DEBRE BERHAN UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF CHEMISTRY

DETERMINATION OF THE LEVELS OF SOME SELECTED METALS (K, Ca, Mg, Fe &Zn) IN POTATO TUBERS GROWN IN ARSI SERU WEREDA

Thesis Submitted to the School of Graduate Studies of Debre Berhan University In partial fulfillment of the Requirements for the Degree of Master of Science in Chemistry.

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ASSURANCE OF PRINCIPAL INVESTIGATOR

The undersigned agree to accept responsibility for the scientific, ethical and technical conduct of the study project and for provision of required progress reports as per terms and conditions of the University in effect of Grant, if grant is awarded as the result of this application.

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DECLARATION

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

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This thesis has been submitted for examination with my approval as university advisor.

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Table of content

Contents

List of table

List of figure

List of Abbreviation

FAO: Food and Agricultural Organization

FAOSTAT: Food and Agricultural Organization of the United Nation Statistics Division

CSA: Central Statistics Agency

WHO: World Health Organization

CHO: Carbohydrate

T2DM: Types 2 diabetes mellitus

BV: Biological Value

VAD: Vitamin A deficiency

CVD: Cardiovascular Disease

ICP: Inductively coupled plasma

ICP-AES: Inductively coupled plasma –Atomic Emission Spectroscopy

%RSD: Percent Relative Standard Deviation

Abstract

Potato (Solanum tuberosum. L) is one of the most widely used as a staple food crop for human diets. It is an excellent source of minerals. In this study, contents of K, Ca, Mg, Fe and Zn in potato cultivars cultivated in Seru district of Arsi Zone, Ethiopia were determined by Inductively Coupled plasma Atomic Emission Spectroscopy. A 2g oven –dried potato sample was digested using a mixture of 6NHCl at 65 ^{0}c for 7hrs. The concentration ranges in dry weight basis in decre asing order were K(16,683.43 ±65.15mg/l),Mg(733.49±17.17 mg/l),Ca(357.18 ±3.56 mg/l),Fe(3 30.04 ±6.70mg/l) andZn(19.74±5.84 mg/l). The K found in high content due to its macro element while Fe was the most abundant microelement. A wide range of variations was observed in the metal contents of potato cultivars collected from the two sites. Potato cultivars grown in Arsi Ethiopia could contribute a substantial amount of Fe and Zn together with the major elements K and Mg in the individual's daily dietary needs if consumed on a regular basis. Further studies with reference to other essential and non-essential elements have to be done including other missed elements in this research.

Keywords: potato, Solanum tuberosum L, Inductively coupled plasma Atomic Emission Spectroscopy, Mineral, Ethiopia

CHAPTER ONE

1. Introduction

1.1 Background

Potatoes are tubers belonging to the Solanaceae family and the genus Solanum(Luis *et al*., 2011; Nugussie *et al*., 2014).In terms of human consumption ,potato is the third most important non-grain food crop in the world after rice and wheat (CIP,2017). However, the crop was introduced to Ethiopia in 1858 by the German botanist known as Shimper (Berga et al., 1992).

According to Lemma Tessema et al, 2018 and Zebenay Dagne et al, 2018 potato is the third most important food crop worldwide after rice and wheat in terms of human consumption and global production exceeds 374 million metric tons. Potato is one of the stable food sources in the world, which have high carbohydrate and low fat content made it a better energy source than cereal for human consumption (Dean, 1994).

Research indicated that approximately 5000 varieties of potatoes are available all over the world of which solanum tuberosum, is the most cultivated species (Burlingame et al. 2009, Lutaladio and Castaldi, 2009). Potatoes are diverse in tuber shapes, size, color, flavor, taste, texture, storage quality and cooking quality (Luis *et al*., 2011; Evers and Deußer 2012). Potato has a more dominant place in the diet of people in develops and developing countries since it can grow quickly cheaply and freed entire populations from hunger (Burlingame *et al*., 2009, Lutaladio and Castaldi, 2009). Potato serves as food and income security to farmers, especially during seasonal food shortage or hunger as potato attain physiological maturity earlier than cereal crops (Sanginga et al, 2009). In Ethiopia, potato is the most important crop in terms of volume consumption among tubers and root crops (CSA, 2010).

Worldwide currently potato is the fourth most important food crop in production after maize ,wheat and rice (FAO 2008,2009, Ayalew2014).Furthermore ,it is a high- potential food security crop because of its ability to provide high yield of high- quality product per unit input than the major cereal crops like maize (Hirpa et al .2010).In many of the countries ,the poorest and most under nourishes farm households depend on potato as a primary or secondary source of nutrition

because it produces large quantities of dietary energy and stable yields under conditions in which other crops may fail (Lutaladio and Castaldi 2009).

Besides to its low fat content ,potato supplies dietary fiber ,carbohydrate ,high-quality proteins ,vitamins and minerals (Burlingame et al.2009,Lutaladio and Castaldi 2009).It is a source of antioxidant compounds ,including polyphenols ,carotenoids and vitamins (Evers and Deußer 2012).The moisture content of freshly harvest potato is about 80% ,where 60-80% of the remaining dry matter is starch (Lutaladio and Castaldi et al.2009).The skins and/or fleshes of the ordinarily cultivates varieties of potato are white .yellow or red , which originates from the accumulation of anthocyanin(Zhao et.al.2009). At present, colored potatoes have attracted special interests in many countries due to their colorful appeals and excellent tastes (Zhao et al .2009).

Ethiopia is among the top potato producers in Africa, with 70% of its arable land in the high altitude areas being suitable for potato production (FAOSTAT 2008). In 2003 ,Ethiopia stood in the 10^{th} position from countries in the production estimating that production has increase from 280,000 tonnes in 1993 to around 775,503 tonnes in 2013(FAOSTAT(Food and Agriculture Organization of the United Statics Division 2015). Currently, potato is produce mainly in the western, central, eastern and southern highlands of Ethiopia (CSA 2008/2009, Bekele et al, 2011, Nugussie et al .2014). The north western part of the country is one of the major production areas and makes up over one third of the total area allottes to potato nationally (CSA 2008/2009, Bekele *et* al, 2011). Ethiopia has good climatic and edaphic conditions for high quality potato production, the national average yield is about 9 tons/ha which lower than the world average of 17 tons/ha (Endale et al, 2008a, Ferdu et al, 2009).

