during periods of inadequate crop residues and natural pasture supply. Even in the presence of abundant crop residues, which are often free fed to ruminants, forage crops especially legumes are needed to improve the utilization of crop residues, crop residues often provide energy while forage legumes provide proteins. Forages also provide benefits such as soil fertility through their nitrogen-fixing ability and are also useful in breaking insect, weed or disease cycles, which are likely to occur when they are not supplemented. In many situations, however, forages compete with other crops. In land scarce smallholder forages may compete with other crops for land, in land abundant pastoral systems, they may compete for the herder's labour **[26]**.

2.3 Livestock feed of Brewers grains

The low cost and high availability of Brewers grains has led to its use as livestock feed. It can be fed to livestock immediate in its wet stage or once processed and dried. The high protein content in Brewers grains suggestions a wide variety of amino acids essential in the diet of livestock **[27]**. In fact, supplementing Brewers grains in cow diets may increase milk yield, milk total solids content, and milk fat yield, when compared to maize **[28]**.Atella is produced year-round in Ethiopia in large amounts. It was reported to be more available during the wet season in the North-Western area of Ethiopia. Only a small proportion of Atella is used as feed, and large quantities accumulate at production sites, causing disposal and public health problems **[9]**. Atella is a typically urban by-product that is used in more than 80% of intra-urban dairy farms of Ethiopia **[18]**. Atella is reported to be more available in the central than in the eastern zone of Ethiopia **[29]**.

2.4 Nutritional characteristics of Atella.

The chemical composition of Atella varies according to the ingredients used to make the Tella. Atella is generally rich in protein (13-24%), the highest crude protein (24%) being obtained from Tella made from sorghum grains **[30]**.

2.5 Ruminants

Ruminant animals in Ethiopia receive most of their dietary feeds from native pastures and crop residues. However, natural pastures and crop residues are usually fibrous, poor in digestibility, and devoid of most essential nutrients including proteins, energy, minerals, and vitamins **[31]**.The nutritive value of crop residue can be improved through supplementation with conventional feed resources **[32]**. However, the strategy of supplementing crop residues with conventional feed resources is both in short supply and expensive **[33]**. In addition to these, conventional feed resources are mostly concentrated in urban areas and hence their availability is very limited to rural farmers. Therefore, to avoid this problem, there is a need to look for some alternatives but locally available and cheap sources of protein. Due to their low cost and availability, nonconventional feed resources such as local brewery byproducts were widely used by smallholder farmers **[31]**. Non-conventional feeds are feeds that have not been traditionally used in animal feeding and or are not normally used in commercially produced rations for livestock **[34]**.

Non-conventional feeds could partly fill the gap in the feed supply, decrease competition for food between humans and animals, reduce feed cost and contribute to self-sufficiency in nutrients from locally available feed sources. Two of the locally available non-conventional feeds are Atella and Birint. Atella and Birint can be a good protein and energy source when included in animal ration although, the nutrient content showed variation due to differences in the ingredients used for preparation and methods of preparation followed in different areas. Atella and Birint are highly produced in Machackel district, however information on the effects of supplementation with Atella alone or in combination with Birint for sheep fed oat straw basal diet is generally inadequate.

In Ethiopia, Atella is part of the farmers' practice aiming at enhancing the energy and/or protein status of diets based on crop residues and low-quality roughages [**35**]. Atella is mixed with other feeds and fed to livestock. Supplementing low-quality residues with green feed and providing mixtures of oil cakes and wheat bran soaked with water and Atella is a common strategy to improve the edibility of crop residues, and the whole nutritional quality of the diet **[29].** In Ethiopia, when

Atella is available during the dry season, it can be used as a major protein source for ruminants and can be fed at low cost **[35, 36]**.

2.5.1 Dairy cows

Atella is widely used in dairy farms of Ethiopia, in particular in the Addis Ababa area [**18**], in Tigray **[37]** and in Amhara **[38]**. Atella is used as a supplementary feed throughout the year [**18**]. In dairy cows, Atella is mostly offered in association with Niger cake, which has a higher OM digestibility and protein content, and with wheat bran [**18**] .Tella-Atella can be included at 9-20% in dairy cows diet in association with Niger cake, wheat bran and barley straw, resulting in increased milk yield (+114%) **[37]**.

2.5.2 Sheep

Atella can be used as a protein supplement in sheep diets during the dry season **[36]**. The protein and energy contents of Atella are high enough to greatly increase the intake, digestibility, N retention and performance of growing sheep fed diets based on low quality forage [**35**, **16, 39**]. Supplementing diets with 25-50% Atella ensures that the dietary protein is able to support an acceptable rumen microbial activity, meeting the maintenance protein requirement [**35**, **16, 39**]. Supplementation of wheat straw with Atella resulted in weight gains similar to those observed in sheep supplemented with concentrates **[16]**.
Supplementation of low protein hay (crude protein 5.5%) with Atella improved total intake, without affecting the intake of the basal forage, and greatly improved protein and energy intake [**40**]. However, this result depended on the protein content of the essential forage. With a hay containing 4.1% protein, a significant substitution between Atella and hay was observed **[39]**. Atella is often associated with other supplements in sheep diets. Especially Katikala-Atella, may be less palatable than other supplements, such as malt leaves. The heating applied during alcoholic fermentation may make proteins more resistant to rumen degradation and reduce digestibility by the formation (Millard reactions) of a nutritionally unavailable dark colored amino-sugar complex. A 50:50 mixture of Katikala-Atella and malt sprouts included at 40% dietary level optimized digestibility, growth performance and feed conversion efficiency in sheep **[39]**.

In urban and peri-urban areas, with growing sheep fed on a straw based diet, Katikala-Atella in combination with poultry litter and coffee pulp, instead of Atella alone, improved nitrogen digestibility, nitrogen retention and basal forage intake, without impairing performance. This combination could save concentrate feeds **[16]**. Supplementation of Atella with Niger cake is commonly practiced for sheep fattening **[36]**.

Sheep supplemented with Atella had a higher digestibility of N than those supplemented with faba bean, field pea, and rough pea hulls **[40]**.The type of the Atella (Katikala or Tella) does not affect intake or N retention in sheep [**40**]. However, sheep fed on Katikala-Atella had a higher level of rumen ammonia and volatile fatty acids related with lower microbial N supply and efficiency. This could be due to the fact that Katikala-Atella is widely fermented during brewing, and thus yields less energy during rumen fermentation **[35]**.

2.6 Poultry

In Ethiopia, availability and cost of feed is one of the major limitations to poultry production **[41]**. This is true because of the fact that there is shortage of cereal grains, protein sources, vitamins and mineral supplements required to formulate balanced poultry rations. This situations merits the evaluations of agricultural and agro industrial by products and incorporation of suitable ones in to poultry rations. Some of the cereal grain by- products, particularly fermentation residues from alcoholic drinks and beverages are abundant in some parts of the country. The Ethiopian local beer by products Atella is produced in large amounts the year round. Currently small proportion of this by product is used as dairy cattle feed and large quantities accumulate at production sites causing disposal and public health problems.

2.6.1 Broilers

The addition of the whole standup age as it is recovered from industrial distilling and brewing in to poultry distribution, dates back to the 1930s. However, the increase in volume of production of the residues encouraged fractioning and drying of the stillage to facilitate storage, milling and shipping **[42]**. Examinations of the production process of the residue raised the possibility that trace elements, B-complex vitamins, yeast metabolites or combinations of these may be responsible for some special dietary value of the dried stillage for poultry. Numerous elements including selenium compounds along with the proteins, vitamins and other trace minerals have been implicated on the intrinsic nutritional properties of these byproducts **[43-47]** Unfortunately however, very little or nothing has been done in Ethiopia to determine the nutritional value of Atella for poultry. Although the principles of alcoholic fermentation remain the same, there seems to be difference in the nutritive value of Atella and industrial Brewers grains attributed to the difference in the raw materials and production methods used. Inclusion of Atella as the only source of protein in starter diets significantly lowered feed intake and weight gain. Although the chemical composition of Atella is close to that of industrial brewer's grains, performance of birds fed Atella was much lower than with similar levels of brewer's grain **[9]**.

2.6.2 Laying hens

Atella may be used to reduce the use of cereal grains in laying hens diets. Up to 20% Tella-Atella (DM basis) could be included in the diets of Lohmann white layers with no or little effect on egg production and egg quality characters. However, increasing the addition rate of Atella reduced the feed transformation percentage **[48]**. The nutritionally available protein content of Atella (15.6%) could satisfactorily contribute about 80% of the total crude protein requirement of baby chicks when adequately consumed and powerfully developed. More over Atella, Brewers grains and Noug seed cake were included in to their respective treatment percentage to contribute about 10% of available proteins. But all proteins are not of equal value, their amino acid composition must be known to accurately to compare the nutritional value of proteins of Atella, Brewers grains and Noug seed cake in poultry ration. Although the principles of alcoholic fermentation remain the same, there seems to be difference in protein and amino acid composition between Atella and industrial Brewers grains.

2.7 Mineral for cattle's

Minerals are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life. Minerals are chemical constituents used by the body in many ways. Although they yield no energy, they have important roles to play in many activities in the body [49, 50]. Approximately five percent of the body weight of an animal consists of minerals. At least 15 mineral elements have been identified as nutritionally essential for ruminants. These are seven major minerals - calcium (Ca), phosphorus (p), potassium (K), sodium (Na), chlorine (Cl), magnesium (Mg) and sulfur (S) and eight micro minerals - cobalt (Co), copper (Cu), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se) and zinc (Zn) [51]. The macro minerals are important structural components of bone and other tissues and serve as important constituents of body fluids. The trace minerals are present in body tissues in very low concentrations and often serve as components of metallo enzymes and enzyme cofactors or as components of hormones of the endocrine system. Production, age level and chemical form of elements in the feed ingredients, interrelationships with other nutrients, supplemental mineral intake, breed and cattle adaptation can determine mineral requirements of the animals but there is greater degree of uncertainty in the mineral requirements of animals depending on such factors [52].

2.8 Natural sources of minerals for grazing cattle

2.8.1 Forages

Cattle normally obtain most of their minerals from the feeds and forages that they consume and their mineral intakes are influenced by the factors that determine the mineral content of plants and their seeds. The concentrations of all minerals in plants depend largely on four factors: plant genotype, soil environment, stage of maturity and climate. The importance of a given factor varies between minerals and is influenced by interactions with the other listed factors and with aspects of crop or pasture farming, including the use of fertilizers, soil amendments, irrigation, crop rotation, intercropping and high yielding cultivars **[53]**.

