



Wolkite University

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College of Engineering and Technology

Food Process Engineering Department

Title: Evaluation of the Effect of Garlic Extract and Calcium chloride coating on the shelf life and physicochemical quality of tomato

A Thesis Submitted to Department of Food Process Engineering in Partial Fulfillment of the Bachelors of Degree in Food Process Engineering

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Declaration

This document which is thesis project final report for partial fulfillment of the requirement for the course Bachelor Thesis and submitted on June 21/6/19 E.C to College of Engineering and Technology, Department of Food Process Engineering At Wolkite University and that no part has been plagiarized without citations. We further declare that the work organizes all the documents present on the following file, the report contains the entire process of the thesis, it also includes all the knowledge that we have got when we were on the work.

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Abstract

Tomato (Solanumlycopersicum) fruits due to their high moisture content are spoiled and deteriorate in short period of time. Once fruits are harvested, respiration and transpiration are the two major physiological processes that significantly affect storage life and quality of the fruits. These have good barrier properties to O₂, CO₂, moisture and water vapor. A 3x3 experiment layout in complete randomized design with 9 treatment combinations and three replication was adopted. The materials that were used for experiment were one variety of tomatoes and two treatment methods (coating by garli, and calcium chloride) and a control. Results from the experiment indicated that all treatments delayed the onset of weight loss, pH, total soluble solids, and total Titrabel acidity. The results also suggested that edible garlic coatings delayed the ripening process and color change of tomato fruits during the storage period and extended the shelf life. However garlic treatment and its combinations performed better than the other treatments. It was therefore recommended that locally produced coating materials such as garlic extract, is a good technology for preserving the quality and extending the shelf life of fresh tomato fruit as well as maintaining the physical and chemical properties. Generally, for stored tomatoes, consumers preferred coated fruits than uncoated fruits. Farmers and traders should be encouraged to use garlic extract, to coat their produce to maintain the quality of tomatoes.

Keywords: coating materials, tomatoes, harvesting stage, storage life

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LIST OF ABBREVIATION AND ACRONYMS

AOAC	Association of Official Analytical Chemists
APC	American Public performed
CA	Control Atmosphere
CALR	Calcium Chloride Replication
CR	Control Replication
GR	Garlic Replication
MAP	Modified Atmosphere Package
MOS	Micro Organisms
TA	Titration acidity
TSS	Total soluble solid
USA	United State of America
%WL	Percentage Weight Los

ANOVA TABLE UNDER APENDIX

Table .1 ANOVA for control treatment

Table .2 ANOVA for CaCl₂

Table .3 ANOVA for Garlic treatment

Table .4 ANOVA for Sensory analaysis of garlic

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CHAPTER ONE

1. INTRODUCTION

1.1 Background

Vegetables and fruits are a major horticultural crop. Widely used in the world. Tomato is one of the fruit and vegetable component and its estimated global production of over 130 million metric tons (Shahid & Abbasi, 2011). It is one of the most widely used vegetables in the world. Tomato is a crop of high economic importance in many countries as it is a relatively short duration crop and gives a high yield (Toyin, 2010). It is economically attractive and the area under cultivation is increasing daily in all parts of Ethiopia. Tomato is the most important crop in recently established dry season gardens in the Ethiopia especially in Amhara, Oromia, and Gambelia and in the Southern Regions. Tomato of the nightshade family is consumed in diverse ways, including raw, as an ingredient in many dishes and sauces and in drinks. Tomatoes and tomato-based foods provide a convenient matrix by which nutrients and other health-related food components are supplied to the body. Tomato forms a very important component of food consumed in Ethiopia and this is obvious in the fact that many Ethiopian dishes have tomatoes as a component ingredient. Tomato is a rich source of vitamin B and phytonutrients, the most abundant in tomatoes are the carotenoids, lycopene being the most prominent, followed by beta-carotene and gamma-carotene, as well as several minor carotenoids (Mujtaba & Masud, 2014). In spite of the modest levels of beta-carotene and gamma-carotene in tomato products, due to their provitamin activity, a high consumption of the vegetable and its products result in a rich supply of vitamin A in the body. Lycopene, an antioxidant, purportedly fights the free radicals that can interfere with normal cell growth and activity. These free radicals according to Shezi (2016) can potentially lead to cancer, heart disease and premature aging. Tomato fruits still live and respire after harvesting, however their quality and appearance change during handling. Shelf life is defined as the period in which a product should maintain a predetermined level of quality under specified storage conditions. Post-harvest weight change in vegetables is usually due to loss of water through transpiration. This loss of water can lead to wilting and shriveling, which both reduce market value and consumer acceptability. Edible coatings are used for

extension of shelf life of fruits and vegetables. These can also be safely eaten as part of the product and do not add unfavorable properties to the food stuff. They are environmentally friendly. In recent years, new edible films and coatings have been developed with the addition of various and edible herbs, antimicrobial compounds to preserve fresh fruits and vegetables. They control maturation, development and respiratory rate. Edible coatings prevent oxidative browning and decrease growth of microorganism in fruits and vegetables for example, Tomato, Cucumber, and Chees etc. Edible coatings or edible films are contributed to enhance the shelf life of fruits and vegetables by reduction of moisture loss, solute migration and gas exchange as well as by reducing the physiological disorders. Edible coatings have high potential to control browning, discolor activity, off flavor, microbial activity of fruits and vegetables and to extend shelf life. The main purpose of edible coating for fruits and vegetables is basically to increase the natural formation or structure.

If already present and to replace it in the cases where handling and washing have partially removed or altered it (Nadine, Jain, Gujarat, & Gujarat, 2005). Moreover, one of the most important things of this edible coating is the fact that they can be eaten together with the fruits and vegetables. So the use of edible coatings appears to be a promising approach to minimize these problems and preserve the freshness of tomatoes (Shahid & Abbasi, 2011).

Generally tomato is known for its outstanding nutritive and medicinal values and therefore grouped under protective foods. The fruits are eaten raw or cooked, and large quantities of fruits are used to produce soup, juice, ketchup, puree, paste, sauce and powder. Tomato fruit supplies minerals, vitamin A and B and is excellent source of vitamin C and adds variety of colors and flavors to the food. Tomato is a rich source of minerals, vitamins and organic acids, tomato fruit provides 3-4 per cent total sugar, 4-7 per cent total solids, 15-30 mg/100 g ascorbic acid, and 20-50 mg/100 g fruit weight of lycopene (Mujtaba & Masud, 2014)

The aim of this work is to investigate the combined effect of harvesting tomato and application of edible coating materials on storage life and quality of tomato fruits. Treatment combinations are the three harvesting stages of the tomato (mature green, turning and light red stages) and two coating materials (pectin from garlic extracting and calcium chloride (CaCl₂)) and with control.

1.2 Statement of the Problem

Tomatoes are one of the most valuable crops, nutritionally, and their global consumption is higher than other fruits. Its mineral nutrients are associated with the reduction of cancer and cardiovascular diseases. However, it is highly perishable and it has the shortest shelf life of all fruits. Kader, A. A. (2000) Developing countries experience high postharvest losses of tomatoes approximately 40-50% of tomato fruit quality loss occurs in developing countries like Ethiopia due to poor postharvest handling. The latest statistical estimates revealed that the Ethiopia tomato supply chain experienced a loss of about 10.2% due to inadequate handling, transportation and storage. This is one of the major constraints affecting small and large scale farmers. In 2001/02, approximately 3,300.55 of private holdings were under tomato cultivation and the total volume of fresh tomato harvested was 347,277.48 quintals. and also tomato fruits still live and respire after harvesting, however their quality and appearance change during handling. Post-harvest weight change in vegetables is usually due to loss of water through transpiration. This loss of water can lead to wilting and shriveling, which both reduce market value and consumer acceptability. Tomato fruits still live and respire after harvesting. Edible coatings are used for extension of shelf life of fruits and vegetables. These can also be safely eaten as part of the product and do not add unfavorable properties to the food stuff. and are environment friendly.

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1.3 Objectives

General Objective

- ❖ To Evaluate the effect of Garlic Extract and calcium chloride coating on the Shelf life and physicochemical quality of tomato fruit.

Specific Objectives

- ❖ To analyze the physicochemical quality of tomato coated with garlic extract and calcium chloride.
- ❖ To evaluate the effect of garlic extract and calcium chloride on the shelf life of tomato fruit
- ❖ To study sensory analysis of tomatoes coated
- ❖ To determine disease incidence of the coated tomatoes in each interval of the storage

1.4 Significance of Study

This thesis is contribute to extend shelf life and to maintain quality of tomatoes and also minimize post harvesting loss.

Therefore increase of large and small scale of farmers and also countries economy reduce the tillers of loss and health effect consumer and increase demand of consumer.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Overview of Tomato

Tomato is a plant in the nightshade family, as are its close cousins, tobacco, chili, pepper, potato and eggplant. The tomato is a native to central, south and southern northern American from Mexico to Peru. It is originated from the highlands of the west coast of South American. According to the British Tomato Grower Association, tomatoes first arrived in Europe via Italy in the 16th century and soon spread to the other parts of the world. When first introduced, it was known as the Golden Apples: pommes d' or in French (the French were also convinced tomatoes in the aphrodisiac properties and called them pommes d' amour or love apple), pomi d' oro in Italian and gold apple in Germany. Soon after the tomato's arrival in Europe, it was also known as the Peruvian. The Italians for tomatoes today is pomodoro. However, it was thought that the pueblo people believed those who witnessed the ingestion of tomato seeds were blessed with power of divination. The large, lumpy tomato, a mutation from smoother, smaller fruit, originated and was encouraged in Central America. This variant is the direct ancestors of some modern cultivated tomatoes. Two modern tomato cultivars group, one represent by the matt, wild cherry tomato, the other by currant tomatoes, both originate by recent domestication of the wild tomato plants apparently native to eastern Mexico. According Smith, tomato was introduced to France through province from Italy during the late 18th century and became a culinary symbol of the French Revolution due to its red color. They are widely eaten in French Cuisine (Toyin, 2010).