All edible plants are sources of minerals in the diet and also sources of heavy metals intoxication to consumers (Islam *et al*, 2007). Anthropogenic activities such as mining, industrial and domestic waste water and sludge, fertilizer and pesticide application to lands, as well as atmospheric deposition are the main sources of metal contamination in plants (Szynkowska e*t al,2009*, Wuana and Okieimen 2011). Among inorganic contaminants, heavy metals are important due to their non-degradable nature leading to bioaccumulation through tropic levels, which may have adverse biological effects (Wagesho 2015). Even at low concentration, elements

such as Cd, Cr, Ni and Pb are harmful to plants and humans (Golia et al, *2008*, Kirkillis et al, 2012, Parsafar and Marofi 2014).

Absolutely, the mineral distribution may vary within the potato tuber and geographical location (LeRiche et al, 2009, Luis et al .2011, Subramanian et al. 2011). Various countries of the world reports the mineral contents of potato cultivars (Navarre et al. 2009, Angelova et al . 2010, Luis et al.2011, Ozturk et al.2011, Srek et al. 2012).These finding shows that physico-chemical nature of the soil, geographical locations ,agricultural practices and climatic conditions of the various regions have significant influence on the levels of minerals in potato . In Ethiopia, potatoes are store for ware and seed in different traditional potato storage materials: underground storage, floor storage, raised beds and sacks.

However, potato yield loss in Ethiopia reaches 30% to 50% due to improper storage systems and post-harvest handling problems (Ayalew et al, 2014). Early harvesting, sprinkler irrigation, cleaning field, storage and separation of infeste tubers from healthy tubers are good cultural practice for the management of P. operculella under small holder farmer (Raman, K.V.1980).

However, there is a scarcity of information regards the levels of mineral in potato cultivars grown in Ethiopia except few reports on other aspects of potato like blooming its production ,paste and disease control mechanisms (Hirpa et al. 2010, Ayalew and Beyene 2011,Mekonen et al. 2011, Ayalew and Beyene 2012 ,Nugussie et al. 2014). Ethiopia has a unique topography and climatic conditions compare to other part of the world.

1.2 Statement of the problem

Many researchers have been done on chemical constituents and nutritional value of Potato in the world. There is published research done on the nutritional value of potato. Among its nutritive purpose, potato grain used to make medicine and preparing food for human consumption. People take raw potato juice for stomach disorders and water retention (edema).

According to Victor Kuete moderate consumption of the juice from the potato tubers is used in the treatment of peptic ulcers bringing relief from pain and acidity. Potato is used to make chips. Potato chips are the most popular snack consumed in people especially by children (Salvador, A., et al .2009).

Furthermore, there is a few published researched works that explains the nutritional value of potato sample. Therefore, the aim of this study will be determine the chemical constituents in potatoes (K, Ca, Mg, Fe & Zn) in Seru land. These findings showed that physic-chemical nature of the soil, agricultural practices and climatic conditions of the various regions had significant influence on the level of minerals in potato cultivars. However, there is no scientific evidence and study that shows the quality status explains the nutritional value of potato sample from the study areas in the Literature.

Faced with the above problem the quality of quality status explains the nutritional value of potato sample from the study area has never been assessed, the determination of the levels of some selected metals (K, Ca, Mg, Fe &Zn) is need in order to provide information on the extent of those menials value in these areas.

1.3. Objective of the study

1.3.1. General objectives

The general objective of this study is to determine the levels of some selected metals such as Potassium, Calcium, Magnesium, Iron and Zinc in potato tubers grown in Seru, Oromia Region, Ethiopia.

1.3.2. Specific objectives

The specific objectives of this study are:

- To determine the quantity (amount) of the level of K, Ca, Mg, Fe and Zn in potatoes.
- To evaluate by comparing the value of those mineral with other published works on potatoes.

1.4. Significance of the study

Farmers who live in Seru Woreda do not specifically know the advantage or purpose of farming potato. They do not farm potato vegetables purposefully, because they do not know the chemicals present in potato and the uses of these chemicals for our body. The significance of the study gives hint or understanding for farmers to farm the vegetables largely. Generally:

- It enabled concerned bodies to be aware of the nutritional value in potato.

- It Provide hint for stakeholder to consider the cultivation of potato in the study area.
- It is Basis for other researcher who interested in related topics for further study.
- It help people to aware about potato value.
- As well as it used to give information about these mineral value in potato.

CHAPTER TWO

LITERATURE REVIEW

The word “potato” comes from the Spanish word “patata.” The nickname “spud” comes from the digging tool will use in planting potatoes. Potatoes are kingdom plants Plantae, potatoes family Solanaceae & Genus Solana L-night shade p. Potatoes are members of the nightshade family, like tomatoes, eggplants and peppers. Potatoes are the family of Potatoes is the first vegetable grown in space. Potatoes are Potatoes is traditionally used to make vodka, although today most vodka is produced using fermented grains such as corn, wheat or rye.

2. Potato Production

FAO (2008) reports that potato is one of the world most important crop and consumed for more than 8000 years ago. Potato starts widely cultivate and expanding around the world in the 16th century. The crop is introduce to Europe and Asia in the 17th century and in Africa in the 19th century by Spanish from South America and Andes (Pliska; 2008). Nowadays, the annual world potato production is estimates to 300 million tons (FAO, 2008). Among this, Asia and Europe are the major potato producing countries, which cover more than 80% of the world production. Today, China is the biggest potato produce in the world which cover about 20%of world production (Pliska, 2008).Potato had been imported and grown in Africa for many years.

According to the report South Africa, Egypt and Morocco are the highest producer with productivity ranges 24.2 t/ha to 34t/ha, while Nigeria and Kenya are the least producer with productivity ranges 3.1t/ha to 6.7t/ha. But, in Ethiopia potato productivity in the same year 7.2 t/h, which is similar to the least producer countries (FAO, 2008). In Ethiopia, the main potato production season is from June to September which is called the rainy season.