Table 2. Recommended minimum element concentrations in pasture dry matter for livestock **[54].**

Macro minerals(g/kg)	**Cattle**	**Sheep**
Calcium	3.5	3.0
Sodium	1.5	1.0
Chlorine	2.0	1.0
Potassium	5.0	4.5
Sulfur	1.5	2.0
Magnesium	1.5	1.0
Trace elements(mg/kg)		
Iron	40	40
Zinc	25	20
Manganese	25	25
Copper	5	12.5
Cobalt	0.10	0.10
Iodine	0.50	0.50
Molybdenum	0.10	0.10
Selenium	0.050	0.05

2.9 Factors affecting mineral content of feeds and soil

Concentrations of mineral elements in forage are dependent upon the interaction of a number of factors, including soil, plant species, stage of maturity, yield, pasture management and climate **[55]**. Most naturally occurring mineral deficiencies in herbivores are associated with specific regions and are directly related to soil characteristics. There is a marked leaching of minerals and weathering of soils in tropical regions under conditions of heavy rainfall and high temperature, making them deficient in plant. Poor drainage conditions often increase extractable trace elements (i.e. Mn and Co), thereby resulting in a corresponding increase in plant uptake. As the soil pH increases, the availability and uptake of forage Fe, Mn, Zn, Cu and Co decrease, whereas Mo and Se concentrations increase **[51]**.

2.10 Mineral deficiencies in cattle

Mineral deficiencies and imbalances for herbivores were reported from almost all tropical regions of the world. These reports include both confirmed and highly suspected geographical areas of mineral deficiencies and toxicities in cattle. The mineral elements most likely to be lacking under tropical conditions are Ca, P, Na, Co, Cu, I, Se and Zn. In some regions, under specific conditions, Mg, K, Fe, and Mn may be deficient and excesses of F, Mo and Se are extremely detrimental **[56]**. Certain trace minerals deficiency affect immunity and may affect disease susceptibility in cattle. Selenium, Cu, Zn, Co and Fe have been shown to alter various components of the immune system. Trace mineral deficiencies may also reduce the effectiveness of vaccination programs by reducing the ability of the animal's immune system to respond following vaccination **[57]**. Reported reproductive disorders associated with a copper deficiency in grazing ruminants include: low fertility associated with delayed or depressed oestrus, and long post-partum return to oestrus period; infertility associated with anoestrus and abortion **[58]**. According to this study, an inverse relationship between serum copper levels and important reproductive parameters such as days to first service (56 vs. 70 days), services per conception (1.1 vs. 4.4) and days to conception (56 vs. 183) in dairy cows with high and low serum copper levels, respectively **[59]**. Calcium and P deficiency causes reduced appetite and milk yield, a decline in reproductive efficiency, poor feed utilization, lowered disease resistance, increased incidence of milk fever, reduce growth rate, osteoporosis and osteomalacia **[51]**. Manganese deficiency in ruminants is associated with impaired reproductive function, skeletal abnormalities, and less than optimal productivity. Cystic ovaries, silent heat, reduced conception rates and abortions are reported reproductive effects. Neonates that are manganese deficient can be weak, small and develop enlarged joints or limb deformities **[60]**.

2.11 Traces of Toxic Metals in Mineral Supplements

Mineral supplements generally contain trace residues of toxic metals, especially of Cd and Pb [**60**].In the animal model, lead has a primary toxic effect on the hypothalamic-pituitary unit, a primary effect on the testes and acts at all levels of the reproductive axis **[61]**. There are reports that some metal such as lead, cadmium, arsenic and mercury can affect male reproductive functions including sperm counts **[62]**, motility and morphology **[63]** and spermatogenesis **[64]**. In fact, mineral supplements are considered one of the feedstuffs with the highest toxic metal concentrations, and the maximum admissible concentrations established by the European Union **[65]** are higher than most of the other feedstuffs [**66**]. However, its contribution to the total dietary intake is difficult to evaluate since mineral supplements and premixes may be added at different rates according to manufacturer's instruction. EFSA has evaluated the risk of the main toxic metals present in the animal feed on the animal health and it was considered. Negligible for mineral supplements, if their content is within the maximum admissible levels established by the European Union **[60, 67, 68, 69**].

The only exception seems to be Cd, not only because its bio accumulative properties can accumulate at very high concentrations in the liver, but especially in the kidney of adult animals causing adverse effects including renal function impairment, hypertension, disturbance of trace mineral metabolism and acute degenerative damage in the intestinal villi. Minimum toxic levels or maximum safe dietary concentrations cannot be estimated with any precision, since Cd deposition is significantly influenced by dietary interactions with Cu, Zn, Fe, and Ca; thus, in some cases, concentrations of Cd as low as 1 mg/kg in the diet did in fact make a contrary effect in animals **[60]**.In addition, a significant increase of Cd accumulation in tissues can be observed when high dietary supplements of trace minerals and Zn are used in the ration This is due to that these metals have similar chemical properties and are able to induce and compete for the binding sites of metallothioneins. This is especially relevant for pigs, where trace minerals and Zn are used at very high concentrations as growth promoters and have a very high capacity to induce metallothioneins **[70]**.for example Cd residues in the liver and kidney were double in animals receiving 200 mg/Kg trace minerals for three months compared to the controls **[71]**. Recent studies in our laboratory indicate that hepatic and renal Cd accumulation was significantly higher in pigs from intensive systems (Cu and Zn supplemented) compared with extensively grown animals (no supplemented) which was related to the metallothione in induction by the former trace mineral **[72-73]**.

Table 3. Dietary requirements and maximum tolerable concentrations of selected minerals for cattle expressed as either parts-per-million (ppm) of diet or % of diet dry matter (DM) **[74].**

Mineral	**Requirement**			**Maximum Tolerable Concentration**
	Growing and Finishing Cattle	Gestating Cows	Lactating Cows	
cadmium, ppm	-	-	-	10
calcium, %	0.6	0.25	0.3	1.5
Copper, ppm	10	10	10	40
Fluorine, ppm	-	-	-	40
Lead, ppm	-	-	-	100
Mercury, ppm	-	-	-	2
Molybdenum, ppm	1-2	1-2	1-2	5
Phosphorus, %	0.22	0.17	0.21	0.7
Potassium, %	0.6	0.6	0.7	2
Selenium, ppm	0.1	0.1	0.1	5
Sodium Chloride, %	0.06-0.08	0.06-0.08	0.1	4.5 (growing animals) 3.0 (lactating cows)
Sulfur, %	0.15	0.15	0.15	0.3 (high concentrate diets) 0.5 (high roughage diets

2.12 Mineral status of cattle feeds in Ethiopia

In an experiment of feed samples collected by **[75],** during the wet and dry seasons from three altitudinal ranges of the central and western parts of Ethiopia, only 4.55% were found to be deficient in Ca. The phosphorus level was found to be sufficient only in 11% of the feeds analyzed. Out of the tested feeds, 31.82 % were found to be deficient in Mg content. Among all minerals analyzed, Na was found to be the most deficient macro mineral in central and western parts of Ethiopia, the majority of the browse species, cereal straws and by-products being deficient to meet animal requirements. On the contrary, the K concentration was found to be adequate in most of the feeds analyzed **[75]**. Cereal straws were found to be deficient in P, Na and Mg, while straws of food legumes were highly deficient in P. Comparatively, less percentage of straws of food legume was categorized as Na deficient compared to the other feed types. Pasture grass and other feeds were found to be deficient in Na, P and Mg in relation to dietary requirements. A large proportion of feed samples were deficient in Cu and zinc. There were wide variations in the concentrations of these elements among the soil and feed samples **[76].** General trend indicated that most of the feeds of the dry season fell in the category of deficient to border line than that of the wet season feeds.

Minerals may be broadly classified as macro (major) or micro (trace) elements. The third category is the ultra-trace elements. The macro-minerals include calcium, phosphorus, sodium and chloride, while the micro-elements include iron, copper, cobalt, potassium, magnesium, iodine, zinc, manganese, molybdenum, fluoride, chromium, selenium and sulfur [50].

The macro-minerals are required in amounts greater than 100 mg/dl and micro-minerals are required in amounts less than 100mg/dl [77]. Evidence for requirements and essentialness of others like cadmium, lead, tin, lithium and vanadium is weak [78].The macro minerals are important structural components of bone and other tissues and serve as important constituents of body fluids. The trace minerals are present in body tissues in very low concentrations and often serve as components of metallo enzymes and enzyme cofactors or as components of hormones of the endocrine system.

Table 4. Function and deficiency signs of macro and micro elements on cattle **[79].**

Macro minerals	Function	Deficiency signs
Calcium (Ca)	Bone & teeth formation, blood clotting, smooth muscle contraction	Rickets, slow growth, bone fractures, lower milk yield, milk fever (hypocalcaemia)
Phosphorus (P)	Bone & teeth formation, energy metabolism, part of DNA	Rickets, poor growth, impaired reproduction, depraved appetite
Sodium (Na)	Acid-base balance, muscle contraction, nerve transmission, osmotic pressure, blood pH	Abnormal eating behavior (pica), urine licking, poor appetite, lower milk production
Chlorine (Cl)	Regulate osmotic pressure and acid-base balance, manufacture of hydrochloric acid	Loss of appetite, weakness, craving for salt, blood alkalosis
Potassium (K)	Osmotic pressure, acid-base balance, nerve transmission	Loss of hair glossiness, decreased feed intake
Magnesium (Mg)	Enzyme activator, bone and muscle, muscle contraction	Muscle hyper-irritability, salivation, convulsions, grass tetany
Sulfur (S)	Sulfur-containing amino acids, B-vitamins, cellulose digestion, acid-base balance	Reduce microbial growth, poor appetite
Micro minerals	Function	Deficiency signs
Cobalt (Co)	synthesis of vitamin B12 by the rumen microbes	Poor appetite, anemia, rough hair coat
Copper (Cu)	Enzyme activation, blood synthesis, nervous system	Rough hair coat, change in hair color (grey or reddish), diarrhea, immune system impairment, mastitis

Iodine (I)	Synthesis of thyroxine (hormone)	Goiter, big neck in calves, reduced metabolic rate, poor reproductive performance
Iron (Fe)	Part of blood hemoglobin, enzyme systems, immune system function	Anemia
Manganese (Mn)	Growth, bone formation, enzyme activation	Impaired growth, poor reproduction, skeletal abnormalities
Selenium (Se)	Enzyme formation (glutathione peroxidase), protect cell membranes, immune function	Reproductive disorders, mastitis, immune system dysfunction, white muscle disease, retained placenta
Zinc (Zn)	Enzyme activation, repair of damaged tissue, immune system, teat keratin formation	Parakeratosis of the skin, elevation in somatic cell count, mastitis, hoof dysfunction, stiff joints