2.2 Tomatoes in Ethiopia

Ethiopia's wide range of agro-climatic conditions and soil types make it suitable for the production of diverse varieties of fruits, and vegetables, including the temperate, tropical and sub-tropical crops. Most of the soil types in fruits, and vegetables producing regions of the country range from light clay to loam and are well suited for horticultural production. Currently, tomato is one of the regional export crops of the country. In Ethiopia, the crop is grown between 700 and 2000 m above sea level, with about 700 to over 1400 mm annual rain fall, in different areas and seasons, in different soils, under different weather conditions, but also at different levels of technology (e.g. with furrow, drip or spate irrigation), and yields (Gemechiset al., 2011) The source of varieties of

fruits and vegetables in Ethiopia can be categorized into two major groups: exotic and endemic ones. State farms and newly emerged private commercial farms usually use exotic varieties, while the small farm holders are mainly confined to local or traditional varieties. Tomato is one among the major vegetables (cabbages, and onion) produced for domestic consumption while green beans and peas have recently emerged for export market. Tomato is a popular and widely grown vegetable crop in Ethiopia, ranking 8th in terms of the annual national production. It is consumed in every household in different modes, but in certain areas, such as Walo, Hararge, Shawa, Jimma and Wallaga, it is also an important co-staple food. It is (tomato) the most important day neutral warm season fruit-vegetable grown throughout the world. It has its origin from the mistition, city of Mexico where it was named as Tomatile. It can be eaten raw as salad or cooked, and are used in the preparation of products like: sauces, pickles, puree, paste, syrup, and ketchup. Tomato still remains as a choice crop of scientists because of its short duration nature, easiness in cultivation, large number of seeds in a fruit, easiness in hybridization and cytology works, and everlasting consumer demand due. The crop is one among the variety of vegetables Ethiopia has grown in different agro-ecological zones, and produced by commercial as well as small farmers both as a source of income as well as food. The introduction of cultivated tomato into Ethiopian agriculture dates back to the period between 1935 and 1940. The Ethiopian Institute of Agricultural Research was established in 1966; during which tomato was recognized as a commodity crop. Since 1969, 300 varieties were tested. However, among varieties tested most showed susceptibility to late blight, powdery mild, and mosaic virus (Gemechis et al., 2011). Tomato is the basic raw material required for the production of processed tomato and it is produced in sufficient quantity and quality locally. In 2001/02, approximately 3,300.55 ha of private holdings were under tomato cultivation and the total volume of fresh tomato harvested was 347,277.48 quintals.

Ethiopia has potential for the production and export of different fresh and canned vegetables and flowers to lucrative markets in the Middle East and southern Europe. Increasing of processing

(Gemchiset al., 2011) industries in Ethiopia indicates the importance of vegetables in foreign currency. Production of tomatoes and conversion into valuable finished products has become an important branch of Ethiopian Agro-industry. The economic and social impact of tomato industry is not only limited to the value of the produce in local currency. After covering the local

demand of canned tomato products, export markets are on the way to be opened with the respective earning of foreign currency. Furthermore, the incomes of thousands of families depend on the employments created by tomato production and processing. Substantial reductions of imports of horticultural products have taken place in the last few years through a systematic program of import substitution (Datta, 2013).

2.3 Centre of Origin and Distribution

Scientific information indicates that cultivated tomato has originated in a wild form in the Peru Ecuador area of the Andes. Its domestication took place in Mexico and the most likely cultivated. It was introduced into Europe in the early sixteenth century and had spread to Philippines' via South American and to Malaysia by about 1650. It was introduced into the USA at the end of eighteenth century. It is possible that it arrived in West Africa ports via Portuguese traders or was brought across the Continent from Egypt from Sudan (*Lycopersicon esculentum* var. *Ceraceiforme*).

2.4 Cultivation of Tomatoes

Tomato is grown throughout the tropical and the temperate region of the world. In terms of climatic tolerance, tomato is highly noted as one of the most adaptable cultivated plants. It thrives well in temperature 10°C to 30°C with optimum range of temperature of 21°C- 24°C. It requires low to medium rainfall and does well under average monthly temperature of 21°C to 23°C. Tomato does very well in most mineral soils, but it prefers deep, well drained sandy loams. Under layer of soil should be porous with little sand and good clay in the subsoil. Soil depth 15 to 20cm proves to be good for healthy crop to a wide pH range. A pH of 5.5-6 is preferred. Tomato is moderately tolerant to acid soil that is pH of 5.5. The soils with proper water holding capacity, aeration, free from salt, are selected for cultivation. It is susceptible to frost (Toyin, 2010).

2.5 Post-Harvest Losses of Fruit in Developing Countries

Post-harvest losses can be measured both by quality and quantity losses. The losses can appear in any stage of the supply chain during activities such as harvesting, transportation, packing and at market places. The qualitative losses are foremost due to biological deterioration including water stress, mechanical injuries, respiration rate, compositional changes and many more. These are often the effect of environmental factors such as temperature, humidity, sanitary factors and the concentration of ethylene,

carbon dioxide and oxygen. The qualitative losses are more complicated to measure, but the quantitative losses are of greater importance to measure in developing countries.

According to Ahmad & Siddiqui (2015), there are three strategies to lower losses of fresh produce; (1) use cultivars that have potential to last long after harvest, together with good flavor and high nutrition, (2) maximizing yield without lowering quality and (3) optimal handling of the product at all post-harvest stages. In developing countries there is a need for better education of producers, improved infrastructure in order for the products to reach the markets, developed value chains, collaboration between actors in supply chains and improved technologies in order to lower the post-harvest losses (Ahmad & Siddiqui, 2015). To minimize post-harvest losses of fruits and vegetables it is of high importance for the actors to apply suitable post-harvest technology procedures, in order to have long shelf-life and acceptable safety and quality of fruits.

Even though fruit and vegetables are produced in high quantities and with acceptable quality the products also need to reach the consumer in an efficient way, or losses will occur (Ahmad & Siddiqui, 2015).

This is the case in many developing countries, often due to bad communication between actors and shortage of market information. Another factor contributing to losses of fresh produce is the poor wholesale markets in many developing countries. The facilities for storage, unloading, loading and packaging are often poor or do not exist at all. Adequate transportation is another essential part of avoiding losses, which is often lacking in developing countries.

Fruits are fragile products and therefore need packaging to protect them from mechanical damage it is important to avoid compression damages on the fruit during storage and transportation. Therefore the packages need to be strong enough to protect the fruit and it is important not to load too much fruit on top of each other. The packages should also hold a weight of maximum 20 kg, as the fruit can be damaged when a heavy box is dropped on top of another. When fruits are transported the main goal should be to have as low amount of losses as possible. In developed countries most transports of perishable goods are cooled. To some extent the transports are also equipped with controlled or modified atmosphere, as well as equipment that controls humidity and vibration. Many fruits are sensitive to vibration and abrasion during transport, on soft fruit such as ripened mango and avocado the damages can be severe. A way to avoid this is to immobilize the

fruit inside the packages and to use smaller packages. One way to improve shelf-life and avoid chilling injuries of fruits and vegetables is to use heat treatment at 38 °C . The heat treatment is best performed in water, as it transmits heat in a more effective way than air. The length and temperature of the treatment is decided by variety and the environment where the fruit matures. Another way of avoiding chilling injuries and increase the quality of the fruit is low temperature conditioning, where the fruit is held just above its lowest tolerated temperature. Low temperature conditioning is more effective than heat treatment to prevent chilling injuries and increase the quality of fruits. Surface coating, wax treatment, controlled atmosphere and usage of the gas 1-Methylcyclopropene are used in well-developed supply chains for fruit and vegetables to extend the shelf-life. (Arah, Amaglo, Kumah, & Ofori, 2015).

2.6 Composition of Tomatoes

Characteristic of tomato fruits differs among the many tomato varieties. Ripe tomato contains about 94% water and 23mg/100g (Salunkhe, Jadhav, & Yu, 1974). The size of the fruit is influence by the availability water to the plant. The large amount of waters also makes the fruit perishable. As the tomato fruits develops, the percentage of fresh weight that is Sucrose decreases; while carbohydrate such as starch and reducing sugar increase. Sugar is mostly in unripe fruit; and starches are in ripe tomato fruits, about 5-7% of tomato fruit in solids.

The main sugar in tomato is glucose. Citric acid is the main acid in tomato juice; and the pH of the juice is normally between 4.0 and 4.5. The pH of the fruit increases throughout the development. Growing plant cell are surrounded by primary wall made of polysaccharide. The cell wall is a complex matrix which contains cellulose, hemicelluloses, pectin and structural protein and other components. The molecules are used to determine downstream phenotypic expression of the plant. As well as been popular with consumer, tomatoes are also highly nutritious. One medium tomato provides 40% of the USRDA of vitamin C and 20% of USRDA of Vitamin A which comes from B-carotene (Salunkhe et al., 1974). Tomato also provide potassium, iron, calcium, phosphorus, magnesium, sodium and Vitamin such as C, B, A, Thiamine, Riboflavin, Niacine and are also a good of dietary fibers

Fresh tomatoes generally, have soluble carbohydrates as reducing sugars and the predominant acids as citric and followed by malic acid. Glutamic acid is the main methionine and S-methyl methionine is also present. The pigments which develop in ripening are the yellow pigments, β carotene and Xanthophyll's', and at a later stage the red pigment Lycopene. A series of quantitative and qualitative changes of the chemical composition takes place during tomato fruit ripening.