Potato (Solanum tuberosum L.) is an important food security crop in Ethiopia that is grown in widely differing agro ecological zones and growing seasons. The country has four distinct seasons(Belg, Meher,Belmehr and Mesino) for production and these have been described by a number of workers (Gebremedhin et al.2008; Agajie et al.2008;Yazie et al.2009;;Gildemacher et al.2009;Kolech et al.2015).

The Belg season ,also called the short rainy season ,starts in January to June commonly used for potato production in Oromia (East and West Arsi) in the South Nations, Nationalities and Peoples' state(SNNP) and some areas of central Ethiopia.

The Meher season, also called the rainy season, starts from June to October. Potato production in Meher is common in Shashemene and surrounding areas (Agajie et al.2008; Kolech et.2015).Ethiopian Research Institutes are working to expand potato production into the Meher season by developing late blight resistant and early maturing varieties.

The Belmehr season overlaps the Belg and the Meher seasons. Belmehr potato production starts in March to August .Most potato production in northwest Ethiopia takes place during Belmehr. Most potato production (more than 62% of 179,000 ha) takes place during Belg and Belmehr seasons (CSA 2014).

2. Nutritional composition of potato

Potatoes are naturally gluten-free and they are packs with nutritional benefits needs for a life style. Potatoes are one of the world's most versatile vegetables. Foundation in a wide range of international and all—American cuisnes, potatoes are the perfect blank canvas for a variety of flavors. When your good health depends on eating a gluten –free diet. An ideal substitution for some of your favorite bread, grain and past based dishes, potatoes add a boost of nutritional benefits. Potatoes are low in calories a medium size bakes potato only about 110calories. They are good source of vitamins C and B6, fiber, antioxidants, manganese, phosphorus, no fat, sodium or cholesterol, more potassium than banana, resistant starch and pantothenic acid.

2.1 Carbohydrate

The potato is historically a starch rich staple food were originated over 7000 years ago in Peru as reviewed (Haverkort A.J 2013).

The third largest carbohydrate food sources in the world, with potatoes will be represent nearly half of all root crops consumed (International Potato Center 2018).

According to current UK government guide lines carbohydrate (CHO) intake will be maintained at a population average of approximately 50% of total energy intake (Scientific Advisory

Committee on Nutrition 2015) and this is strongly supported by a recent meta-analysis indicating that a carbohydrate intake of 50-55% is optimal (Seidmann S.B., et al 2018).

According to Scientific Advisory Committee on Nutrition 2015 the intake of free sugars within the recommendation will not be exceed 5% (Scientific Advisory Committee on Nutrition 2015). The world health organization (WHO) scientific update on carbohydrate in human nutrition (2007) which recommends a minimum of 50% of total energy intake from CHO, with free sugars will be restricted to <10% (Mann J., et al 2007) . Further recommend that carbohydrates consist mainly of starchy foods , such as potatoes pasta ,rice and bread at about one third of our total food intake (Eat Well-NHS.UK. 2018).Annual per capital data from 2013 also shows that potatoes and potato products are the third most consumed in the diet behind wheat and rice (FAOSTAT 2018).The maize rates higher interms of world production ,it is used in large quantities as a raw materials for the manufacture of glucose ,fructose and high glucose corn syrup as animal feed and which will be increasingly used for industrial application(Ranum P.,et al 2014).The nutritional value of the potato could easily be overlooked partly because it is not counted towards the five –a- day fruit and vegetable intake recommendation (Eat Well-NHS.UK 2018)and because it is often prepared with fats or oils. Increase income and perceived association of potato consumption with weight gain and chronic diseases like types 2 diabetes mellitus (T2DM) will be identified as some factors responsible for the change ,although low-carbohydrate ,weight –reducing diets have given conflicting results (Churuangsuk C.,et al 2018).

2.2. Protein

Potatoes contain all nine essential amino acids and complete protein (Woolfe 1987).A recent study examining the protein and amino acid content of commercially available plant based protein isolates found that potato protein will be superior to other plant based and similar to animal base3d proteins interms of essential amino acid content (Gorissen et al., 2018).Peptides isolated from potato protein (e.g. Potato protease inhibitor) will be shown antioxidant activity in vitro and some limited evidence from human studies suggests they may have a favorable impact on serum lipids and may enhance satiety (Hill et al.1990; Kudo et al.2009; Liyanage et al.2008).

The industrial proteins are defined as “proteins produced and or processed on a comparatively large i.e. industrial scale” (Voragen 2005).They include protein of animal, plant and microbial

origin. The four major global plant crops (potato, corn, rice, wheat) three of them including potato, corn, wheat and potato are sources of industrial proteins.

Potatoes have relatively high biological value (BV) of 90 compared with other key plant sources of protein (eg.soy bean with a BV of 84 and beans with a BV of 73) (Mc Gill et al., 2013).

2.3. Vitamins

Potatoes contain a variety of essential Vitamins such as vitamin C and vitamin B6. A medium potato provides 27mg of vitamin C qualifying it as an excellent source of vitamin C per FDA guidelines and potato will be not rival the vitamin C content(in mg) of citrus fruits and peppers, they do contribute significantly to daily vitamin C requirements. Data indicate that potatoes rank 5^{th} in terms of dietary sources of vitamin C for Americans (Cotton et al.2004; O'Neil et al.2012). Potatoes also contain the B vitamins riboflavin, thiamin and folate and are a good source of vitamin B6 (12% of the us daily value per serving). Most vegetables, processing and preparation methods do impact the bioavailability of certain nutrients in the potato, particularly water soluble vitamins. Nutrient loss appears to be greatest when cooking involves water (e.g., boiling) and/or extend periods of time at high temperatures (e.g., baking) (Bethke and Janksy 2008; Woolfe 1987). Vitamin C is probably most impact since it is not only water soluble but also, heat and oxygen labile(Mc Gill et al.2013;Liu 2013)

Vitamins A deficiency (VAD) remains the major cause of blindness in children increases the probability of morbidity and mortality due to infectious diseases. The Copenhagen consensus report developed in 2008 compiled a list of worldwide priorities that included the biofertification of staple food crops in order to provide nutritionally adequate amount of provitamin A for eliminating vitamin A deficiency (VAD) (Copenhagen Consensus). Potatoes are an excellent source of energy due to their high content of vitamin thiamin , starch fiber ,protein and folate but contain very low to null levels of provitamin A and vitamin B6,B12, D and E (USDA Food Composition database).β- carotene has the highest provitamin A activity and accumulates in plant food such as carrots ,apricots and peaches, but not in major staples such as rice , wheat ,maize ,potato and cassava that are the primary source of energy for those residing in developing region (Giuliano G et al.,2017). Potatoes will be contribute key nutrients to the diet vitamin C (Mc Gill et al., 2013).