Table 5. Some of selected feed stuff for cattle with nutritional and mineral contents **[80].**

Feed stuff	% DM	% TDN	NEm Mcal/cwt	NEg Mcal/cwt	% CP	% CF	% EE	% Ash	% Ca	% P	% K	% Cl	% S	Zn (ppm)
Alfalfa leaf meal	89	60	60	30	26	16	3.0	10	2.88	0.34	2.2	-	0.32	39
Barley straw	90	44	44	1	4	42	1.9	7	0.32	0.08	2.2	0.67	0.16	7
Bermuda grass	89	53	53	18	10	29	1.9	8	0.46	0.20	1.5	0.70	0.25	31
Brewers grains, wet	23	85	93	62	26	13	7.5	4	0.30	0.58	0.1	0.15	0.32	78
Molasses cane, dried	94	74	78	49	9	2	0.3	14	1.10	0.15	3.6	3.00	-	30
Oat straw	91	48	48	9	4	41	2.3	8	0.24	0.07	2.5	0.78	0.22	6
Rice straw	91	40	42	0	4	38	1.4	13	0.23	0.08	1.2	-	0.11	-
Sorghum Stover	87	54	54	20	5	33	1.8	10	0.50	0.12	1.2	-	-	-
Soybean straw	88	42	43	0	5	44	1.4	6	1.59	0.06	0.6	-	0.26	-
Wheat straw	91	43	44	0	3	43	1.8	8	0.17	0.06	1.3	0.32	0.17	6

3.0 MATERAILS AND METHODS

3.1 Study area

The study is carried out in Jimma city, Jimma zone of Oromia regional state of Ethiopia (Figure.1). Jimma city is located at a distance of 350 km away from Addis Ababa, the capital city of the country. It is located at latitude of 7°40'26.01''N and longitude of 36°50'8.85''E. Based on the 2007 Census conducted by the CSA, Jimma Zone has a total population of 2,486,155, an increase of 26.76% over the 1994 census, of whom 1,250,527 were men and 1,235,628 were women; with an area of 15,568.58 square kilometers, Jimma has a population density of 159.69. While 137,668 or 11.31% are urban inhabitants, a further 858 or 0.03% are pastoralist. The study area is situated between 1689 and 3018 meter above sea level and receives an average rainfall between 1200 and 2400 mm per annual.

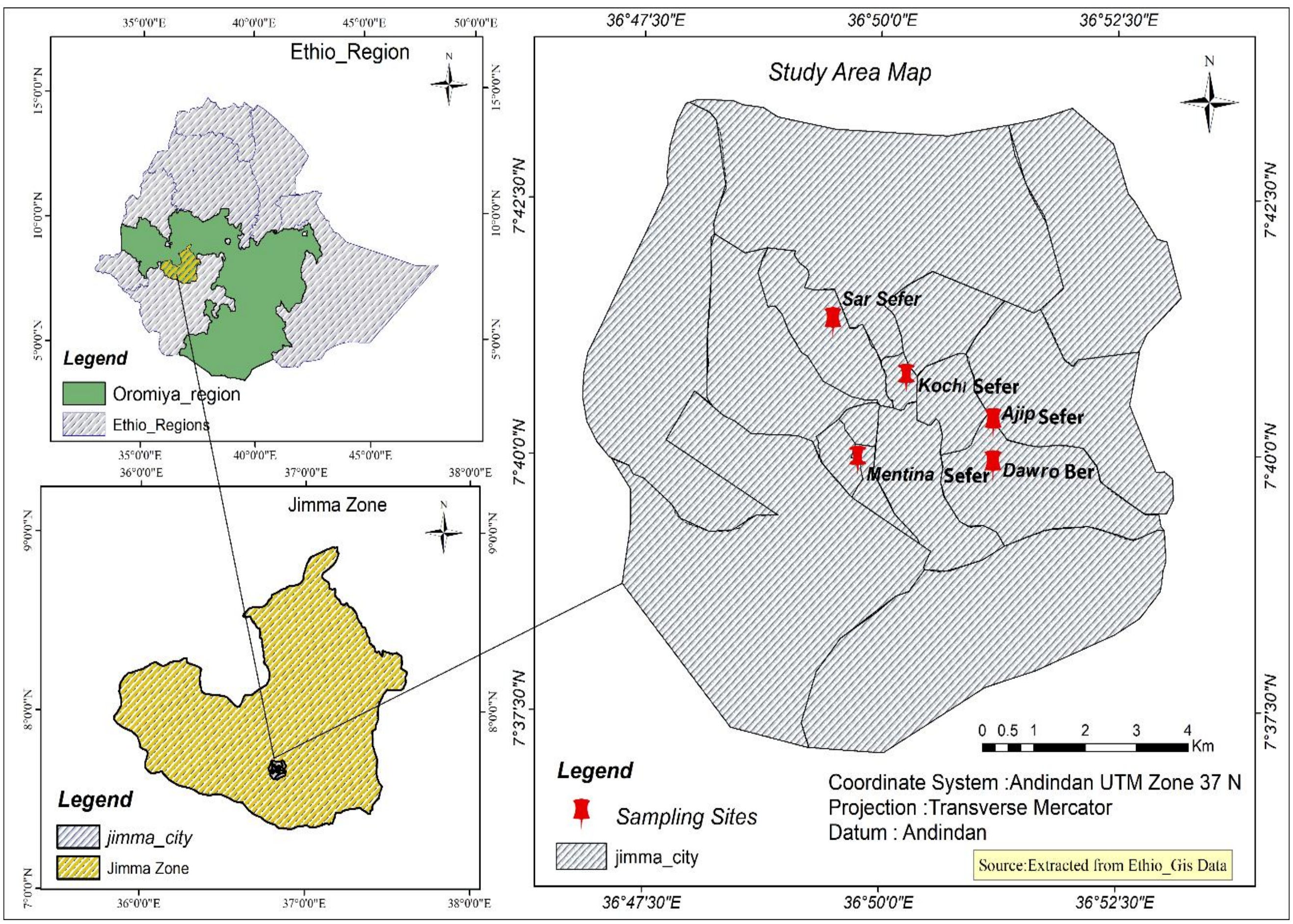

Figure 1. Map of study area and sampling sites

3.2 Sample collection sites and sampling technique

The study was conducted in Jimma city by collecting Tella residue samples from 25 Tella vending houses. Tella residue samples were collected from five potential Tella vendering localities of Jimma city, namely: Ajip Sefer, Kochi Sefer, Sar Sefer, Mentina Sefer, and Dawro Ber (Figure. 1). From each sampling localities, five Tella vendering houses were selected randomly. The Tella residue was collected using poly ethylene bottles. The polyethylene bottles were soaked in 10% HNO_3 overnight and then washed and rinsed several times with double distilled water before using for sampling of Tella residue. About one liter of Tella residue sample was collected from each Tella vendering house and labeled. Then, samples were directly transported to analytical chemistry laboratory, Jimma University. The temperature of each sample was measured and stored in the refrigerator at 4 °C for further measurement and analyses. Purposive interview was also made with each Tella vender during sampling using structured questionnaire (Appendix 1).

3.3 Sample preparation

Tella residue was collected, in a one liter plastic bottle, from the five Tella vendering houses of each localities. Then, about 200 mL of Tella residue from each of five vending houses of the five different localities (Ajip Sefer, Kochi Sefer, Sar Sefer, Mentin Sefer, and Dawro Ber) were mixed and form five composite samples in plastic bottles. Then, the composite samples were analyzed for selected heavy metals contents and proximate values.

3.4 Chemicals, Apparatus and Instruments

Apparatus and instruments such as Pestle and mortar, Crucible, Kjeldahl flask(GerahardtVAPODEST®450 Made in German), Drying Oven (Memmert), Muffle furnace(D-6072 Driesch, West Germany), Flame Atomic Absorption Spectrophotometer (280FS, Malaysia), Heating mantle, Micropipette, Filter bag (model coarse fiber determinator SLQ6A Made in China), Filter paper and cotton, Volumetric flask, Digital pH meter, Conductvity meter (model DDS-307, Jiangsu company, made in China), Aluminium foil, Electronic balance (Model AAA dam Co limited), Desiccators, Soxhlet apparatus, Cellulose thimble, Plastic bottles, Conical Flask, Separatory funnel, Rota rotatory.

Chemicals like Nitric acid (HNO_3 (70%)), Distilled water, Sulphuric acid (H_2SO_4 (98%)), Boric acid (H_3BO_3 (4%)), Sodium hydroxide (NaOH (40%)), n-Hexane (95%), pellet of $CuSO_4$ and K_2SO_4, Hydrochloric acid (HCl (0.1N)), Methyl Red.

3.5 Physic-chemical properties

3.5.1 pH and Temperature

In a cleaned beaker, 50 mL of distilled water and 10 mL of Tella residue (5:1) ratio were mixed and stirred well as described in **[81]**. The pH meter was calibrated with buffer solutions of pH=4.0 and 7.0. First, pH value of double distilled water was recorded. Then, the pH of Tella residue solutions of the composites from the five different localities were determined. The temperature of each Tella residue was determined directly by using thermometer. Replicates of each sample were measured and results were reported as mean ± standard deviation (SD).

3.5.2 Electrical conductivity

200 mL of distilled water and 10 mL of Tella residue (20:1) ratio were mixed and stirred well in a 500 mL of cleaned beaker. The meter was connected with conductivity probe and temperature sensor. The range of conductivity was adjusted at 200 µS/cm. To guarantee measuring accuracy, probes should be rinsed with distilled water three times. The conductivity of distilled water was measured and found to be 0.5 µS/cm. Finally, the probe tip was rinsed with distilled water and immersed the conductivity probe into the prepared sample solution and the conductivity of the Tella residue was recorded. The measurement was performed in triplicate. The results were reported as mean ± SD, after the conductivity of distilled water subtracted from the measured conductivity value of each sample.

3.6 Proximate Analysis

3.6.1 Moisture content

The composite samples were analyzed for moisture content following the method employed in [82]. A cleaned crucible was dried in an oven at 100 °C for 2 h, cooled in a desiccator, and recorded its weight. Then, 2 g of a composite sample was measured. The crucible contain the samples were heated in the oven at100 °C for 8 h until constant weight was obtained. Then, the crucibles were cooled in desiccators and measure their weight. The drying and cooling cycle were done several times until the weight difference between consecutive measurements for a sample is negligible.