Degradation of starch and production of glucose and fructose. The production of red color of the ripe fruit is due to loss of chlorophyll and the extensive accumulation of carotenoids, better carotene and Lycopene. Increase in soluble pectin resulting from wall softening and degradation.

Production of flavor and aroma compounds. There are more than 200 individual volatile Constituents but the significance and relative importance of these in flavor and aroma is far from clear. Increase in citric acid concentration at the mature growing stage. This remains at this level during ripening while malic acid concentration decreases. The ratio of malic acid to citric acid falls from 1.3-0.6 in the whole fruit during ripening, Increase in glutamic acid, Breakdown of the toxic alkaloid Salunkhe et al., 1974).

2.6.1 Chemical Composition of Tomatoes

Fresh tomatoes generally, have soluble carbohydrates as reducing sugars and the predominant acids as citric and followed by malic acid. Glutamic acid is the main methionine and S-methyl methionine is also present. The pigments which develop in ripening are the yellow pigments, β -carotene and Xanthophyll's', and at a later stage the red pigment Lycopene. A series of quantitative and qualitative changes of the chemical composition takes place during tomato fruit ripening.

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- The production of red color of the ripe fruit is due to loss of chlorophyll and the extensive accumulation of carotenoids, better carotene and Lycopene
- Increase in soluble pectin resulting from wall softening and degradation.
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- Increase in citric acid concentration at the mature growing stage. This remains at this level during ripening while malic acid concentration decreases. The ratio of malic acid to citric acid falls from 1.3-0.6 in the whole fruit during ripening.
- Increase in glutamic acid.
- Breakdown of the toxic alkaloid α -tomatine.

2.7 Factors Affecting Deterioration of Tomato Fruit Quality and Its Shelf Life

Tomato continues with metabolic processes after harvest, and these processes cannot be stopped but can rather be controlled up to certain limits. Therefore, to ensure maximized fruit quality, it is important to harvest fruit at the optimum maturity stage and during the correct time of the day. Tomato quality deterioration after harvest occurs due to physiological deterioration, biochemical changes and microbiological growth that are taking place within the fruit. (Bartz, Sargent, &Mahovic, 2009). There are many factors which affect the postharvest life of tomato fruit.

2.8 Coatings of Tomato

2.8.1 History of Coating Materials and Packaging

Edible coatings or edible films have been used for centuries in the food industry to preserve food products this is not a new preservation technique. Edible coatings have been used since 12th century in China. It was not until 1922 the waxing on fruits was invented and first time was commercially applied on fruits and vegetables. Edible films and coatings form a barrier for chemical, physical and biological changes.

At the time of purchasing fruits and vegetables, consumer judge the freshness and quality of the produce on the basis of its appearance. The most common and challenging problem are to maintain and control fresh quality, growth of spoilage and pathogenic microorganism in fresh cut fruit industry. The solution of this problem is edible coating. Edible coating provides an additional protective coating for fresh fruits and vegetables and can also provide the same effect as modified atmosphere storage in modifying internal gas composition. Recently, various edible coatings were applied successfully for preserving fruits and vegetables such as orange, apples,grapefruit, cherries, cucumber, strawberry, tomato and capsicum were applied successfully. Edible coating of fruits and

vegetables is successful or not totally depends on the control of internal gas composition(Raghav et al., 2016).

Edible coatings are defined as the thin layer of material which can be consumed and provide a barrier to oxygen, microbes of external source, moisture and solute movement for food. In edible coating a semi permeable barrier is provided and is aimed to extend shelf life by decreasing moisture and solute migration, gas exchange, oxidative reaction rates and respiration as well as to reduce physiological disorders on fresh cut fruits. according to (Raghav et al., 2016) different type of materials were used for coating and wrapping various fruits and vegetables to extend their shelf life, and this is eaten together with foods, with or without removal is considered an edible coating. Edible coating or edible films provide shiny appearance to fruits and vegetables. Thickness of edible coating is generally less than 0.3 mm. The main characteristic feature of edible coating is to increase shelf life of fresh or processed fruits and vegetables and it is protected from postharvest damages and environmental damages. An edible coating protects outer membrane of fresh fruits and vegetables. Under high relative humidity, edible coating should be stable, generally recognized as safe. Edible coating or edible films are mostly tasteless, colorless and odorless they should have good mechanical properties.

Edible coatings have good gas barrier and moisture barrier properties.

2.8.2 Definition:

Edible coatings are defined as the thin layer of material which can be consumed and provide a barrier to oxygen, microbes of external source, moisture and solute movement for food. In edible coating a semi permeable barrier is provided and is aimed to extend shelf life by decreasing moisture and solute migration, gas exchange, oxidative reaction rates and respiration as well as to reduce physiological disorders on fresh cut fruits.

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films are mostly tasteless, colorless and odorless they should have good mechanical properties. Edible coatings have good gas barrier and moisture barrier properties.

2.8.2.1 Properties of Coating Material

Properties of edible coatings are based on their molecular weight, molecular size and its chemical composition. These properties are following. Edible coatings have good barrier properties to water, moisture, O₂, CO₂, and ethylene. It improves appearance and mechanical handling to maintain structure and color of Fruits and Vegetables. Edible coating contains active components such as antioxidants, vitamins etc., they enhance nutritional composition of Fruits and Vegetables without affecting its quality. These coatings provide a protective covering on Fruits and Vegetables and enhance their shelf life.

2.8.2.2 Classification of edible coating

Edible coatings are having hydrophobic group, for example lipid-based or waxes, and hydrocolloids or hydrophilic group, for example polysaccharides-based, protein-based or combination of both groups to improve function of edible coating. Edible Coatings are not chemically synthesized and it is natural. It is generally used for good appearance and preservation of fruits and vegetables. The main advantages of edible coating are its edibility, non-toxic nature and cost effective as compared to other synthetic coating. Edible coating materials are generally made up of polysaccharides, proteins and lipids. The edible coatings are mainly divided into three classes; these are following.

- ✓ Hydrocolloids: e.g., polysaccharides, proteins and alginate.
- ✓ Lipids: e.g., fatty acids, acryl glycerides and waxes.
- ✓ Composites: e.g., protein/protein, polysaccharides/protein, lipid/polysaccharides

Edible coating materials are produced with a variety of natural substances such as polysaccharides, protein, lipids by the addition of surfactants and plasticisers. The function and performance of edible coating mainly depends on its mechanical, barrier.

Generally coating is defined as a thin layer of material which can be eaten by the consumer, be applied on or within the food by wrapping, dipping, brushing or spraying and act as barriers against transmission of gases, vapors and solutes and provide mechanical protection. Application of coatings to fresh produce has been one method of

extending its shelf life by slowing down its metabolic processes. With the advent of new materials for use as coatings and consumer demand for more naturalness in food, environment friendly coatings have become popular and a very wide list of applications has been found. Edible packaging materials include both edible films and edible coatings along with primary and secondary packaging materials originating from agricultural and marine sources (Valencia-chamorro, Oficial, & Oficial, 2015).

Edible coatings are used for extension of shelf life of fruits and vegetables. These can also be safely eaten as part of the product and do not add unfavorable properties to the foodstuff. Edible coatings or films increase the shelf life of fruits and vegetables and are environment friendly. In recent years, new edible films and coatings have been developed with the addition of various and edible herbs, antimicrobial compounds to preserve fresh fruits and vegetables. They control maturation, development and respiratory rate. Edible coatings prevent oxidative browning and decrease growth of microorganism in fruits and vegetables for example, Tomato, Cucumber, and Cherries etc. Edible coatings or edible films are contributed to enhance the shelf life of fruits and vegetables by reduction of moisture loss solute migration and gas exchange etc.; as well as by reducing the physiological disorders. Edible coatings have high potential to control browning, discolor activity, off flavor, microbial activity of fruits and vegetables and to extend shelf life. The main purpose of edible coating for fruits and vegetables is basically to increase the natural barrier, if already present and to replace it in the cases where handling and washing have partially removed or altered it. Moreover, one of the most important things of this edible coating is the fact that they can be eaten together with the fruits and vegetables important things of this edible coating is the fact that they can be eaten together with the fruits and vegetables(Raghav et al., 2016).

2.8.2.3 Garlic Extracts Pectin Treatment

The peeled garlic (200 g) and 500 ml of distilled water will be blended for 2 minutes and will be left for 24 hours in a shaking chamber/incubator. Extract will be concentrated in a rotary evaporator at 50°C for further use. The different concentrations of garlic extract (0%, 2%, 4%, 6% and 8%) were incorporated into the coating(Cheng, Cheng, Meng, & Tang, 2016).

.The garlic-tomato intercropping system has been shown to improve microorganism populations and the enzyme activity of the medium, increase tomato fruit quality and produce a higher net income than a monoculture system(Cheng et al., 2016) reported that

tomato-garlic intercropping or the application of a garlic oil blend or the garlic allelochemical diallyl disulfide (DADS) increased the population density of natural enemies. Numerous studies have revealed that garlic extract, volatile oil, allicin, and mercaptan sulfur compounds have strong antibacterial, antifungal, and antiviral activities. The antibacterial protective effect of garlic is due to its organ sulfur compounds.