2. 4. Minerals

Potatoes are known as an excellent source of mineral such as potassium (K), magnesium(Mg),iron(Fe) ,zinc (Zn) ,calcium(Ca) phosphorous(P) and manganese(Mn) (Bush way et al.,1984).

2.4.1. Potassium

Potassium is the thee third abundant minerals found in human body next to P & Ca. Potassium is a mineral that is under consumed by the majority of Americans with only 3% will be meet their daily requirement (Drewnuwski and Rehm 2013; DGA 2015). Potassium is an irregular heartbeat, loss of appetite and muscle cramps are deficiency symptoms of potassium (Wardaw 1996).Potatoes provides one of the most concentrated sources of potassium significantly more than those foods commonly associated with being high in potassium such as bananas, oranges and broccoki (DGA 2015) and research suggests it also one of the most affordable vegetables in the National School Lunch Program (Drewnowski 2013).

2.4.2. Calcium

Calcium is a mineral required by plants for a wide range of purposes, including signaling pathways within cells and structural roles and walls (White and Broadley, 2003).Adequate calcium is a critical aspect of the mineral nutrition of potatoes. Inadequate intake of calcium increases the risk of osteoporosis (bone loss with no apparent cause (Wardaw, 1996).Calcium is involved in both the structure and function of all plant cell walls and membranes. Abundant tissue calcium also increase the tubers resistance to self-rot during storage and may improve the performance of seed potatoes (Waterer, 2005).Calcium sensing proteins are involved in many cellular process like cytoplasmic streaming, organell and vesicles transport microtubes ,dynamics , cell division , chromosomes segregation , cell elongation ,tip growth and morphogenesis(Reddy,2001).Calcium is improves membrane stability, and has an influence on resistance of potatoes to environmental stresses including heat(Palta,1996), and microbial and nematode infection (McGuire and Kelman,1984).

2.4.3. Magnesium

Magnesium has several important role in plants including as an essential component of the chlorophyll molecule (White and Broadly 2009). Deficiency of magnesium is linked to high blood cholesterol, high blood pressure, pregnancy problems, weakness, muscle pain and poor heart function (Tortora, G.J.et al; 1990; Ensminger, M.E.et al.; 1995). Magnesium is another nutrient under consumed by the majority of American (Volpe 2013). A medium (5.3 oz) potato with the skin provides 48 mg of magnesium and recent research indicates potatoes contributes 5% of the total magnesium intake in the diets of Americans (Freed Mans and Keast 2011). Tuber magnesium concentration will be found to decrease from the stem end to the bud end in our study and some other studies (Johnston et al., 1968; Dekock et al; 1979; Shekhar and Iritani 1978).The uniform distribution of magnesium in tuber will be found in still other work (Bretzloff, 1971, Bretzloff and Mc menamin, 1971). Small amounts of magnesium will be appear in the starch granules (Brautelcht and Get chell, 1951; Blennow et al,. 2005).

2.4.5. Iron

Iron is an essential element found in the tissue of animals and plants even at normal ambient concentration. Iron is critical component of hemoglobin, myoglobin and cytochromes. Deficiency of iron results in anemia which is recognized by its symptoms such as low blood iron levels, small & pares red blood cells & low blood hemoglobin values (Tortora, G.J. et al .1997, Wardaw, G.M.; et al.1996, Ensminger, M.et al.1995 & Fifield, F.W.et al.1997).

In plants iron occur in chemical forms such as inorganic ions, inorganic metals oxides, organic acid salts and organic complexes (Broadly et al.2007, White and Broadly, 2005). Iron deficiency can also decrease learning ability of children (Tortora, G.J.et al.1997).High concentration of iron, found in the protein fraction and only a small amount found in the starch fraction (Horiguchi and Nishihara, 1981). 25% of iron in potatoes will be associated with the protein fraction as metalloproteinase complexes (Levitt and Todd, 1952). Iron disease causes over absorption and accumulation of iron, which can result in severe liver and heart damage (Wardaw, G.M.et al.1996). Potatoes is a good source of iron that promotes iron absorption FAO (2008).).

According to FAO (2008) potato is a good source of minerals such as potassium, calcium, magnesium, manganese, iron and zinc contains folate, pantothenic acid and riboflavin.

2.2.4.6 .Zinc

Zinc is an essential element found in the tissue of animals and plants even at normal ambient concentration. In plants zinc occur in chemical forms such as inorganic ions, inorganic metals oxides, organic acid salts and organic complexes (Broadly et al.2007, White and Broadly, 2005). High concentration of zinc found in the protein fraction and only a small amount in the starch fraction (Horiguchi and Nishihara, 1981). Zinc is playing metabolically role in plants. Zinc element partially interferes in most of the enzymes structure like dehydrogenases, aldoses & isomerase. In production of energy &crabs cycle Zn is effective (Alloway, 2004). Zinc is the most ubiquitous of the trace element in human metabolism.

Zinc is essential element for human, has been reported since 1994(Prasad, 31). A zinc defiency results in adequate growth, loss of appetite, inadequate mental function, reduced sense of test &smell, fall in immune function, hair loss &a persistent rash (Tortora, G.J.et al.1997, Wardaw, G.M.et al.1996, Ensminger, M.et al.1995 and Tsalev, D.L.et al .1984).

More than one hundred specific enzymes require zinc for their catalytic function. If zinc removed from the catalytic site, activity is lost; replacement of zinc restores activity (Manahan, Stanley E.et al.2003). According to FAO (2008) potato is a good source of minerals such as potassium, calcium, magnesium, manganese, iron and zinc contains folate, pantothenic acid and riboflavin.