The measurement was done in triplicate and the results were reported as mean ± SD. The amount of dry matter (DM) was calculated using Eq. 1. The moisture content can be calculated by subtracting the percentage of dry matter from 100.

$$\text{DM}\ (\%) = \frac{(\text{Wt of Crucible} + \text{Wt of FS}) - (\text{Wt of Crucible} + \text{Wt of DS})}{\text{Wt of FS}} \times 100 \qquad (1)$$

Where, DM is dry mater; Wt of Crucible is the weight of crucible; Wt of FS is the weight of fresh sample; and Wt of Ds is the weight of dry sample.

3.6.2 Crude Protein (CP)

The Kjeldahl wet digestion procedure was used to determine the total N content of the composite samples [**82]**. Then, crude protein (CP) content was estimated by multiplying the total %N by the factor 6.25. The method is briefly described below:

Step1: Digestion

1g of sample was added in Kjeldahl flask. Then, 5 g of pellet K_2SO_4 and 0.5 g $CuSO_4$ of catalyst were added into the Kjeldahl flask containing the sample. Next, 20 mL of conc. H_2SO_4 (98%) was pipetted and transferred into Kjeldahl flask containing the sample and catalyst. The digester power was turned on and set the temperature at 420 °C and digest the sample for 2 h until the green color appears. Then, the digested sample was kept at room temperature to cool. Afterwards, the digested sample was transferred in to 100 mL volumetric flask with 20 mL of distilled water. The Kjeldahl flask was rinsed three times with distilled water into the volumetric flask. Then, distilled water was added until it reached the mark of volumetric flask.

Step 2: Distillation

10 mL of digested sample solution was transferred into the distillation flask and 50 mL of 40% NaOH was added into it. Then, 50 mL of distilled water was added into the flask containing digested sample. Next, 30 mL of 4% boric acid was added into a conical flask and set-up with the distillation unit so that the condenser tip is immersed in the boric acid solution. Finally the distillation was run at 200 °C for 1 h. 100 mL of distillate sample was collected and the distillation was turned off.

Step 3: Titration

0.1N HCl was taken into a burette and the initial burette reading was recorded. A Few drop of methyl red indicator was added to distillated solution then yellow color was observed. Finally Titration was started by adding 0.1N HCl from the burette until the color change yellow to orange. The final volume of burette was recorded.

Step 4: Calculation

The percentage of nitrogen content of the sample and the corresponding crude protein content can be calculated by using Eqns. (2 &3).

$$\%\mathrm{N} = \frac{\mathrm{V}_1 \times \ \mathrm{N} \times 0.014}{\mathrm{W}_1} \times 100 \qquad (2)$$

Where, V_1= volume of HCl used in titration, N=Normality of HCl used in titration, W_1 =Weight of sample.

$$\text{Crude protein } (\%) = \%N \ \times 6.25 \qquad (3)$$

Where, %N is the percent of nitrogen content of the sample; and 6.25 is the protein-nitrogen conversion factor. The analysis was performed in triplicates and results were reported as mean ± SD.

3.6.3 Crude fat

Crude fat contents of the composite samples was determine by Soxhelet extraction technique using ether extract of samples according to **[83]**. The Soxhelet extraction apparatus was washed with distilled water and detergent and rinsed several times with distilled water before drying. 10 g of sample was added into a thimble and cotton was placed at the top of the thimble to cover the sample. The sample containing thimble was immersed in the Soxhlet extraction apparatus and 140 mL of n-hexane was added a round bottomed flask of the soxhelet set-up. The hot mantle was turned on at 20 ^{o}C for 4 h, then the flask was cooled for 15 min. Next, concentrate of crude fat was collected by using Rotavapur at reduced pressure at 40 °C. Beakers (50 mL) were cleaned, dried in oven at 100 °C for 2 h and put in desiccator until cooled then the weight of beaker was recorded. Then concentrate was transferred into a dry beaker of known mass. The round bottomed flask was rinsed three times with n-hexane into the beaker. The beaker was kept in a hood until all the solvent removed. Then, the weight of beaker contain crude fat was measured and recorded. The amount of crude fat was calculated using Eq. 4. The experiment was done in triplicate and results were expressed as mean ± SD.

$$\text{Crude Fat (\%)} = \frac{W_2 - W_1}{W_s} \times 100 \quad (4)$$

Where W_2 = Weight of beaker with crude fat; W_1= Weight of beaker; and Ws = Weight of sample

3.6.4 Ash

Ash content of the composite Tella residue samples were determined following the protocol used in reference **[83]**. First, crucibles were cleaned and dried in oven at 100 °C for 2 h. Then, put the dried crucibles into the desiccator and weighted them after cooled. A 3 g of powdered sample was added in to crucible and put on a hot plate for partial oxidation of samples. Next, the sample containing crucible was put in the muffle furnace and turned on muffle furnace. The ashing temperature was selected for a sample at 550 ^{0}C.Furnace controls were set as to ramp or set up to thus temperature at the rate of 35 ^{0}C per hours followed by 8 hours of ashing. Afterwards, the furnace was turned off and taken out the crucible and put them into the desiccator until they are cool enough. The weight of crucible and the ash was measured and recorded. The percentage of ash content of the samples was calculated by using Eq. (5).

$$\text{Ash (\%)} = \frac{(W_C + W_{DS}) - (W_C + W_A)}{W_{DS}} \times 100 \quad (5)$$

Where, W_C is weight of crucible; W_{DS} weight of dry sample; and W_A is weight of ash.

3.6.5 Crude fiber content

Crude fiber content of Tella residue samples were determined by Association of Official Analytical Chemists (AOAC) method, sub component 962.09 which involve digestion, filtration, washing, drying and combustion **[84]**. In brief, 2 g powdered dried Tella residue was weighed and transferred to a filter bag (model coarse fiber determinator SLQ6A Made in China) and labelled on the filter bag for different samples. 50 mL of 1.25% hot H_2SO_4 prepared solution was added in to Pyrex glass for boiling. It was heated the heating mantle to boiling the solution and digest the filter bag contain sample at 120 °C for 30 min under condensers. After 30 min, the boiled solution of acid with sample was cooled and the bag was washed with distilled water. The sample in the bag was again boiled at 120 °C for 30 min with hot 50 mL of 1.25 % NaOH. After 30 min, the boiled solution of base with sample was cooled and the bag was washed with distilled water. The sample in filter bag was transferred in to crucible and the crucible contain sample was put in oven at 130 °C for 2 h. Then, the dried sample was put in desiccator until cool, then weight of the crucible with sample was recorded. The dried sample with crucible was weighed and put it in the furnace at 550 °C for 2 h. The mass of crucible and the ash was recorded after cooled in the desiccator. Crude fiber content was then calculated by using Eq. 6.

$$\text{Crude Fiber (\%)} = \frac{(W_C + W_{DST}) - (W_C + W_A)}{W_{ODS}} \times 100 \quad (6)$$

Where, W_C is weight of crucible; W_{DST} is weight of dry sample after acid and base treatment; W_A is weight of ash; and W_{ODS} is weight of original dry sample.

3.6.6 Carbohydrate by difference

The carbohydrate content of the samples was determined by subtracting the sum of moisture, ash, crude fat, crude fiber, and crude protein from 100 percentage as indicated by Eq. 7 **[84]**.

$$\text{Carbohydrate (\%)} = 100 - [(\text{M (\%)} + \text{A(\%)} + \text{CFa (\%)} + \text{CFb (\%)} + \text{Cp (\%)}] \quad (7)$$

Where; M = moisture; A = ash; CFa = crude fat; CFb = crude fiber; and Cp = crude protein.

3.6.7 Gross Energy

The gross Energy value of Tella residue samples was estimated by using the Atwater factors for protein (4), fat (9), and carbohydrate (4) **[85]**.

.The gross energy was calculated by using Eq. 8.

$$\text{Gross Energy (\%)} = [(\text{Cp (\%)} \times 4) + (\text{CFa (\%)} \times 9) + (\text{CH (\%)} \times 4)] \quad (8)$$

Where; Cp = crude protein; CFa = crude fat; and CH = carbohydrates

3.7 Sample preparation for minerals analysis

The wet ashing method for minerals analysis was used for determination of selected metals by atomic absorption spectrophotometer (AAS) **[86]**. A composite sample was made by mixing all the 25 samples from different localities. Then, 20 mL of HNO_3 (69%) was added into a conical flask containing 2 g of powder of the composite Tella residue. And, 10 mL of $HClO_4$ (70%) was added to digested flask using a pipette then shaked the solution. The sample solution was heated on heating mantle at 120 °C for 1 h after covering the digested flask with watch glass. The heating mantle was turned off. The bottom of watch glass was rinsed with1% HNO_3 into the flask and digestate mixture was filtered using what man No 1 filter paper on a steam less funnel into a cleaned 50 mL volumetric flask. The filter paper was rinsed with distilled water until the mark of 50 mL of volumetric flask. The blank sample was digested in the same way like the sample. Flame Atomic Absorption Spectrophotometer (FAAS), 280FS, was used to determine the concentration the selected metals in both blank and the sample solution at appropriate wavelength of interested metals in the sample solution (Table 6)

Table 6. FAAS instrumental condition

Elements	**Wavelength (nm)**	**Slit width (nm)**	**Lamp current (mA)**	**Instrumental LOD (mg/L)**
Ca	422.7	0.7	2	0.01
Mg	285.2	0.5	1	0.001
Fe	248.3	0.2	7	0.03
Cu	324.7	0.7	1.5	0.005
Cr	357.9	0.7	2	0.04
Pb	283.2	0.7	2	0.04

3.8 Method Validation for Metal Analysis

3.8.1 Instrument calibration

Calibration curves were constructed to determine the concentration of the metals in the sample solutions. Intermediate standard solution of each metal was prepared from stock standard solutions containing 1000 mg/L of Ca, Mg, Fe, Cu, Cr, and Pb **[87]**. According to the instrument operation manual to attain its better sensitivity, the working standards were then put one after the other into the Atomic Absorption Spectrometer and its observance was recorded. Calibration curves were plotted with different points (1 – 5 mg/L) for each metal standard solution against the corresponding absorbance.