2.9 Dipping calcium chloride solution (CaCl₂)

Three gram of CaCl₂ was measured by using beam balance and dissolved in 70% of distilled water and 60 samples of turning stage of tomatoes were randomly selected fruits and divided into 4 lots in equal (CR, BR, CaIR and GR). Each treatment was contained 15 fruits. The calcium chloride solution at 3% for 5 minutes was dissolved and dipped into the solution and after dipping the sample was dried for some minutes to remove the water. Then the samples were transferred into carton and kept at room temperature in corrugated soft board cartons.

2.10 Assessment of fruit quality

Tomato fruit quality is assessed using various parameters, such as physical, chemical, biochemical, microbiological and sensory properties. This is due to the fact that all of these parameters are the components of fruit quality (Wilkerson et al., 2015).

2.10.1 Quality of tomato

Quality is a very complex property and is the combination of attributes of a product that have significance in determining the degree of acceptability of the product to a user, and that determines its value or worth. The quality of agricultural product is an important factor to both the producers and consumers. Usually after harvesting, the quality of fruits and vegetables cannot be improved. All efforts are directed towards production quality. The most basic factor affecting quality is harvesting at the proper stage of maturity ("University of Ghana <http://ugspace.ug.edu.gh>," 2014).

2.11 Physicochemical properties

2.11.1 Quality evaluation by weight loss

Weight loss of the plastic film packed fruit was lower and linearly increased throughout storage. For unwrapped fruit weight losses were higher but also linear over the first 40

days, and then the rate highly increased. It could be due to senescence or more desiccation of tomatoes. There was no significant difference in weight loss value of tomatoes sealed with PE20 and PVC. Weight loss of fruit sealed in different films indicated that their weight losses were related to film permeability.

Weight loss of the fruits with respect to harvesting methods and calcium chloride treatments were studied. Harvesting method did not influence the weight loss of tomato. Physiological weight loss after 10 days of storage ranged from 15.07 to 15.27%. On the other hand, calcium chloride treatment significantly influenced the physiological weight loss of the fruits right after second days of storage and subsequently afterwards. After two days of storage, controlled fruits exhibited 4.2% weight loss which was significantly higher than calcium treated fruits.

Most fresh fruits are harvested while they contain approximately 70-95% of water thus have maximum fresh mass. The fresh mass of tomato fruit is dominated by water. Approximately 94-95% of tomato fruit is water and organic compounds only contribute about 6%, of which skin and seeds contribute 1%. Physiological mass loss occurs as a result of fruits continuously losing water through transpiration, resulting in softening, shrinkage, and fading appearance(Baraiya et al., 2012). The fruit physiological mass loss is greatly influenced by the storage temperature and relative humidity surrounding the produce.

2.11.2 Total soluble solids (TSS)

Total soluble solids (TSS) are important parameters in assessing maturity and quality of many fruits and vegetables. TSS is measured using a digital Refractometer which expresses the results in degree brix (°Brix indicative of the TSS percentage). °Brix defines the ratio of the total soluble solids to water in a solution. Sucrose, glucose and fructose are the major components of the TSS, and major determinants of fruit flavor. These sugars contain the majority of the total dry matter content of tomato and increases with fruit ripening stage and quality. TSS denotes the dry matter content of tomato fruit and it is inversely proportional to the fruit size(Vf et al., 2009). The increment of sugars with ripening stages of tomato is associated with metabolism of carbohydrates, proteins and lipids(Toyin, 2010). Tomato fruit flavor is determined by the amount of sugars (glucose, fructose and sucrose) and acids contained in it. The best flavor of tomatoes occurs as a result of high sugars and relatively high acids content,

because too high acid contents results in sour tomatoes (Toyin, 2010). High sugars are practically denoted by high TSS value; therefore, total soluble solids are good indicators of quality in fresh produce such as fruits and vegetables.

2.11.3 Titratable Acidity:

Titration acidity was determined by the method described by AOAC (2000). Ten grams (10g) of the sample was weighed in a clean beaker; 25 cm³ of distilled water was added to it and the content shaken together. The solution was then filtered using 10 ml of the filtrate was pipette into a conical flask and two drops of phenolphthalein indicator added. 0.1M NaOH was added drop wise and the solution shaken thoroughly until a pink color was obtained. Titratable acidity was expressed as percentage citric acid. Acidity in fruits is an important factor in determining maturity. Titratable acidity gives the total or potential acidity, rather than indicating the number of free protons in any particular sample. It is a measure of all aggregate acids and sum of all volatile and fixed acids. Titratable acidity (TA), also referred to as total acidity, measures the total acid content in a food or beverage system and is determined by titration of the acids in the food system with a standard base.

2.11.4 Determination of Total Sugar (Brix/acid ratio)

In climacteric fruits, carbohydrates accumulate during maturation in the form of starch. As the fruit ripens, starch is broken down into sugars.

Sugar/Acid Ratio was calculated by taking ratio between brix and Titration acidity. In many fruits, the acidity changes during maturation and ripening, and in the case of citrus and other fruits, acidity reduces progressively as the fruit matures on the tree. Normally, acidity is not taken as a measurement of fruit maturity by itself but in relation to soluble solids, giving what is termed the brix: acid ratio (Igoe & Edition, 2011).

2.11.5 Quality evaluation by pH

The term pH is used to express the concentration of free H⁺ in a sample and results from dissociation of the acids present. pH is defined as the negative logarithm of the hydrogen ion concentration, and can span a range of 14 orders of magnitude. $pH = -\log [H^+]$. A lower pH value indicates a more acidic sample due to free H⁺, and a higher pH value indicates a more basic sample. pH is the measure of the strength of the acids. Increase in pH in wax treated fruits might be due to high rate of metabolic activities, hence acidity decreased but pH increased and results in high TSS contents. An accurate

pH measurement is usually determined instrumentally with a pH meter. Most acid in the fruit is contained in the locules and acidity ranges in pH from 4 - 5 in tomato. A pH < 4.5 is required for processed tomato because microbial growth is inhibited. The pH values of the samples were measured weekly and directly using a pH meter (PHS 25). Five grams (5g) of each sample was first dissolved in 50 cm³ distilled water in a beaker and thoroughly shaken. The pH meter was standardized using buffer solutions pH 4. PH of the fruit juice harvested without retaining the stalk showed slightly higher pH compared to those harvested with stalk.

2.11.6 Citric acid

This is the major primary acid found in tomato fruit, and it is responsible for giving sourness in tomato fruit (Toyin, 2010). Tomato is known as one of the highly acidic fruits with a pH range between 4 and 4.5. Acidity in tomatoes makes it less susceptible towards bacteria, yeast and moulds as compared to other vegetables, Citric acid is measured together with other acids such as malic acid contained in tomatoes by using a pH meter. The pH meter measures citric acid as total acidity, however these results are reliable since citric acid is the dominant organic acid in tomato fruit. Tomato fruit pH at harvest is the major determinant of quality and shelf life (Workneh et al., 2011).

2.11.7 Disease incidence

Disease incidence was calculated as number of infested fruits showing any disease symptoms out of the total numbers of tomato fruits stored. Five separate tomato fruits were allocated and used for disease incidence and percent disease index evaluation were performed according to (Abebe, Tola, & Mohammed, 2017).

2.11.8 Shelf Life

Shelf life is defined as the period in which a product should maintain a predetermined level of quality under specified storage condition. Fruits shelf life during storage is an important feature from a producer's and a distributor's point of view, allowing the determination of risks arising from the loss of commercial value of fresh fruit in trade turnover. Tomato can be stored at ambient temperature for a period of up to 7 days. The shelf life is a period of time which starts from harvesting and extends up to the start of rotting of fruits. (Toyin, 2010) reported that the use of a mineral oil treatment preserved the quality of tomato fruit to the greatest extent and concluded that mineral oil wax could be a good alternative for preserving the quality and extending the shelf life of fresh

tomato fruit. The effects of bee wax coating were very effective in improving the overall quality and extending the shelf life of sweet orange fruits at room temperature. This result is in line with (Mujtaba & Masud, 2014) who revealed that the effect of tomatoes starch coating on fresh- cut pineapple delayed the change in color, maintain quality of the pineapples and prolong the storage life.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Experimental Site

The experiment was conducted at Wolkite University College of Engineering and Technology, Department of Food Process Engineering Laboratory

3.2 Materials Collection

The experimental material (tomatoes, Garlic) were collected from local market of Wilkite town. Then the purchased raw materials and reagents were transported to Wilkite University College of Engineering and Technology Department of Food Process Engineering laboratory.

3.3 Equipment, Chemicals and Reagents

Weight balance, pipettes, PH meter, Burettes, aluminum foil, carton boxes, volumetric flask, sieve, and measuring cylinder, Knife, Refract meter, Washing bowl, beakers, conical flasks and Calcium chloride, garlic extract, buffer⁴ solution, phenophtaline, sodium hydroxide (NaoH) and ethanol, spoon, retort stand, juceme kermashine,

3.4 Sample Preparation

3.4.1 Methods

Tomatoes were visually sorted turning stage from green to red color, physical damage absence and the tomato was further washed with water to remove dirt's and soils. Then about 15 fruits were separated for each treatment.