2.5. Phytonutrients

Potatoes contain several types of phytonutrients including carotenoids , anthocyanin and chlorogenic and caffeic acids (Lachman J.,et al 2005).Potatoes also contain a variety of phytonutrients, such as carotenoids and phenolic acids (Brown et al.2005, Liu et al .2013,McGill 2013) and are the largest contributor of vegetable phenolic to the caronoids, such as lutein, zeaxanthin and violaxanthin are found mostly in yellow and red potatoes ,although small amounts are found in white potatoes (Brown et al.,2005).Potatoes will be reported as having approximately <40mg gallic acid equivalents/100g,compared to the highest measured,broccoli,which had>100mg gallic acid equivalents/100 g. The lowest group for

antioxidant activity, displaying 4.86µmol of vitamin C equiv/g of sample, compared with the highest, red pepper, which displayed 46.95µmol of vitamin C equiv/g of sample and also displayed minimal anti-proliferative activity.

2.6 .Cardiovascular Disease (CVD) and CVD Risk Factors

According to Larsson et al., will be investigate associations between potato consumption and risk of myocardial infraction, heart failure, stroke or mortality from CVD in Swedish men and women (Larsson S.C, et al., 2016). In a large cohort study investigating the relationship between fruit and vegetable consumption and risk of ischemic stroke ,total potato consumption is not associated with ischemic stroke risk ,although individual preparation not explored (Joshipura K.J.,1999).In a Chinese cohort, total potato consumption ,stir-fried and non-stir fried potato consumption will be associate with increased risk of developing HT(Huang M.,et al 2018).Arterial stiffness is an independent risk factor for the development of CVD (Safar M.E et al 2001). Tsang et al., will be explore the effects of an anthocyanin-rich potato, purple majesty (PM),on pulse wave velocity (PWV),a cinical measure of arterial stiffness(Tsang C.,et al 2018).

2.7. Blood sugar

Potatoes are the third most important food crop in the world after rice and wheat more than 1 billion people worldwide eat potatoes and global total crop production will be exceeds 374 million metric tons (AHermansen A., et al 2012). Potatoes belong to the vegetable group in US dietary guidelines (McGuire S., et al 2011), its consumption can influence glucose metabolism due to large amount of starch easily absorbed (McGill, et al 2013). Potatoes have high glycemic index (GI) and glucose load GL) (Nayak B., et al 2014; Dtl K., et al 2017). Some studies evidenced significant association of high GI diet and GL with an increased risk of T2D (Van Bakel MM., et al 2009; Salmeron J., et al 1997 and Ascherio A., et al 1997; Rimm EB, et al 1997). When potatoes will be heated the starch becomes more digestible which can result in raise blood sugars levels (Livia S.A Augustin., et al 2013). Prevention of T2D is a major public health challenge Alwan A, (2011). Genetic component of pathogenesis of T2D involves environmental factors that are potentially modifiable. Studies in nutritional epidemiology have highlighted the importance of dietary risk factors for T2D. The dose-response meta-analysis will be report increased T2D risk associated with greater than or equal to 3 eggs consumed per week low dairy intake and tea consumption of less than 3 cups /day (among women).World Health Organization (WHO) suggests T2D will become the seventh leading cause of the death worldwide by 2030 (WHO).

2.8. Blood pressure/ Hypertension

Research indicates that diets low in sodium and rich in potassium will be reduce the risk of hypertension and stroke (Androgue and Madiam 2014; Appel et al.2006; Seth et al.2014; Yang et al. 2011; Zhang et al. 2013). The US Food and Drug Administration (FDA) will be approved a health claim for potassium and blood pressure which states ,"Diets containing foods that are good sources of potassium will be reduce the risk of high blood pressure and stroke" (USDA FDA Labeling 2016). Higher potassium intake on the LNNAHK diet and OD diets will be given a list of potassium rich foods and in structured to eat a potato a day Nowson et al (2004). Recent study, Vinson et al. (2012) fed purple –pigmented potatoes (purple majesty cultivar) to 18 over weight (average BML of 29), hypertensive adult subjects for four weeks in cross-over design.

2.9. Physical Performance

According to Mitch Kanter and Chelsea Elkin 2019 reports with increasing access to sports dietitians, personal trainers, nutrition trackers and online apps, today's athletes(from the weekend warrior to the elite, competitive performer) are more tune with dietary trends and open to modifying their nutritional intake than before .Limiting carbohydrate consumption (and total calorie intake overall) may make sense for those who are less physically active ,but high activity individuals like athletes still need high-quality carbohydrates to enhance muscle glycogen storage and to deliver carbohydrate to muscle and other organs during strenuous exercise (Helge 2017;Maughan and Shirreffs 2011). The specific combinations may vary, but carbohydrates, protein and fluids are vital components of an active individual's diet, preferably from natural, whole-food sources (Murray and Rosenbloom 2018). Potato is often cited in the literature as a key example of a high-carbohydrate food that provides multiple nutritional benefits. A medium skin –on baked white potato (148g) is an excellent source of potassium (23%DV), vitamin C (24% DV), and vitamin B6 (23% DV) and a good source of dietary fiber (13% DV) and magnesium (10% DV) based on a 2000 kcal/day diet (Anonymous 2012). Potatoes is the most significant sources of dietary potassium and can provide health benefits from minimizing the risk of hypertension to supporting bone health. The dietary potassium serves as an electrolyte that helps athletes maintain fluid balance, a key factor during and after strenuous exercise that can help to stave off dehydration (James et al.2015).

CHAPTER THREE

3.MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Location

Seru Woreda is one of the administrative units of Arsi Zone in Oromia National Regional State. The capital town of the Woreda, Seru Abas, is located at about 300 kms away from Addis Ababa to the south-east and 175 kms from the Zonal capital, Asella to the East. Seru Woreda located between 7º 27' 05" N to 7º 54' 36" N and 40º 02' 56" E to 40º 43' 59" E. The size of the Seru is 1687.7 km^2. The Woreda is bordered by Amigna Woreda in the north, Balegasgar Woreda in the west, Bale Zone in the south, southeast, and east ; western Hararghe Zone in the north east. The Seru Woreda total area is 1687.7 km^2 and its annual rainfall is 800mm-1200mm.