3.8.2 Method of validation

Through the accuracy, precision, limit of quantification (LOQ), limit of detection (LOD) and percent recovery were evaluated to validate the employed method for metal analysis.

i. Accuracy

Accuracy is the degree of agreement of test results generated by the method to the true value. It is measured by spiking the sample matrix of interest with a known concentration of analyte standard and analyzing the sample using the “method being validated”.

ii. Precision

Precision is the degree of agreement among individual test results when the procedure is applied repeatedly to multiple samplings. It’s measured by injecting a series of standards or analyzing series of samples from multiple samplings from a homogeneous lot. From the measured standard deviation (SD) and Mean values, precision as relative standard deviation (% RSD) is calculated (Eq. 9).

$$\text{RSD (\%)} = \frac{\text{SD}}{\text{Mean}} \times 100 \quad (9)$$

iii. Limit of detection and limit of quantification

The term limit of detection (LOD) is defined as the lowest possible concentration at which the method can detect (but not quantify!) the analyte within the matrix with certain degree of confidence. The term Limit of quantification (LOQ) is defined as the lowest possible concentration of the analyte that can be quantified by the method in a reliable way. Reliable means, that a suitable precision and trueness must exist and be demonstrated. The LOD and LOQ can be calculated by using Eqns. 10 &11.

$$\text{LOD} = 3 \times \text{SD blank} \quad (10)$$

$$\text{LOQ} = 10 \times \text{SD blank} \quad (11)$$

Where; SD blank is standard deviation of blank.

iv. Percentage of recoveries

The validity of the method will be assessed by spiking of samples with standards of known concentrations and calculating percentage recoveries (%R) as given by Eqn. 12.

$$\%R = \frac{\text{Conc. in spiked sample} - \text{Conc. in unspiked sample}}{\text{Conc. actual spiked sample}} \times 100 \qquad (12)$$

3.9 Data analysis

All analyses were done in triplicates and results were reported as mean ± standard Deviations of the replicate determinations. Data from physic-chemical parameters and proximate analysis were computed using SPSS (statistical software packages for social science). One way analysis of variance (ANOVA) was used to determine the significant difference among the samples with respect to the studied parameters. Least significant difference (LSD) at $P < 0.05$ is used to determine which means were significantly different.

4.0 RESULTS AND DISCUSSION

4.1 Ingredients of Tella

All participant of this study were women, because Tella production was considered to be the art and responsibility of women and almost all process operation were carried out by them. From the result of interview response of Tella maker women during Tella preparation the common ingredient used was Gesho(*Rhamnus prinoides*), barley (*Hordeum vulgare*), maize (Zea *mays*), wheat (*Triticum aestivum*), sorghum (*Sorghum bicolor*) or teff (*Eragrostis tef*) etc etc. But there was a variation or un common response which was used different at each vending house of Tella maker. For example at Kochi sefer location from five Tella maker women some women used Powdered Gesho, maize, barley and sorghum ingredient only while the other women used Powdered Gesho, maize, barley and teff only. As asked the reason why to use different ingredient from one ingredient from one vending house to the other Tella maker women response, thus was due to the availability and different cost value of each ingredient.

As discussed with Tella maker got the response result based on the duration of time required for Tenses and Difdif during step of Tella preparation there was a variation time from one vending house to the other vending house of Tella. Example I asked the time required for Tenses and Difdif was five and twelve day respectively while some Tella maker women response as six and fourteen day respectively. Thus variation might be due to use of different container during Tella preparation and different in temperature occur. There was also a variation depend on the time required Tella residue separated from fresh (primary cycle) filtered Tella drunk by a person. Some women separated Tella residue from fresh (primary cycle) filtered Tella and other women used as a second by adding water to the (primary cycle) filtered Tella which is known as *Kirari (ቂራሪ)* (in Amharic language). Thus might be due to the quality of Tella prepared, availability of market and customer. From interview response some women after filtered Tella drunk by a person the residue left which was known as Tella residue was used as feed stuff for a cattle by selling to a people who has a cattle but at some vending house of Tella maker example Kochi Sefer location some Tella maker does not sell the Tella residue, they discarded or simply without selling they give to a person who has a cattle. Thus might be due to lack of awareness on the availability of Tella residue for animals feed, lack of transport and relationship between Tella maker with people who has a cattle.

4.2 Physicochemical properties of Tella residue

Tella residue is a semi-liquid leftover during the production of local drink called "Tella". The color of Tella residues varies from dark-brow to black depending on the preparation methods of "Tella". The pH, temperature and electrical conductivity measurements of composite samples were performed and the obtained results are presented in Table 7.

Table 7. Physicochemical properties of Tella residues samples (mean±SD), where n=3

Sampling area	pH	Temperature (°C)	Conductivity (*µs/cm*)
Kochi Sefer	3.36 ±0.01	20.20±0.00	124.1 ± 0.7
Sar Sefer	3.86±0.03	19.83±0.28	130.66±0.37
Dawro Ber	4.13±0.00	19.60±0.20	153.5±0.26
Mentina Sefer	3.94±0.00	19.7±0.00	138±0.20
Ajip Sefer	4.23±0.00	19.26±0.23	130.66±0.11

The acidity or alkalinity of a food is usually expressed as pH. The pH of a food can dramatically alter the growth of microbes in food and is a major determinant of the type of food preservation process used for that food. From Table 7, the pH value of Tella residue samples was found in the range of 3.34 to 4.23. The increasing order of pH of Tella residue samples were Kochi Sefer < Sar Sefer < Mentina Sefer < Dawro Ber <Ajip Sefer respectively. The pH values significantly different from location to location of samples. Thus differences can be related to the ingredients used to prepare Tella, Tella preparation methods, and storage conditions of Tella and its residue. Samples from Kochi Sefer and Ajip Sefer have the lowest and the highest pH value, respectively. However, all the samples were in acidic pH range (3.34 – 4.23). This may be due to some bacterial growth in the Tella residues and/or oxidation of ethanol to an organic acid (acetic acid) by yeast cells **[88]**. Table 7 also shows the temperature of Tella residue samples from the five localities, which it was found that in the range of 19.60 °C to 20.20 °C. The temperature of Tella residue samples from the five locations differ at the maximum of 0.6 °C. The significant different in temperature affects the growth of microorganisms present in the product and other properties of food such as chemical reactivity **[89]**. Means microorganism growth fast at high temperature than low temperature. At

high temperature ethanol in Tella is quickly changed in to ethanoic acid than at low temperature which change the flavor of beverage.

From Table 7 the electrical conductivity value of Tella residue samples was found in the range of 124.1 µs/cm to 153.5 µs/cm .The five location sample recorded significantly different electrical conductivity values with location of samples. Samples from Kochi Sefer and Dawro Ber resulted the lowest and the highest electrical conductivity values respectively. The lowest electrical conductivity samples from Kochi Sefer indicates the presence of less ions concentration, were as samples from Dawro Ber supposed to have the highest concentration of ions. Generally, the variation in electrical conductivity can be described to the amount of ingredients and source of water used during preparation of Tella.

4.3 Nutritional value of Tella residue

To evaluate the nutritional value of Tella residue for cattle feed, proximate analysis has been performed for Tella residue samples from each localities. The obtained results are given in Table 8 (Mean ± SD).

Table 8. Proximate composition of the Tella residue samples (Mean ± SD; n =3)

Sample Location	**Moisture (%)**	**Crude protein (%)**	**Crude fat (%)**	**Crude fiber (%)**	**Total ash (%)**	**Carbohyd rate (%)**	**Gross energy (Kcal/g)**
Kochi Sefer	20.16±0.76	16.47±0.61	5.43±0.15	17.83±0.52	3.58±0.10	36.51±0.54	255.44±10.60
Sar Sefer	18.83±1.52	17.50±0.70	3.93±0.25	15.51±0.60	3.71±0.15	40.50±1.36	267.40±6.80
Dawro Ber	18.72±0.25	18.13±0.22	3.73±0.20	19.73±2.00	4.21±0.15	35.46±2.28	247.98±7.91
Mentina Sefer	19.50±0.50	17.96±0.75	4.30±0.20	19.20±2.37	3.88±0.07	35.01±1.69	247.41±8.20
Ajip Sefer	15.75±0.35	18.72±0.31	4.73±0.15	16.73±0.82	4.46±0.07	39.14±1.09	271.13±3.35
Average	18.59±0.67	17.75±0.51	4.42±0.19	17.8±1.26	3.96±0.10	37.32±1.39	251.87±7.37
%RSD	3.60	2.87	4.29	7.07	2.52	3.72	2.92

The moisture contents of a sample was measured as the difference in mass after drying the samples at 100 °C **[82]**. Moisture content affects the physical and chemical properties of food that affect stability and storage of the food for a long period of time. Moisture rich foods are easily susceptible to the microbial attack and get spoil and damaged easily. On the other hand, low moisture containing foods usually show slower growth of microorganisms and can stay for a longer period without severe damage. From Table 8, the moisture contents value of Tella residue samples was found in the range of 15.75% to 20.16%. The moisture content of the five samples of different localities are significantly different ($p < 0.05$). The highest moisture content was observed samples from Kochi Sefer, whereas the lowest moisture content was recorded for samples from Ajip Sefer. The increasing order of moisture contents of Tella residue samples were Ajip Sefer < Dawro Ber < Sar Sefer < Mentina Sefer <Kochi Sefer. This difference in moisture content may be due to the variation in amount of water added during Tella preparation. When the dry matter of Tella residue analyzed obtained in Jimma city compare with the other feed stuff present in Table 5 it has low dry matter value or higher moisture content except Brewers grains, wet which has high value of moisture content.

There was a variation on the same nutritional value obtained on the some cattle feed stuff from one researcher to the other researcher. For example based on the % of dry matter obtained Rice straw, Wheat straw, Barley straw and Sorghum Stover from Table 1 obtained has higher than the value obtained in table 5 with the same feed stuff of cattle.

As Table 8 shows the crude protein contents of Tella residue was found that in the range of 16.47% to 18.72%. The crude protein contents of samples from the five localities are significantly different ($P < 0.05$). Sample from Kochi Sefer contained the lowest protein, whereas sample from Ajip Sefer had the highest protein. The increasing order of crude protein contents of Tella residue samples were Kochi Sefer < Sar Sefer < Mentina Sefer < Dawro Ber < Ajip Sefer. Generally, this variation of crude protein contents may be due to the difference amount and types of ingredient used during Tella preparation. When compare the value of crude protein obtain with other feed stuff present on Table 5 it has higher then Barley straw, Bermuda grass, Molasses cane, Oat straw, Rice straw, Sorghum Stover, Soybean straw and Wheat straw while lower than Alfalfa leaf and Brewers grain wet. There was a variation on the same nutritional value obtained on the some cattle feed stuff from one researcher to the other researcher. For example based on the % of crude protein obtained Wheat straw and Sorghum Stover from Table 1 obtained has lower than the value obtained in Table 5 with the same feed stuff of cattle.