3.4.2 Garlic Extracts (pectin)

The cleaned and Peeled garlic was crushed in the form of juice by using juice maker and this juice was weighed by beam balance in the ratio of 200 g of juice and 500 ml of distill water.(Cheng, Cheng, Meng, & Tang, 2016).The extract was filtered and some amount of solution was taken for tomato coating

3.4.3 Dipping in calcium chloride solution (Cacl₂)

Three gram of Cacl₂ was weighed by using beam balance and dissolved in 70ml of distilled water and 15 samples of changing color from green to light stage of tomatoes fruits were randomly selected.3g of calcium chloride weighing and for 5 minutes was dissolved with disteiled water and dipped the sample into the solution and after dipping the sample was dried for some minutes

to remove the water. Then the samples were transferred into carton and kept at room temperature in corrugated soft board cartons(Mujtaba & Masud, 2014)

The process of tomatoes coating

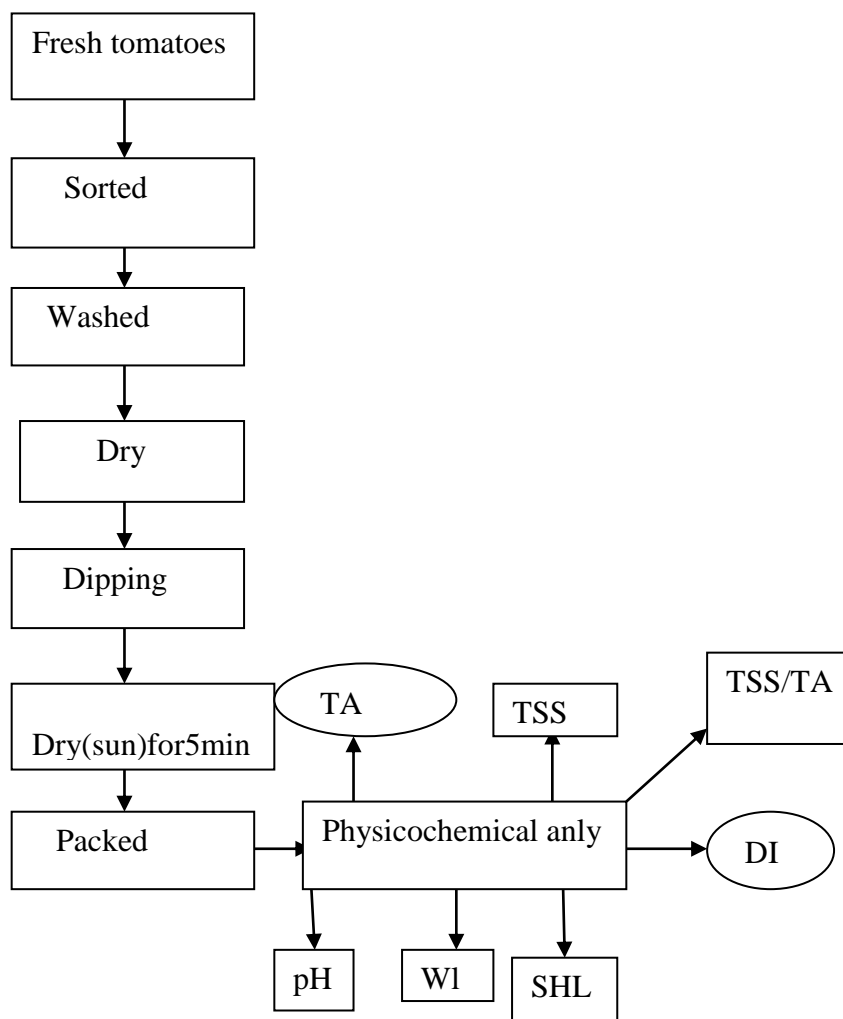


Fig 1 Flow diagram of the coating treatment

3.5 Analysis Method

3.5.1 Physico- chemical analysis

Weight Loss (%)

Most fresh fruits are harvested while they contain approximately 70-95% of water thus have maximum fresh mass. The fresh mass of tomato fruit is dominated by water. Approximately 94-95% of tomato fruit is water and organic compounds only contribute about 6%, of which skin and seeds contribute 1%. Physiological mass loss occurs as a result of fruits continuously losing

water through transpiration, resulting in softening, shrinkage, and fading appearance (Baraiya et al., 2012). The fruit physiological mass loss is greatly influenced by the storage temperature and relative humidity surrounding the produce.

For the determination of weight loss during storage, 2 fruits were marked at the start of experiment from each treatment and kept separate for periodic weighing to calculate weight loss during storage. And each treatment checked the weight loss after three days. The percent weight loss will be calculated as

percent wt loss =

$$\frac{\text{wt of fresh tomato} - \text{wt of tomatoes after dipping interval of storage}}{\text{wt of fresh tomatoes}} \times 100$$

PH

This was carried out using the pH meter which will be standardized by buffer pH of 4.0. The pH of each tomatoes juice sample were measured by using digital pH meter (model: Knick 646) according to Association of Official Analytic Chemist (AOAC) method No. 981.12-b (1990)

Titrateable Acidity

Neutralize this was determine using Pearson's method 1981. Distilled water and ethanol was using Phenolphthalein in the ratio of 50:50:1 respectively for distilled water, ethanol and phenolphthalein and 0.1M NaoH were measured in balance and dissolve in 500ml of distilled water. Then ten milliliter of the sample was weighed into a conical flask and 50ml of the neutralized water and from this solution ten milliliter sample and two drops of phenolphthalein indicator were added to it and this was titrated against 0.1M NaoH.

Calculation

$$\% \text{ Titrateable Acidity} = \frac{(\text{Titer} \times \text{M NaoH} \times 0.064 \times 100)}{\text{weight of solid}}$$

Total Soluble Solids (TSS)

Total soluble solids were determined according to AOAC (1990) using Refractometer at room temperature. The extract juice from each lot was shaken well and the representative samples were placed on dry Refractometer prism and readings were taken directly.

Total soluble solid to Titrable acid ratio (TSS: TA)

The ratio between total soluble solids and Titratable acidity was determined by dividing the TSS to that of TA in order to have sugar-acid balance of samples for each treatment. To calculate the amount of sugar acid ratio.

$$\text{Sugar acid ratio} = \frac{\text{Degree brix value}}{\text{Percentage acid}}$$

Disease incidence

Disease incidence was calculated as number of infested fruits showing any disease symptoms out of the total numbers of tomato fruits store. The disease incidence was taken on the basis of visual observation of last count on individual plant.(Abebe, Tola, & Mohammed, 2017).

Storage Site (days)

The shelf life of these tomatoes fruits were calculated by counting the days require for them to attain the last stage of ripening, but up to the stage when they remained still acceptable for marketing. The fruits were kept at room temperature until they start to deteriorate. The number of days taken before rotting were observed on fruit was recorded as the shelf life .

3.6 sensory analyses

Appearance and color

The weight, color and visual quality of tomatoes will be evaluated for all the tomatoes. The visual quality of the tomatoes will be evaluated by subjective method using a rating scale of 5 points . because that we use semi trend students.

3.7 Experimental Design and Data Analysis

The data obtained from the experiment was subjected to analysis of variance (ANOVA) using SPSS V.9. Software. The Tukey was used to compare the means of observation subjected to the different level of the factors. A 3x3 experiment layout in complete randomized design with 9 treatment combinations and three replication was adopted. with one factor (coating material) having two levels (garlic extract and calcium chloride) with one control. Total runs = (3) x3= 9. The confidence level was taken as 5%

CHAPTER FOUR

4 Results and Discussions

4.1. Physicochemical quality of tomatoes

4.1.1 %Weight loss of tomatoes

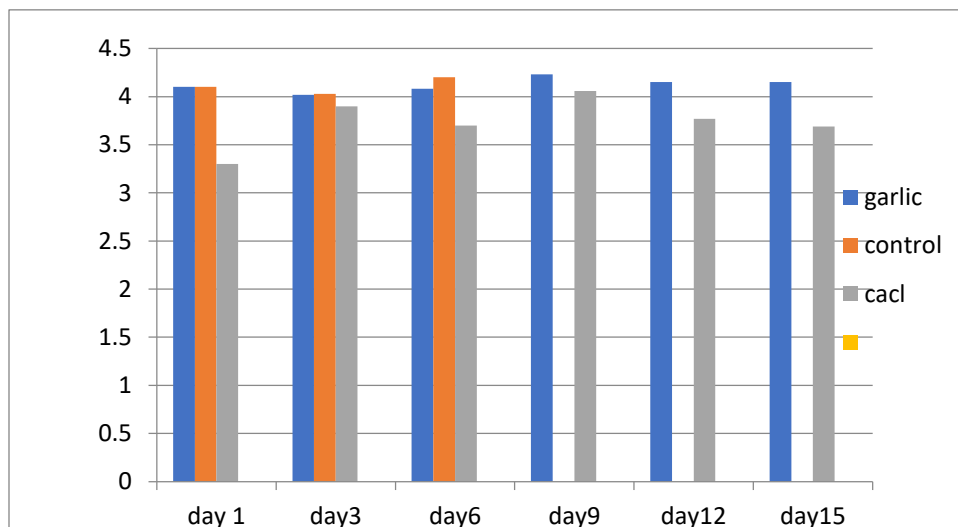


Figure 1. % Weight loss

On day 1 no weight loss on all but cacl2 and garlic increase after day 6 because control percible on day 6. On day 15 maximum loss of weight both of garlic and cacl2.but compare to each other the better loss of weight seen on garlic so garlic extract and calcium chloride treatment of tomato used as water-loss barriers, causing high relative humidity in the surrounding atmosphere of the tomato fruit and thus reducing the moisture gradient to the exterior showed that lower weight loss was observed in the case of treated tomato as compared to control samples When fruits are coated, it builds a moisture barrier that is able to prevent transpiration of water hence a lower loss in weight as compared to uncoated fruits The lower loss in weight compared to control that was seen in fruit coated with different garlic materials are consistent with the findings of several researchers(Janie Sarkar, Mazumder, & Shikder, 2008)