3.1.2 .Apparatus and Equipment

During analytical study the laboratory apparatus was measuring cylinder, different in size beaker, test tube digestion flask, spatula mortar ,pipettes, funnel and volumetric flask, filter paper, beam balance, muffle furnace, porcelain crucibles, Inductively Coupled Plasma-Atomic Emission Spectrometry. All glassware and apparatus were soaked in detergents for 24hr and were rinsed with double distilled water.

3.1.3. Chemicals and reagents

For digestion of potato samples 1NHCl –dilute 83.3ml ,concentrated HCl to 1L deionized H_2O and 6N HCl- Dilute 50ml concentrated HCl to 100ml deionized H_2O. Double distilled water was used for dilution of sample and preparing working standard.

All glassware and apparatus were soaked in detergents for 24 h and rinsed with double distilled water. Then the sample were soaked and rinsed with double water and oven-dried at 65°C.

3.1.4. Sample collection storage and preparation

Fresh raw potato samples were purchased from the local markets of the towns and kept in plastic bags. In the laboratory, the samples were washed with tap water to remove the adsorbed soil

particulates and rinsed with distilled water. The sample were cut into small pieces before being oven dried to constant weight. The samples were then pulverized with ceramic mortar and pestle to fine powder. About 2g of dried powder sample were weighted and transferred into porcelain crucibles and place sample into furnace and increase temperature gradually until temperature reaches 540 ℃, ash for 6h after reaching temperature wet sample with a small amount of distilled H_2O, then add 5-10 ml of 6NHCl and bring to dryness on hot plate, dissolve ash by adding 10ml 1NHCl to crucible. Quantitatively transfer dissolved ash into 100ml volumetric flasks then wash down sample with distilled H_2O and dilute to volume with distilled H_2O and shake and finally place aliquot into ICP test tube.

3.1.5. Preparation of standard solution

Standard solution1000ppm of metal cartons or soluble metal compounds of K, Ca, Mg, Fe and Zn were used to prepare working standard for each metals from given standard solution, the working solution for each metal was used for quantitative analysis and to obtain right calibration curve.

3.1.6 Sample analysis

3.1.7 Inductively Coupled-Plasma- Atomic Emission Spectrometry.

Before starting any measurement, blank solution having all the things to that as working solution except analyte were run, and the concentration of elements were determined by ICP-AES. The samples were analyzed by Inductively Coupled-Plasma- Atomic Emission Spectrometry (ICP-AES). Air-acetylene flame, that used decompose sample at limited temperature, with air support will be used. The analysis was done using external calibration curve with a correlation coefficient$\geq$0.998. To check contribution of matrices to signal, spike a known amount of metal solution were spiked in sample solution and run in the ICP-AES.

3.1.8. Sample Digestion

Dry ashing method was used for digestion of the potato sample. The potato sample was washed with distilled water to remove absorbed soil and then cut into small pieces. The sample was put

into drying oven (Model 6x6SB Temp. range 10-300 ºC) and heated at a temperature of 65 ºC for 12 h. 2g of potato sample was accurately weighted into a digestion tube. The digestion tube were then placed on digestive box types resistance furnace (Model5x2-5-12G 120000 ºC) and heated at high temperature for 7 h until the sample was ashed. 6N HCl were measured and added into the digestive tube and swirled gently to mix the sample properly and the digestive sample was put on hot plate (Stuart Model, Model CB 302) 1NHCl were measured and added into the digestive tube and all the digests were cooled and filtered through whatman No.42 filter paper and diluted to 100ml by double distilled water. The sample was digested in replicates of five and transferred to acid washed stoppered glass bottle until analysis.

3.1.9. Statistical analysis and Validation

Determination of levels of some selected metals in potato samples were performed using inductively Coupled-Plasma- Optical Emission Spectrometry. Average values of three replicates were taken for each determination. Recorded data were organized in a table and the results of the experimental data were analyzed by using application of software MS EXCEL Version2010. Descriptive statistics like mean and standard deviation were used to describe the findings and results of the experimental data. Recorded data were organized and summarized that presented in table as mean ± standard deviation. The comparisons between the result and other published research on potato tubers were performed graphically. Finally, the analysis results were interpreted and compare with other published values.

Table 3.1: The Values of minerals in potato tubers as mean ± SD.

Metals	The values of minerals as mean ± SD (mg/Kg)
Ca	357.18 ±3.56
Mg	733.49±17.17
K	16,683.43 ±65.15
Fe	330.04 ±6.70
Zn	19.74±5.84

Chapter 4

Results and Discussion

Precision and accuracy

The most common terms related to analytical quality procedures to express the extent to errors in analytical measurements are accuracy and precision. Most of the common statistical methods applied in analytical chemistry are the standard deviation, relative standard deviation and range of series of measurements (Skoog et al., 1996).

The precision of analytical procedure expresses the closeness of agreement between a set of results. The precision of our analytical procedure is expressed as the r^2 of the calibration, the spike test and the recovery of our control sample which is the concentration limit.

The spiked sample were digested and analyzed following the same analytical procedure as the sample. Precision was expressed as relative standard deviation (RSD) of triplicate results. The relative standard deviations of the sample were obtained using Eq. (1) given as (Javed I et al, 2010 and William AC, Shelly LC, et al. 2010).

$$RSD = \frac{\text{Standard deviation}}{\text{Mean value}} \times 100$$

The percentage recoveries of the analyte were calculated to evaluate the accuracy of the analytical procedure. Recovery was then calculated using Eq. (2) given as (Javed I et al, 2010 and William AC, Shelly LC, et al. 2010).

$$\% \text{ Recovery} = \frac{\text{conc. In spiked sample- conc.in un spiked sample}}{\text{Actual spiked conc.}} \times 100$$

The precision of the results were evaluated by standard deviation and percentage of relative standard deviation (%RSD) of the analyte (Appendix).

4.2. Levels of Major and Minor Metals in potato samples

Calcium (Ca) Concentration: Of all the secondary macronutrient, calcium is required by plants in largest amount. The experimental value of calcium content in potato tubers was 357.18 ±3.56 mg /Kg. the recorded value was high as compared to the published value in USA and Ethiopia as shown on table 4.1.