Table 8 shows that the crude fat contents of Tella residue samples was found in the range of 3.73% to 5.43%. The fat contents of samples from the five locations were found to be significantly different ($p < 0.05$). The lowest crude fat content was found for sample from Dawro Ber and the highest value was obtained sample from Kochi Sefer. The increasing order of crude fat contents of Tella residue samples was Dawro Ber < Sar Sefer < Mentina Sefer < Ajip Sefer <Kochi Sefer. Fats play many essential roles for animal by yielding energy, enhancing the absorption and storage of vitamins (particularly lipid soluble ones) and along with carbohydrate and protein constitute the chief structural component of all living cell **[90]**. When compare the value of crude fat contents obtain with other feed stuff present on Table 5 it has higher then Alfalfa leaf ,Bermuda grass, Molasses cane, Oat straw, Rice straw, Sorghum Stover, Soybean straw and Wheat straw while lower than Brewers grain wet.

Fibers are the sum of non-starch polysaccharides (cellulose, hemicelluloses, and pectin substances) and lignins, which are main components of plant cell walls. It is the measure of the quantity of indigestible (not fermentable) in the diet and structural carbohydrate in a sample **[91]**. From Table 8, the crude fiber contents of Tella residue samples was found in the range of 15.51% to 19.73%. The increasing order of crude fiber contents of Tella residue samples was Sar Sefer < Ajip Sefer < Kochi Sefer < Mentina Sefer < Dawro Ber. This implies that Dawro Ber Tella residue contained the highest cellulose, hemicelluloses and lignin's than the others samples, while Sar Sefer Tella residue consist of the smallest amount of cellulose, hemicelluloses and lignin's than the other areas. However, the crude fiber contents of samples from the five locations were not significantly different ($p > 0.05$).

When compare the value of crude fiber contents obtain with other feed stuff present on Table 5 it has higher then Molasses cane, Brewers grain wet and Barley straw but it approximately equal to the Alfalfa leaf while lower than Bermuda grass, Oat straw, Rice straw, Sorghum Stover, Soybean straw and Wheat straw. When compare the crude fiber obtained in the same feed stuff of cattle between one researchers with the other researcher there is the variation. For example there was a variation with the same the nutritional value obtained in Rice straw, Wheat straw and Sorghum from Table 1 compare with the nutritional value obtained from Table 5. Generally this variation

might be due to the use of different personal and instrumental error response during sample preparation and different time maturity stage of ingredient during harvesting the sample.
Ash contents are the minerals or inorganic residues left after higher temperature combustion (> 500 °C) of the samples **[83]** and are used as crude measure of mineral contents.

From Table 8, the ash contents of Tella residue samples was found in the range of 3.58% to 4.46%.The ash contents of five location samples were significantly different (p<0.05). The increasing order of ash contents of Tella residue samples was Kochi Sefer < Sar Sefer < Mentina Sefer < Dawro Ber <Ajip Sefer. The differences in the total ash content may be related to the mineral contents of ingredients used in the Tella preparation. When compare the value of ash contents obtain with other feed stuff present on Table 5 its Lower than Molasses cane, Barley straw, the Alfalfa leaf, Bermuda grass, Oat straw, Rice straw, Sorghum Stover, Soybean straw and Wheat straw but it approximately equal Brewers grain wet.

Carbohydrates are a polyhdroxy of aldehydes, ketones or compound that yield such substance up on hydrolysis. From Table 8, the carbohydrate contents of Tell residue samples was found in the range of 35.01% to 40.50%. The increasing order of ash contents value of Tella residue sample were Mentina Sefer < Dawro Ber < Kochi Sefer < Ajip Sefer < Sar Sefer. The carbohydrate contents of samples from the five locations were significantly different (p <0.05).When compare the value of carbohydrate contents obtain with other feed stuff present on Table 5 its lower than Molasses cane, Barley straw, Alfalfa leaf , Bermuda grass, Oat straw, Sorghum Stover, Soybean straw and Wheat straw but its approximately equal to Rice straw.

Energy is a principal requirement for living organisms and as such, most nutrients function to a large extent as sources of energy. Gross energy represents the total energy available in a substance; however, living organisms are not capable of capturing all of the energy in the foods they consume because of digestive and metabolic inefficiencies **[92]**. From Table 8, the gross energy contents of Tella residue samples was found in the range of 255.44 kcal/g to 271.13 kcal/g. The increasing order of gross energy contents of Tella residue samples was Kochi Sefer < Mentina Sefer < Dawro Ber < Sar Sefer <Ajip Sefer. However, the gross energy in all the sampling stations did not differ significantly at (p > 0.05) between the sampling stations.

4.4 Correlations of physico chemical properties and proximate analysis of Tella residue

Table 9. Correlations of physico chemical properties and proximate analysis of Tella residue significant at the 0.01 and 0.05 level (2-tailed).

Pearson Correlation	pH	Temperature	Electrical .C	%Moisture	%C. Fat	%C .protein	%Ash	%C. fiber	%carbohyd rate	%G. Energy
pH	1	-0.841**	0.597*	-0.684**	-0.619*	0.821**	0.839**	0.087	0.098	0.133
Temperature		1	-0.357	0.751**	0.364	-0.873**	-0.866**	0.112	-0.164	-0.297
Electrical .C			1	-0.004	-0.739**	0.418	0.436	0.539*	-0.432	-0.492
%Moisture				1	0.015	-0.615*	-0.765**	0.202	-0.451	-0.638*
%C. Fat					1	-0.454	-0.284	-0.017	-0.059	0.149
%C .protein						1	0.788**	-0.085	0.076	0.282
%Ash							1	0.073	0.060	0.225
%C. fiber								1	-0.890**	-0.783**
% carbohydrate									1	0.865**
%G. Energy										1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlation is a statistical method or a statistical technique that measures the degree of association between two or more variables. Correlation can be classified as positive and negative.

A. Positive correlation: When two variables X and Y move in the same direction. When one increases the other also increases and when one decreases the other also decreases, the correlation between the two is positive. Table 9 shows that pH has positive correlation with electrical conductivity, percent of crude protein and percent of ash means increase pH value increase electrical conductivity, percent of crude protein and percent of ash value this might be due to more cations ions or more alkaline ions present in a given solution during conductivity and more cations in crude protein and ash contents in a given sample.as Table 9 indicate that electrical conductivity has also positive correlation with percent of crude fiber this might be due to high contents of ions present in a crude fiber.as Table 9 show that percent of crude proteins has positive correlation with percent of ash as well as carbohydrate has positive correlation with gross energy this means increase gross energy by increase carbohydrate they have direct proportional each other as shown from equation (8).

As Table 9 indicate Electrical conductivity has also positive correlation with percent of ash. This is due to high amount of ions or high amount of inorganic minerals in percent of ash and the more electrical conductivity will be occur.

B.Negative correlation: When two variables X and Y move in the opposite direction, the Correlation is negative. Table 9 shows that pH has negative correlation with temperature , percent of moisture and percent of crude fat this means as increase the pH value temperature , percent of moisture and percent of crude fat becomes decrease. This might be due to become lower hydrogen ions concentration as temperature decrease and the amount of hydrogen ions concentration in moisture contents and crude fat decrease with increase pH values. Temperature has also negative correlation with percent of crude protein and percent of ash. This means at very high temperature solid powdered substance changed to ash. But the more temperature applied on ash the ash content become decrease due to more mineral residue changed to vapor gas(volatile minerals may be lost at high temperature).due to this increase temperature percent of ash contents become decrease. As Table 9 indicate that electrical conductivity has negative correlation with percent of crude fat means electrical conductivity increase as the percent of crude fat decrease. Crude fat is due to non-polar compounds so increase nonpolar compound in a given solution make decrease in conductivity. As Table 9 show that Percent of moisture contents has negative correlation with percent of crude proteins, percent of ash and gross energy means decrease percent of moisture content in a given sample increase the amount percent of crude protein, ash and gross energy because percent of crude protein, ash and gross energy can be calculated or analyzed in the laboratory after moisture contents removed (become dried) in a given sample. as Table 9 indicate percent of crude fiber has negative correlation with percent of carbohydrate and gross energy means as increase the value of percent of crude fiber the value percent of carbohydrate and gross energy become decrease. Crude fiber is the indigestive carbohydrate component that is present in plants where as carbohydrate is a substance contain highly digestible like reducing sugar and soluble protein Therefore as increase percent of crude fiber value the carbohydrate value become decrease.

4.5 Mineral contents of Tell residue

4.5.1 Analytical method Performance of FAAS

Before determination of mineral contents of Tell residue samples by using FAAS, calibration curves for Ca, Mg, Fe, Cu, Cr and Pb metals were constructed using five concentration points ranging from 1 – 5 mg/L. The obtained curves linear dynamic ranges (LDR), LOD, LOQ and coefficient of determination (R^2) are presented in Table 10.

Table 10. Analytical method performance of FAAS for selected metals

Metals	**LDR mg/L**	**LOD**	**LOQ**	**R^2**
Ca	1.0 -5.0	0.03	0.1	0.9991
Mg	1.0 -5.0	0.08	0.27	0.9988
Fe	1.0 -5.0	0.01	0.03	0.9980
Cu	1.0 -5.0	0.11	0.37	0.9995
Cr	1.0 -5.0	0.14	0.47	0.9986
Pb	1.0 -5.0	0.02	0.07	0.9984

4.5.2 Recovery Study

Spiking of known concentration standard is usually used for recovery study in the absence of

Certified reference material (CRM). The obtained percent of recovery are presented in Table 11. It was observed that the percent of recovery of the studied elements ranging from 87.49 – 98.19 %, which is within the acceptable range for metal analysis, indicating good accuracy of the method.

Table 11. Recovery study of the spiked Tella residue sample Concentration in mg/L

Metals	Un spiked sample (mg/L)	Spiked amount (mg/L)	Spiked sample (mg/L)	Recovery (%)
Cr	0.14	3.0	2.9	92
Cu	0.81	3.0	3.48	89
Pb	0.03	3.0	2.76	91
Fe	2.27	3.0	5.15	96
Ca	12.86	3.0	15.65	93
Mg	5.39	3.0	8.09	90

4.5.3 Minerals contents of Tella residue samples

The mineral contents of the Tella residue was determined by using FAAS and the obtained results are presented in Table 12.

Table 12. Mineral content of Tella residue samples (Mean ± SD, mg/Kg, n =3)

Metals	Current study Tella residue(ppm)	Reported [93] Teff straw (ppm)	Reported[94] Filter cake
Ca	656.70±5.79	2229 ± 94	25.02(%)
Mg	274.74 ±4.97	755 ± 47	45.89(%)
Fe	79.16 ±1.53	108 ± 9	34.33(ppm)
Cu	7.73 ±1.28	4.4 ± 0.2	1.89(ppm)
Cr	1.55 ± 0.33	3 ± 0.3	0.26(ppm)
Pb	0.40 ± 0.15	< 3	0.17(ppm)

Tella residue may also play a vital role when animals use as a supplementary feed so human being can get milk (calcium source) from animals. From the current study, the Ca contents of Tella residue was found to be 656.70±5.79 mg/kg. The highest Ca content can detected in Tella residue when compared with the concentration of Mg, Fe, Cu, Cr and Pb. From the current study as shown Table12 the obtained Mg contents in Tella residue were (274.74 ±4.97) mg/kg.The highest Mg content can detected in Tella residue when compared with the concentration of Fe, Cu, Cr and Pb but lower content than Ca. This variation difference between Mg with these other metals may due to variation of minerals content in the soil and minerals content in the water from different ingredient used during Tella preparation.