4.1.2 PH

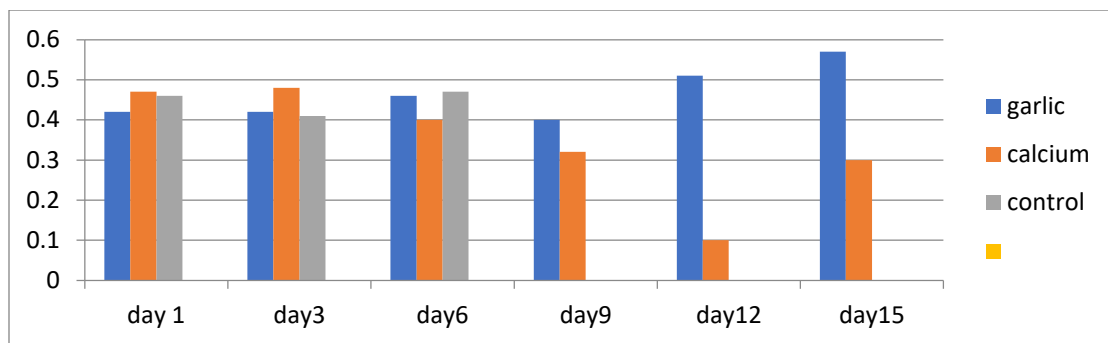


Figure 2 PH

The pH value at day one garlic pH is decrease cacl2 increase in pH and also the control decreased compared to the calcium chloride while in day three the garlic extract and control have the same value but calcium chloride have high pH value than control and garlic. At day six garlic and control have the same value while cacl2 decreased in pH. on day 9 garlic have high in pH than calcium chloride and control are perciable on day 6.on day 12garlic extract have high pH value than calcium chloride (0.52and 0.3). on day 15 garlic extract have high pH value than cacl2, this result indicates the acidity is decreased at this storage period. The garlic extract treatment of tomato. this result show that the cacl2 is an important to prevent the increase of pH. Similar works done by(Thumula 2006) revealed that increase in pH in garlic treated fruits might be due to high rate of metabolic activities, hence acidity decreased but pH increased and result in high TSS contents.

4.1.3 Titrable acidity

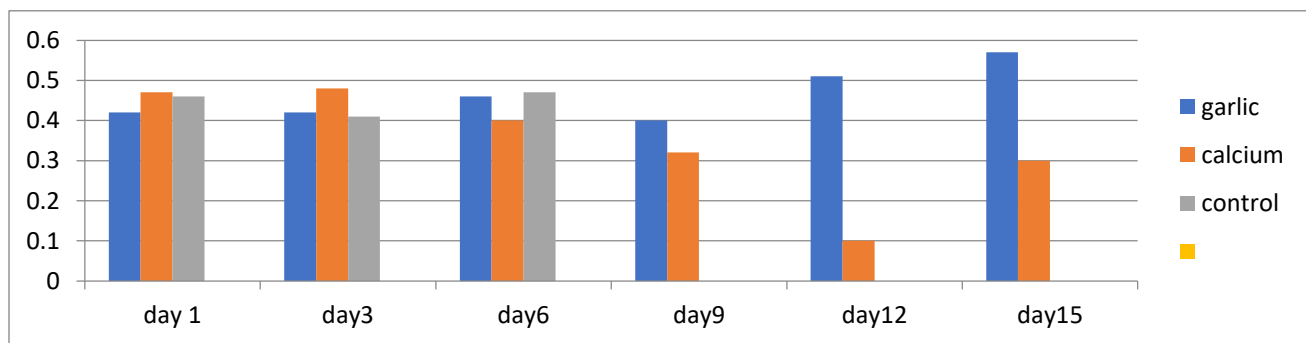


Figure 3 TA

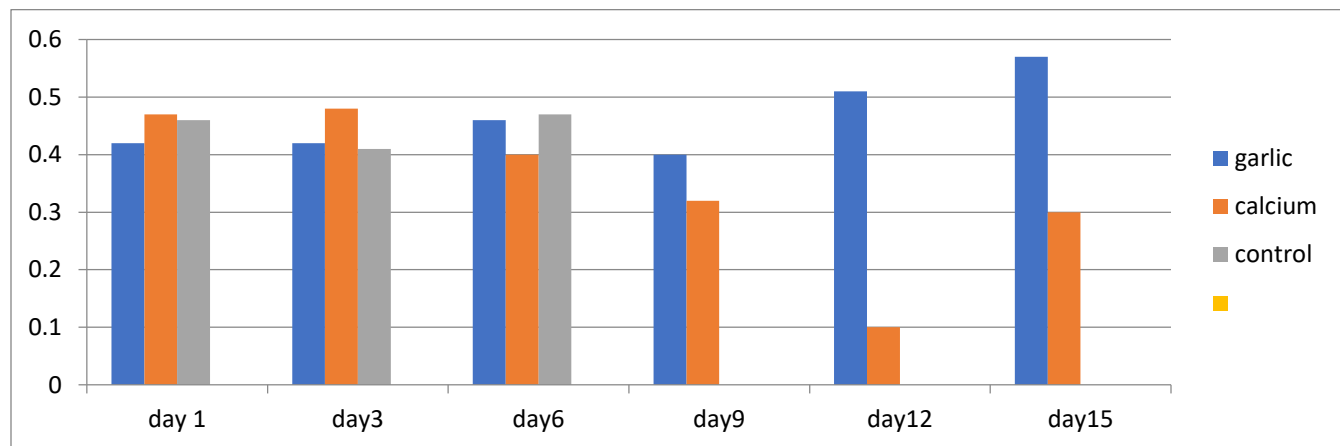
The result of coating garlic treatment of tomatoes are acidity value from (1-15) day have high acidity value because the pH is increased the tomato store for longer as shown in the above fig

while the difference value is some extent varies at each storage period compare with control treatment there is the increase of ph and a large extent acidity differential at each storage time.

Maximum acidity of garlic at (2.8) was observed at day nine and 12 in treatment of garlic extract. The Increase acidity in control treatment might be due to the formation of carbonic acid (acidosis) or it might be due to the fermentation of sugars resulting in production of acids while, decrease in acidity in changed starch to suger garlic might be due to the fact that as fruit ripens, it diminishes its malic and citric acid contents and favored the formation of Sugars (Workneh et al., 2011). As the result observed that garlic extract have the highest degree brix terms of TSS in the first day and the increase of total soluble solid from(1- 12) day (3-4brix) in terms of TSS ,while the value of TSS is decreased from (1-15) day in some extent differential at each interval of storage.

Similarly, change in brix (total soluble solids) might be due to decline in water contents and conversion of polysaccharides into simple sugars. The results are justified by the findings of (Chatterjee, 2013) who also reported increment in brix of citrus fruits during post-harvest handling and suggested that this might be due to conversion of polysaccharides into simple sugars and loss in water during ripening.

4.14 Total soluble solid



Figur 4 TSS

As the result observed that garlic extract have the highest degree brix (3.5)in fig1in terms of TSS in and the increase of total soluble solid from(1- 15) days in terms of TSS ,while the value of TSS is varies from (1-15) days in some extent differential at each interval of storage, this value indicates for the fermentation of sugar to produce acid while the other treatments are the same in day one (3.9 brix) in terms of TSS.

Similarly, change in brix (total soluble solids) might be due to decline in water contents and conversion of polysaccharides into simple sugars. The results are justified by the findings of (Chatterjee, 2013) who also reported increment in brix of citrus fruits during post-harvest handling and suggested that this might be due to conversion of polysaccharides into simple sugars and loss in water during ripening.

4.15 Sugar To Acid Ratio

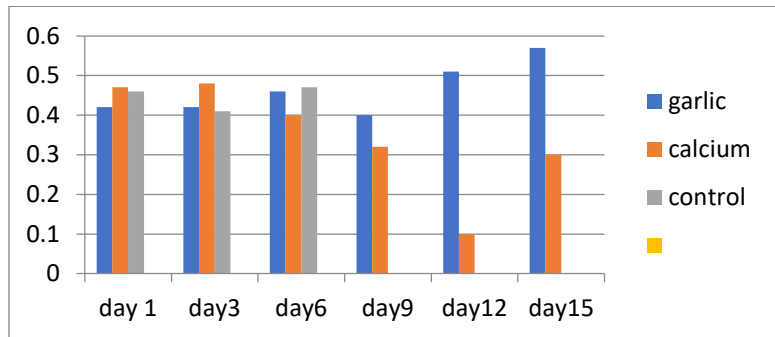


Figure 5 of Sugar to Acid Ratio

The sugar/ acid ratio on zero day is the same at each treatment, while the sugar/ acid ratio of tomato coating with calcium chloride and garlic extract have different value from first day to 15 day. The sugar /acid ratio of uncoated tomato have 0.45 slightly greater compare with the tomato coated with calcium chloride and garlic extract on day one. The sugar/acid ratio of uncoated tomato on three day have 0.42 this lower value become as result of ferment ability sugar and production of acid and the value is decreased from days nine to 15 as result of acid consumption by microorganisms . TSS/acid ratio during 15 as depicted in chart indicates that treatm garlic extract retained maximum TSS/acid ratio throughout the storage period. While, 8% bee wax have lowest value (0.6).The higher change in TSS/acid ratio in garlic etract treatment is directly correlated with hydrolytic changes in the starch concentration (conversion of starch to sugars). The higher TSS/acid ratio in store of tomato at fifteen day in control treatment than the other treatment at the same storage time (fifteen day). The results of current research work clearly illustrated that there was no fungal attack in case of tomato which were coated by incorporation of garlic extracts. These results revealed that the garlic extracts possessed antifungal potential which might be due to the presence of volatile compounds in garlic extract such as allicin, diallyl sulfide, diallyl disulfide, and low amounts of nonvolatile, water-soluble sulfur compounds. These results are also justified by the findings of (Valencia-chamorro et al., 2015)who also

reported antimicrobial and antifungal potential of garlic extracts due to the presence of volatile as well as non-volatile compounds.