Magnesium (Mg) Concentration: All the studied potato sample were found to contain high amount of Mg 733.49±17.17 mg/kg. Magnesium is one of essential secondary macronutrient and found in high amount in the soil .They are easy soluble and highly mobile into the plant tissue (Atlabachew and Chandravanshi 2008). the recorded value was high as compared to the published value in USA and Ethiopia as shown on table 4.1.

Potassium (K) Concentration: Potassium is primary macronutrient required by plants in large amount plant were absorbed from the soil in the form of K ion. In this studied potato samples were found higher concentration 16,683.43 ±65.15mg/kg. the recorded value was high as compared to the published value in USA and Ethiopia as as shown on table 4.1.

Iron (Fe) Concentration: Of all the micronutrient, iron is required by plants in the largest amount. Iron is essential for formation of chlorophyll. From the studied trace metals, Fe was found to be at higher concentration equal to 330.04 ±6.70mg/kg. the recorded value was high as compared to the published value in USA and Ethiopia as shown on table 4.1.

Zinc (Zn) Concentration: Furthermore, the farmers usually use manure and organic residues as fertilizer to enhance the production. Zn was found to be high concentration 19.74±5.84mg/kg. The higher concentration of in the potato samples could be attributed to their availability in the soil of the farmland. The high concentration of zinc in the studied samples could be due to the usage of organic and phosphate fertilizer as well as fungicides likes mancosim to flourish their production ((Dvorak et al.2003). the recorded value was high as compared to the published value in USA but less than Ethiopia as shown on table 4.1.

Table 4.1.Comparison of determined metals concentration (mg/Kg) of result and published reported values.

Metals	Values as mean ± SD (mg/Kg) of Arsi Seru	Published Values (mg/Kg)	
		USA	Ethiopia
Ca	357.18 ±3.56	13.2-127	176-254
Mg	733.49±17.17	117-361	420-438
K	16,683.43 ±65.15	10, 190-11995	11,189-13914
Fe	330.04 ±6.70	3.0-4.9	27.3-90.4
Zn	19.74±5.84	3.0-4.9	20.6-27.7

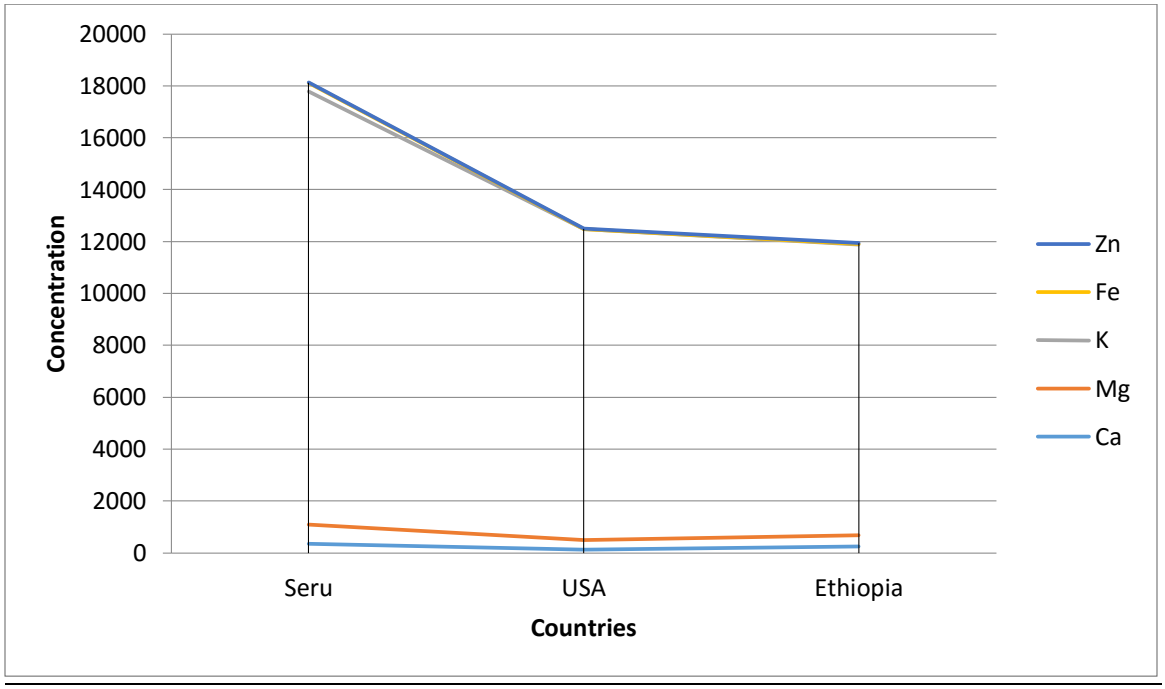

Figure4.1. Comparison of determined metals concentration (mg/Kg) of result and published values graphically.

5. Conclusion and Recommendation

5.1. Conclusion

The concentration levels of selected elements in the potato samples followed the trend K>Mg>Ca>Fe>Zn. The potato tuber contains substantial amount of Fe and Zn consumed together with major elements, K and Mg on a regular basis. The finding of this study have potential to promote the production and diversification of the potato consumption in Ethiopia.

5.2. Recommendations

It is recommended that:

- Further studies with reference to other essential and non-essential elements have to be done including other missed elements in this research.
- It is a bases for other researcher who interested in related topics for further study.