From the current study as shown Table 12 the obtained Fe contents in Tella residue were (79.16 ±1.53) mg/kg. Fe content is higher than Cu, Cr and Pb in Tella residue but lower than Ca and Mg. From the current study as shown Table12 the obtained Cu contents in Tella residue were (7.73 ±1.28) mg/kg. From the current study as shown Table 12 the obtained Cr contents in Tella residue was (1.55 ± 0.33) mg/kg. When compare the concentration of Cr with the Ca, Mg, Cu, and Fe it's lower in Tella residue but higher than Pb.

From the current study as shown Table 12, the obtained Pb contents in Tella residue were (0.40 ± 0.150) mg/Kg. When the concentration of Pb in Tella residue compared with other metals like as Ca, Mg, Fe, Cu, and Cr it has least in concentration. High concentration of Pb consuming animals is not supported due its toxicity even in lower concentration. When compared to Tella residue minerals contents with other animals feed like Teff straw minerals contents from Table 12 the value of Ca,Mg, Fe,Cr and Pb in Teff straw is higher than in Tella residue except Cu where as higher in Tella residue, even though the contents minerals in Tella residue is lower than in Teff straw its important when the scarcity of animals food is occur used as a supplementary food.in addition to this Tella residue is one of the best animals feed due to the best minerals content like Ca,Mg,Fe and Cu.

As Table 2 show the recommended minimum element concentrations of calcium and Mg in pasture dry matter both for cattle and sheep has higher than the recommended minimum element concentrations in Tella residue. But As Table 2 show the recommended minimum element concentrations of iron and copper in pasture dry matter for cattle has lower than the recommended minimum element concentrations in Tella residue but higher copper in pasture dry matter then Tella residue for sheep. When compare the Ca, Mg contents in Tella residue with Filter cake(by product of sugar cane which used as feed stuff for cattle) present in Table 12 Ca and Mg content in Tella residue was lower than in filter cake while the concentration of Fe,Cu,Cr and Pb in Tella residue has higher than in Filter cake. Generally macro nutrient mineral like Ca, Mg in Tella residue was less than the macronutrient in filter cake but when compare the trace nutrient mineral like Fe,Cu present in Tella residue has higher than present in Filter cake.

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In the present study, the physico-chemical, nutritional values as well as their correlation and mineral compositions in Tella residue sampled from different location in Jimma city were studied. The finding demonstrated that Tella residue samples collected from Dawro Ber contain relatively the highest electrical conductivity and Tella residue sample collected from Ajip Sefer contain the highest pH value than the other samples. Tella residue sample collected from Kochi Sefer contain the highest % moisture and % crude fat where as Tella residue samples from Ajip Sefer contain the highest % crude protein,% ash and % gross energy where as Dawro Ber and Sar Sefer contain the highest % crude fiber and % carbohydrate respectively. These variations in nutrient content greatly reflects the differences in some of the raw materials utilized during Tella preparation and the fermentation time. From a different five location collected samples (Composited samples) of Tella residue collected in Jimma city ‘’Ca’’ contains the highest concentration than Mg, Fe, Cu, Cr and Pb. Generally Macro minerals content in Tella residue were higher than Micro minerals contents in Tella residue. In general, the finding shown that Tella residue contain appreciable amounts of nutrients and minerals Therefore, increasing its production and consumption as a feed for animals is helpful to supplement/formulate diets and alleviate the problems associated with malnutrition and Mineral deficiencies in animals.

5.2 Recommendations

Based on the findings the researched would like to forward the following recommendations.

- Maximizing production and consumption of Tella residue needs as a food for animals to be encouraged in all part of the country because of its good nutrient contents and Macro minerals like Ca and Mg.
- The concentration of other macro minerals like phosphorus, sodium ,chloride and micro minerals like cobalt, potassium, iodine, zinc, manganese, molybdenum, fluoride, selenium and sulfur were not studied be need be assessed.
- Other types of traditional local beverage by product like Areki residue which was used as supplementary animals feed should be analyzed the nutritional value and minerals contents. The researcher believes that Tella residue production has not received the scientific attention that it deserves. Therefore, research has to be done to improve community awareness about the

potential of Tella residue as a commercially workable enterprise that can contribute to small-scale Tella maker' 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 Tella residue that can be reliably traded for income since majority of the women in the study areas were illiterate and also have no control over financial resources due to wrong cultural perceptions towards them.
- To alleviate feed marketing problems that were aggravated due to absence of feed processors and sellers, the local authority should organize interested farmers or landless youths to make an association that aims to supply feeds to local farmers. Credit service should also be Facilitated in order to promote those individuals or groups involved in livestock feed marketing.
- There was seen different variation of nutritional and mineral value between the same feed stuff from different researcher result so to minimize the gap different value of nutritional and mineral result it require repeatly work or update.

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APPENDIX 1

Interview questionnaire during Tella residue samples collected.

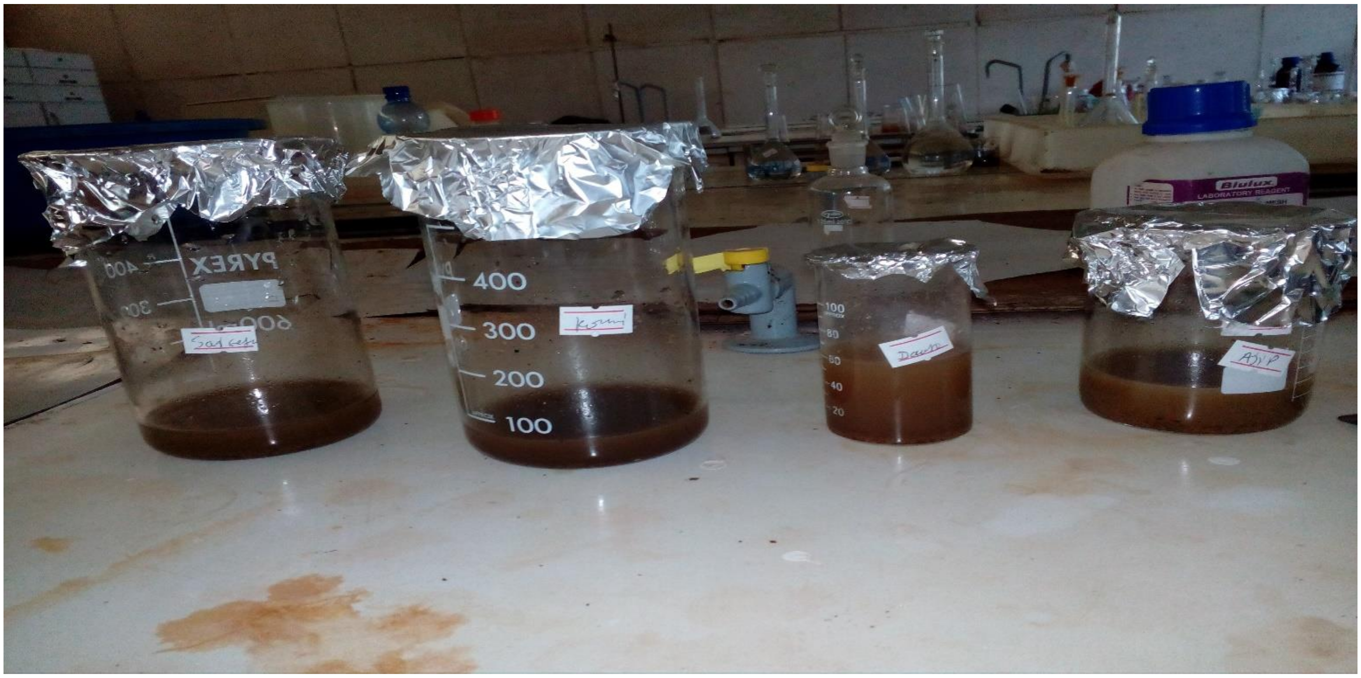
1. What ingredients do you use in Tella preparation?
2. What are the main steps in the preparation of Tella?
3. After how long the Tella is ready its residue is separated?
4. What do with the Tella residue? Do you discard it? Or used to feed animals?
5. How often you prepare Tella?
6. How much kilograms of cereals, approximately, do you use in one batch production of Tell?

APPENDIX 2.

Photo (A-F) depicting during nutritional analysis of Tella residue in laboratory.

A. composite of Tella residue collected from different location

B. Solution of Tella residue prepared during measuring pH value.



C. Dried sample of Tella residue for reserve prepared

D. Powdered Tella residue

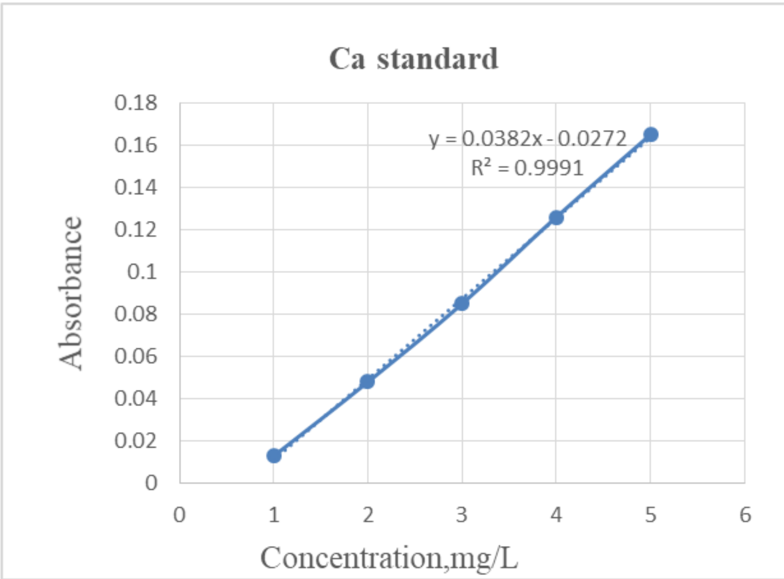
E.Powdered Tella residue for further analysis