4.16 Disease incidence

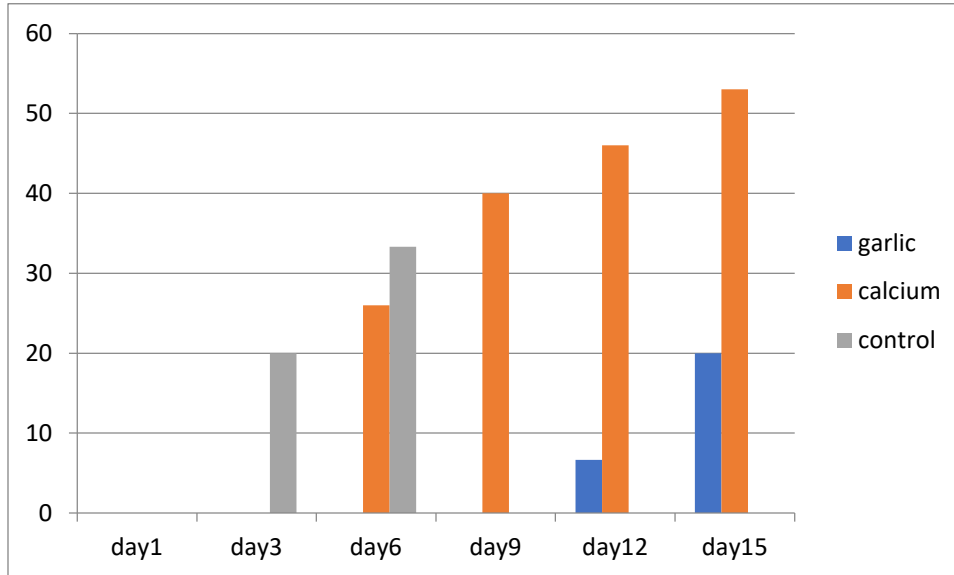


Figure 6 Disease Incidence

As the result shown that the disease incidence of tomato coating with calcium chloride, and garlic extract and uncoated tomato have zero value on day one while the disease incidence of uncoated tomato have 0,0,20,33 , 00.and 00 percent on 3,6,9,12 and 15 storage days respectively .the tomato coating with calcium chloride have 0,0,25,40,45,53 and11 percent on3,6,9, 12,15 day respectively while the disease incidence of tomato coating with garlic extract have 0,0,0 ,5 and20 percent on 3,6,9,12 and 15 day respectively as shown the above fig7 and table seven After 6 day of storage all control fruits were spoiled and discarded. then the tomato coating with control have high disease incidence compare with tomato coating with garlic extract and calcium chloride treatment of tomato. Then the uncoated tomato became more susceptible to fungal contamination and exhibited a 100% incidence.

These result indicates that tomato coating with garlic extract have lower disease value compare with tomato coating with calcium chloride.

4.1.7 sensory analysis

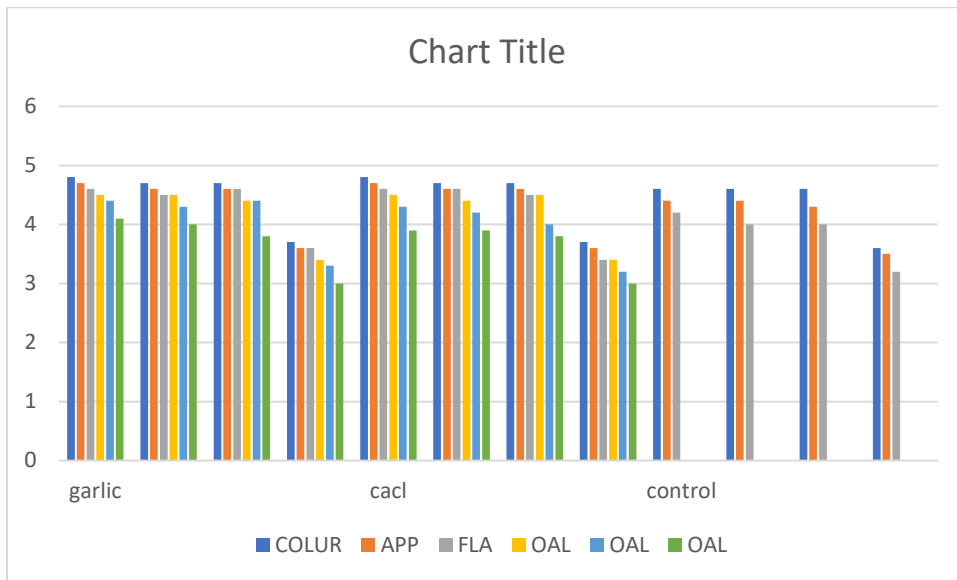


Fig 7 sensory analysis

Our result is on day 1, 3, 6, 9, 12 and 15 of garlic 4.8, 4.6, 4.5, 4.4, are color appearance, flavor, over acceptability, and cacl 4.9, 4.6, 4.4, 4.4, 4.2 on color, appearance, flavor, appearance over acceptability. And also control is 4.3, 3.4, 3.4 on color appearance, flavor, over acceptability so our sensory result is more better than the garlic treatment it is acceptab

CHAPTER FIVE

5 Conclusions and Recommendations

5.1 Conclusions

We concludes that tomato is one of the perishable products in some period of time at most it stays in 1-4. Then the use of coating materials like calcium chloride and garlic extract to increase the shelf life of tomato while garlic extract have the best treatment compare with calcium chloride. While calcium chloride is also the best treatment of tomatoes next to garlic extract of tomato to keep the physico chemical quality and shelf life

5.2 Recommendation

Study on our result the best result was garlic treatment and it is highly recommended that garlic coating on Tomato fruit for the best physico chemical quality as well as for extending the shelf life of the fruit garlic extract concentration should be further tested by conducting systematic research studies for increasing the shelf life of tomatoes. The cost analysis is also conducted for further research to determine profit. The Locally produced coating materials such as garlic extract, calcium chloride are a good technology for preserving the quality and extending the shelf life of fresh tomato fruit as well as maintaining the physical and chemical properties. Farmers and traders should be encouraged to use garlic extract and calcium chloride materials to coat their produce to maintain the quality of tomatoes.

REFERENCES

- A case study, 199–204. University of Ghana 2014. Valencia-chamorro, S. A., Oficial, A., & Oficial, A. 2015. Antifungal Edible Coatings for Fresh Citrus Fruit:
- Abebe, Z., Tola, Y. B., & Mohammed, A. 2017. Effects of edible coating materials and stages
Affects Tomato Root Growth by Influencing Cell Division, Phytohormone Balance and Expansin Gene Expression,
- Ahmad, M. S., & Siddiqui, M. W. 2015. Postharvest Quality Assurance of Fruits, Kader 2002.
- Baraiya, N. S., Gol, N. B., & Rao, T. V. R. 2012. Influence of Polysaccharide-Based Edible Coatings on the Shelf Life and Nutritional Quality of Tomato Fruit.
- Bartz, J. a, Sargent, S. a, & Mahovic, M. 2009. Guide to Identifying and Controlling Postharvest. Tomato Diseases in Florida. University of Florida IFAS Extension
- Cheng, F., Cheng, Z., Meng, H., & Tang, X. 2016. The Garlic Allelochemical Diallyl Disulfide
- Corbo, M. R., Campaniello, D., Speranza, B., & Bevilacqua, A. 2015. Non-Conventional Tools to Preserve and Prolong the Quality of Minimally-Processed Fruits and Vegetables,
- Datta, S. 2013. Impact of Climate Change in Indian Horticulture - a Review. *International*
- Donkoh, S. A., Tachega, M., & Amowine, N. 2013. Estimating Technical Efficiency of Tomato Production in Northern Ghana, Fruits of Sweet Orange Cv. Blood Red Fruits of Sweet Orange Cv. Blood Red
- Gemechis, A. O., Struik, P. C., & Emana, B. 2011. Tomato production in Ethiopia : constraints and opportunities, 2009–2012.
- Gil, M. I., Conesa, M. A., & Arte, F. 2002. Quality changes in fresh cut tomato as affected by modified atmosphere packaging,
- Gorris, L G M 2005. “Modified Atmosphere and Vacuum Packaging to extend the Shelf life of Respiring food products”