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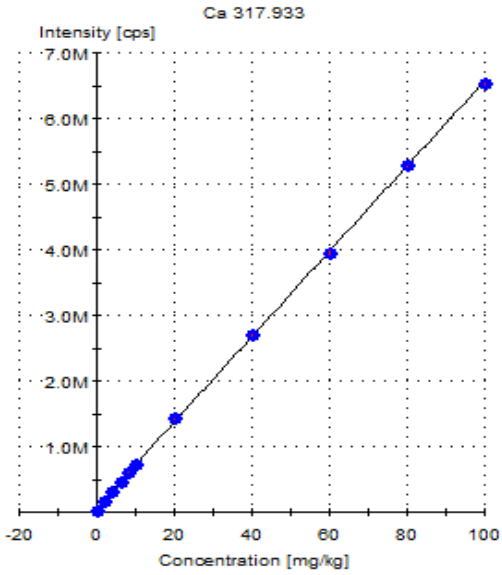
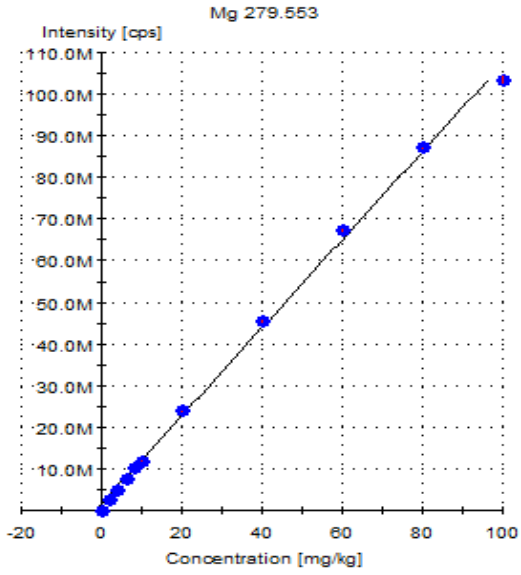
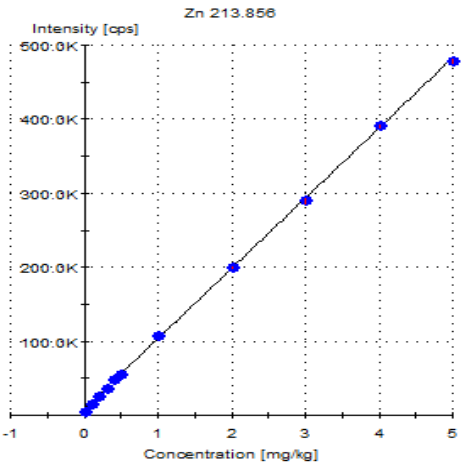
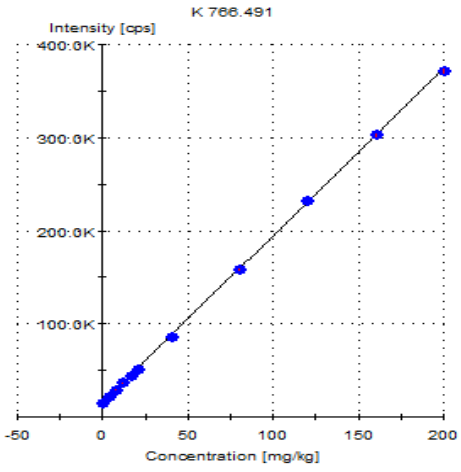
APPENDIXE

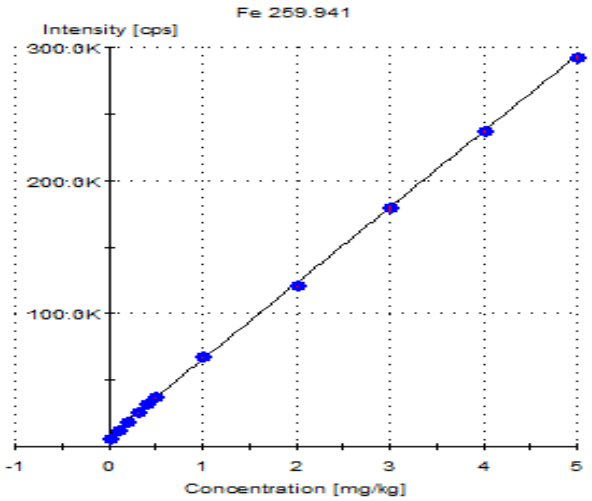
The calibration graphs of each of standard solution of metals of interest obtained are shown in figure below.










Fe 259.941
Intensity [cps]
300.0K
200.0K
100.0K
-1
0
1
2
3
4
5
Concentration [mg/kg]

Ashed potato sample

Inductively coupled plasma

Solution of potato sample

Horticoop Ethiopia (Horticulture) PLC

Soil and Water Analysis Laboratory

Analysis Certificate

Test Overview

Customer: Gebi Amano Ebrahim

Tel: +251 921 36 63 69

Address: Seru,

Country: Ethiopia

Information about sample			
Sampled By	*Client*	*Order Number*	*HEON-152/20*
Report Date	*August 20, 2020*	*Date Received*	*1-Aug-20*
Location	*Seru*		

Lab. Code	Discription	Conc.	Parameters				
			Ca	Mg	K	Fe	Zn
			mg/l	mg/l	mg/l	mg/kg	mg/kg
Blank	*Blank*	*Conc.1*	*3.59*	*< 0.004*	*10.65*	*< 0.07*	*< 0.096*
		Conc.2	*4.03*	*< 0.004*	*10.29*	*< 0.07*	*< 0.096*
		Conc.3	*4.87*	*< 0.004*	*11.94*	*< 0.07*	*< 0.096*
		Mean	*4.16*	*< 0.004*	*10.96*	*< 0.07*	*< 0.096*
		Stdv	*0.65*	*-*	*0.87*	*-*	*-*
HPA2651/20	*Potato*	*Conc.1*	*353.79*	*721.98*	*16,643.20*	*324.35*	*13.01*
		Conc.2	*360.88*	*753.22*	*16,758.60*	*337.42*	*22.84*
		Conc.3	*356.88*	*725.28*	*16,648.50*	*328.37*	*23.39*
		Mean	*357.18*	*733.49*	*16,683.43*	*330.04*	*19.74*
		Stdv	*3.56*	*17.17*	*65.15*	*6.70*	*5.84*
Added Concentration			*250.00*	*250.00*	*600.00*	*250.00*	*250.00*
HPA265120	*Potato Sample After Spike*	*Conc.1*	*659.65*	*1056.18*	*17,237.90*	*626.61*	*297.53*
		Conc.2	*659.79*	*1031.74*	*17,330.50*	*628.26*	*289.76*
		Conc.3	*661.20*	*1035.50*	*17,372.70*	*629.95*	*296.34*
		Mean	*660.21*	*1041.14*	*17,313.70*	*628.27*	*294.54*
		Stdv	*0.86*	*13.16*	*68.95*	*1.67*	*4.19*
	Recovery		*121.21*	*123.06*	*105.04*	*119.29*	*109.92*