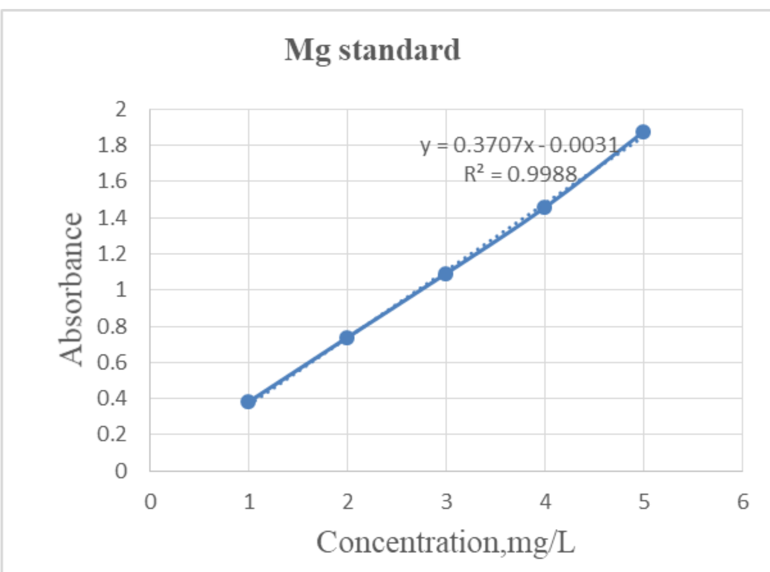
Furring Crude fat extraction

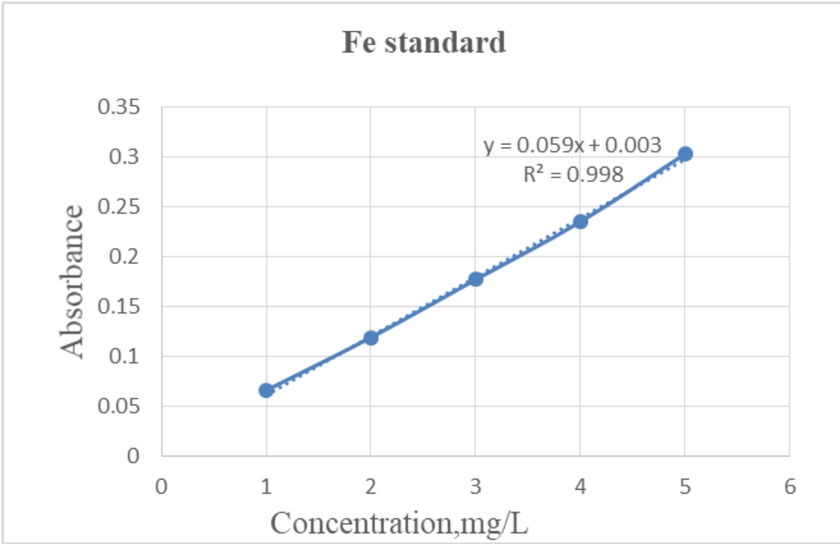
F. Dried crude fat after soxhlet extraction accomplished

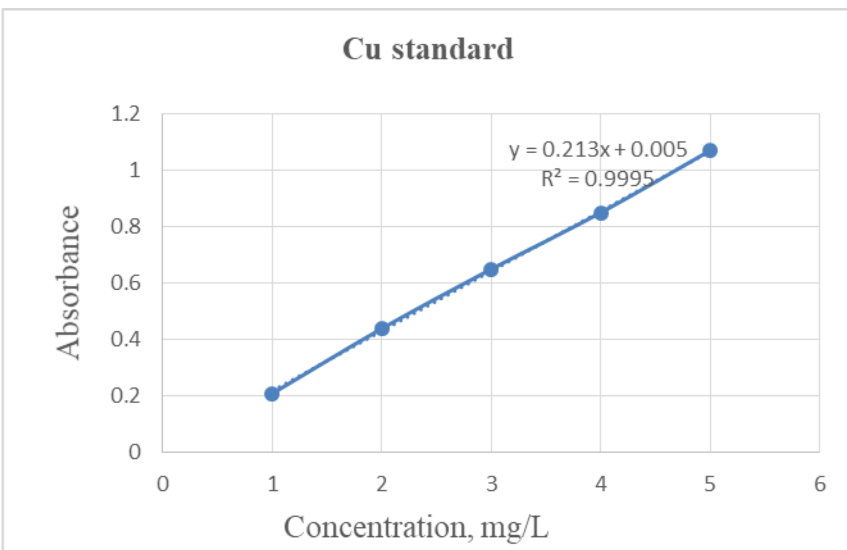
APPENDIX 3.

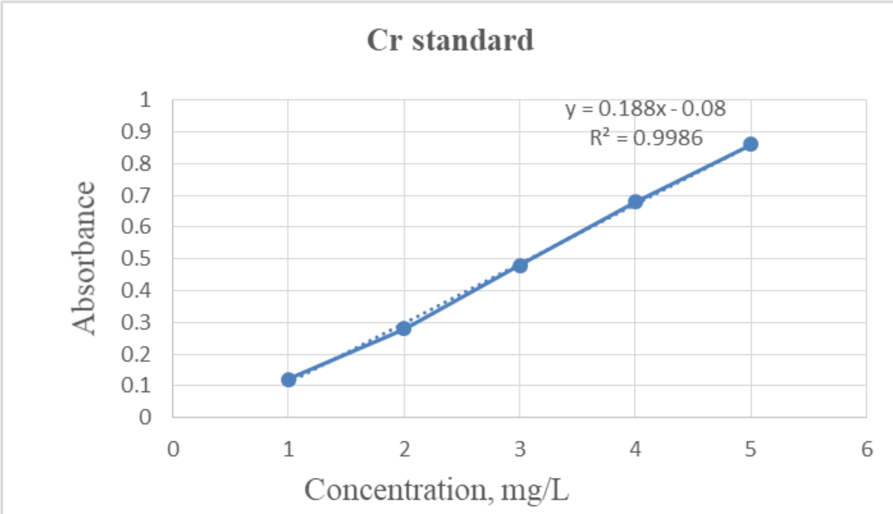
Calibration curve for the use of standards.

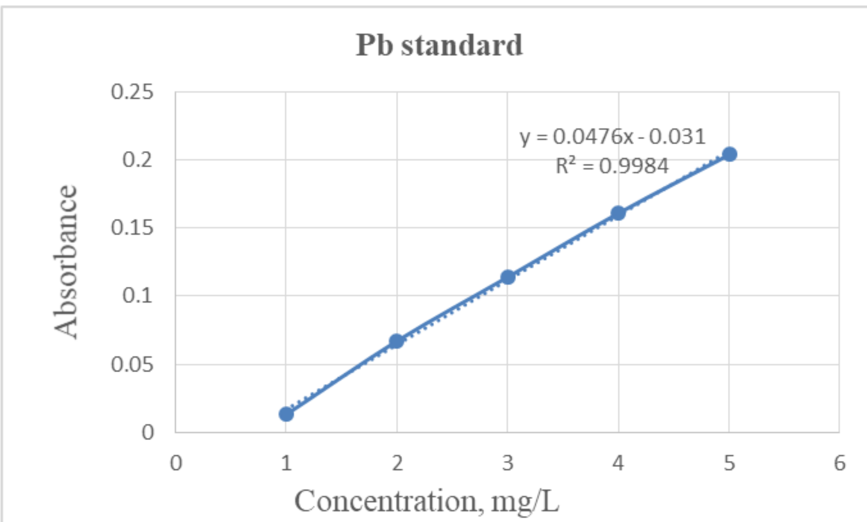





Fe standard
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Absorbance
y = 0.059x + 0.003
R² = 0.998
0
1
2
3
4
5
6
Concentration,mg/L


Cu standard
1.2
1
0.8
0.6
0.4
0.2
0
Absorbance
y = 0.213x + 0.005
R² = 0.9995
0
1
2
3
4
5
6
Concentration, mg/L


Cr standard
y = 0.188x - 0.08
R² = 0.9986
Absorbance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
Concentration, mg/L


Pb standard
y = 0.0476x - 0.031
R² = 0.9984
Absorbance
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
Concentration, mg/L

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
PH Meter	15	.89	3.34	4.23	58.61	3.9073	.08119	.31445	.099
Temperature	15	1.20	19.00	20.20	295.80	19.7200	.09113	.35295	.125
Electrical Conductivity	15	30.40	123.40	153.80	2030.80	135.3867	2.69224	10.42702	108.723
% Moisture	15	5.50	15.50	21.00	278.92	18.5947	.44163	1.71041	2.925
% Crude Fat	15	2.10	3.50	5.60	66.40	4.4267	.16803	.65079	.424
% Crude Protein	15	3.24	15.83	19.07	266.38	17.7587	.23552	.91216	.832
%Ash	15	7.02	14.94	21.96	267.04	17.8027	.52573	2.03614	4.146
% Crude Fiber	15	1.05	3.50	4.55	59.60	3.9733	.09062	.35095	.123
Total carbohydrate	15	8.75	33.06	41.81	559.91	37.3273	.66006	2.55641	6.535
Total Gross energy	15	36.84	237.99	274.83	3868.15	257.8767	3.11590	12.06785	145.633
Valid N (listwise)	15								

One way of ANOVA between and within physico-chemical and proximate analysis of Tella residue at 95% confidence level.

		Sum of Squares	df	Mean Square	F	Sig.
PH Meter	Between Groups	1.381	4	.345	1056.908	.000
	Within Groups	.003	10	.000		
	Total	1.384	14			
	Between Groups	1520.604	4	380.151	2512.011	.000

Electrical conductivity	Within Groups	1.513	10	.151		
	Total	1522.117	14			
% Moisture	Between Groups	34.369	4	8.592	13.043	.001
	Within Groups	6.588	10	.659		
	Total	40.957	14			
% Crude Fat	Between Groups	5.543	4	1.386	35.836	.000
	Within Groups	.387	10	.039		
	Total	5.929	14			
% Crude Protein	Between Groups	8.484	4	2.121	6.702	.007
	Within Groups	3.165	10	.316		
	Total	11.649	14			
%Ash	Between Groups	1.586	4	.396	28.663	.000
	Within Groups	.138	10	.014		
	Total	1.724	14			
% Crude Fiber	Between Groups	36.139	4	9.035	4.125	.031
	Within Groups	21.903	10	2.190		
	Total	58.042	14			
Total carbohydrate	Between Groups	68.593	4	17.148	7.488	.005
	Within Groups	22.900	10	2.290		
	Total	91.493	14			
Total Gross energy	Between Groups	1438.685	4	359.671	5.993	.010
	Within Groups	600.176	10	60.018		