- Harel, D., Fadida, H., Alik, S., Gantz, S., & Shilo, K. 2014. The Effect of Mean Daily Temperature and Relative Humidity on Pollen, Fruit Set and Yield of Tomato Grown in Commercial Protected Cultivation. *Agronomy*,
- Igoe, R. S., & Edition, F. 2011. *Dictionary of Food Ingredients*
Journal of Science, Environment and Technology,
- Kader, A. A. 2000. Pre and postharvest factors affecting fresh produce quality, nutritional value, and implications for human health. *Proceedings of the International Congress Food Production and the Quality of Life*.
- Mishra, S. Technologies, T. & Woodlands, T. 2004. Calcium Chloride Treatment of Fruits and Vegetables
- Mujtaba, A., & Masud, T. 2014. Enhancing Post Harvest Storage Life of Tomato (*Lycopersicon esculentum* Mill.) Cv.
- Nandane, A. S., Jain, R. K., Gujarat, A., & Gujarat, A. 2005. Effect of Composite Edible Coating treatment on Physical, Textural and Microbial Quality of Tomatoes Stored At Ambient Conditions, Of maturity at harvest on storage life and quality of tomato (*Lycopersicon Esculentum* Mill.) fruit
- Raghav, P. K., Agarwal, N., Saini, M., Vidhyapeeth, J., & Vidhyapeeth, J. 2016. Edible Coating of Fruits and Vegetables : *International Journal of Scientific and Modern Education*
- Rio Grandi Using Calcium Chloride Shezi, S. 2016. Evaluation of the Effects of Supply Chain Routes and Pre-Storage Treatments On The Postharvest Quality of Tomatoes, April.
- Salunkhe, D. K., Jadhav, S. J., & Yu, M. H. 1974. Quality and nutritional composition of tomato fruit as influenced by certain biochemical and physiological changes. *Qualitas Plantarum Plant Foods for Human Nutrition*
- Shahid, M. N., & Abbasi, N. A. 2011. Effect of Bee Wax Coatings on Physiological Changes
- Toyin, A. D. 2010. Effect of Variety and Pre-Treatment Condition on The Shelf Stability of Dried Tomato Slices The Department of Food Science and Technology, College.
- Underhill, S. J. R., & Kumar, S. 2015. Quantifying postharvest loss tomato supply chain in Fiji

- Vf, R., Moneruzzaman, K. M., Hossain, A. B. M. S., Sani, W., Saifuddin, M., & Alenazi, M. 2009. Southern Cross Journals © 2009 Effect of harvesting and storage conditions on the post-harvest quality of tomato
- Wilkerson, E. D., Anthon, G.E., Barrett, D.M., Sayajon, G. F.G. Santos, A.M., & Rodriguezsaona, L. E. 2015. Rapid Assessment of Quality Parameters in Processing Tomatoes Using Hand-Held and Benchtop Infrared Spectrometers and Multivariate Analysis.
- Workneh, T. S., Osthoff, G., & Steyn, M. S. 2011. Influence of preharvest and postharvest treatments on stored tomato quality

Appendix

Table 1.1.....ANOVA for control threatment

		Sum of Squares	df	Mean Square	F	S i g .
Weight loss	Between Groups	3.084	2	1.542	61.32 4	. 0 0 0
	Within Groups	.151	6	.025		
	Total	3.235	8			
PH	Between Groups	.690	2	.345	51.87 1	. 0 0 0
	Within Groups	.040	6	.007		
	Total	.730	8			
titrable acidity	Between Groups	.006	2	.003	31.67 2	. 0 0 1
	Within Groups	.001	6	.000		
	Total	.007	8			

Total soluble solid	Between Groups	5.842	2	2.921	269.9 11	. 0 0 0
	Within Groups	.065	6	.011		
	Total	5.907	8			
TOTAL SOLUBLE SOLID RATIO TO TITRABLE ACIDITY	Between Groups	.202	2	.101	533.7 06	. 0 0 0
	Within Groups	.001	6	.000		
	Total	.203	8			
Disease incidence	Between Groups	1658.000	2	829.000	.	.
	Within Groups	.000	6	.000		
	Total	1658.000	8			

Table .2 ANOVA for CaCl₂

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Weight loss	Between Groups	145.114	5	29.023	29682.382	.000
	Within Groups	.012	12	.001		
	Total	145.126	17			
PH	Between Groups	.877	5	.175	7.250	.002
	Within Groups	.290	12	.024		
	Total	1.167	17			
Titratable acidity	Between Groups	.170	5	.034	127.721	.000
	Within Groups	.003	12	.000		
	Total	.173	17			
Total soluble solid	Between Groups	4.543	5	.909	96.200	.000
	Within Groups	.113	12	.009		
	Total	4.656	17			
Total soluble solid to titratable acid ratio	Between Groups	729.493	5	145.899	.959	.479
	Within Groups	1824.974	12	152.081		
	Total	2554.467	17			
Disease incidence	Between Groups	7990.500	5	1598.100	.	.
	Within Groups	.000	12	.000		
	Total	7990.500	17			

Table .3 ANOVA for Garlic threatment

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
Weight loss	Between Groups	42.739	5	8.548	13987.324	.000
	Within Groups	.007	12	.001		
	Total	42.746	17			
PH	Between Groups	.087	5	.017	116.126	.000
	Within Groups	.002	12	.000		
	Total	.089	17			
Titratableacidity	Between Groups	.039	5	.008	10.886	.000
	Within Groups	.009	12	.001		
	Total	.048	17			
Total soluble solid	Between Groups	3.113	5	.623	58.989	.000
	Within Groups	.127	12	.011		
	Total	3.240	17			

Total soluble solidtotitrable acid ratio	Between Groups	.071	5	.014	37.058	.000
	Within Groups	.005	12	.000		
	Total	.076	17			
Disease incidence	Between Groups	977.689	5	195.538		
	Within Groups	.000	12	.000		
	Total	977.689	17			

Table .4 ANOVA for Sensaory analysis of garlic

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
Over all acceptability	Between Groups	.956	5	.191	14.342	.000
	Within Groups	.160	12	.013		
	Total	1.116	17			
Flavor	Between Groups	1.431	5	.286	10.304	.001
	Within Groups	.333	12	.028		
	Total	1.764	17			
Apperance	Between Groups	1.371	5	.274	7.594	.002
	Within Groups	.433	12	.036		
	Total	1.804	17			
Color	Between Groups	2.638	5	.528	31.653	.000
	Within Groups	.200	12	.017		
	Total	2.838	17			

Table 5 ANOVA for Sensory analysis of cacl

		Sum of Squares	df	Mean Square	F	Sig.
Coior	Between Groups	.487	5	.097	5.475	.007
	Within Groups	.213	12	.018		
	Total	.700	17			
Apperance	Between Groups	.263	5	.053	3.379	.039
	Within Groups	.187	12	.016		
	Total	.449	17			
Over all acceptability	Between Groups	.209	5	.042	3.770	.028
	Within Groups	.133	12	.011		
	Total	.343	17			
Flavor	Between Groups	.336	5	.067	3.103	.050
	Within Groups	.260	12	.022		
	Total	.596	17			

Table 6 ANOVA for Sensory analysis of control

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Colour	Between Groups	.669	2	.334	23.154	.002
	Within Groups	.087	6	.014		
	Total	.756	8			
Apperance	Between Groups	.482	2	.241	19.727	.002
	Within Groups	.073	6	.012		
	Total	.556	8			
Flavor	Between Groups	.980	2	.490	49.000	.000
	Within Groups	.060	6	.010		
	Total	1.040	8			
Over all acceptability	Between Groups	.242	2	.121	6.813	.029
	Within Groups	.107	6	.018		
	Total	.349	8			

Figures under appendix

Fig 1. Sample preparation



Figure 2 .Garlic extract

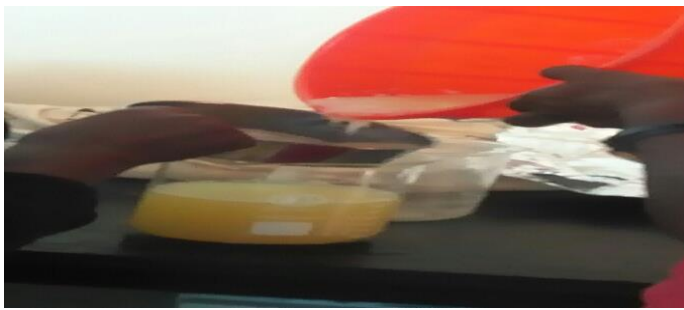


Figure 3. Dipping calcium chloride



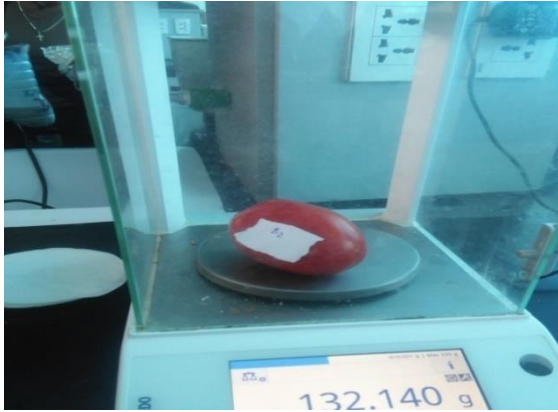
Figure 4 .Dipping of garlic extract



Figure 5. Preparation of Tomatoes fruits for data collection



Fig 6 %Weight loss and PH



A)% wheght loss



B) PH

fig 7 titreble acidity and total soluble solid

