KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF SCIENCE

FACULTY OF BIOSCIENCES

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

THE IMPACT OF GLOBAL GOOD AGRICULTURAL PRACTICE (GLOBALG.A.P) CERTIFICATION ON THE QUALITY AND SAFETY OF FRESH PINEAPPLE AND MANGOES: A CASE STUDY IN THE AKUAPIM SOUTH AND YILO KROBO MUNICIPALITIES OF GHANA

BY

LESLIE ADWOA AGYAPONG

A THESIS SUBMITTED TO THE DEPARTMENT OF FOOD SCIENCE AND TECNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN FOOD QUALITY MANAGEMENT

MARCH 2017

DECLARATION

I testify that this research work was carried out entirely by me in the Kwame Nkrumah University of Science and Technology. This thesis has never been presented, either in part or in whole, for the award of a degree in this university or any other institution. All cited works and assistance have been fully acknowledged.

…….. ……..……..

(Leslie Adwoa Agyapong) Date

(PG4367515)

……. …….

Dr. Herman E. Lutterodt Date

(Supervisor)

…… .....……

Mr. John Barimah Date

(Head of Department)

ABSTRACT

Safety and quality of fruits has been a great concern to all stakeholders therefore investigations were conducted to assess the impact of GLOBALG.A.P certification on fresh fruits (Pineapple and mangoes). The study adopted a descriptive cross -sectional design and quantitative data collection approach using structured questionnaires. Observational and laboratory studies were also conducted. Titratable acidity, pH, %brix, total coliforms, total viable counts and yeast and mould were determined using standard methods. A total of 160 farmers, 10 farms and 40 fruits were randomly selected using stratified sampling technique for the study. The findings of the study showed the following variations in chemical and microbiological quality of GLOBALG.A.P certified pineapple fruits; pH (4.32); % Brix (11.6), Titrable acidity (0.03 %), TVC (3.9×102 cfu/g/ml), TC(3.2×102 cfu/g/ml) and yeast and moulds (7.2×102 cfu/g/ml) whilst the non-certified farms also showed the variations in fruit quality; pH (4.41); % Brix (9.27), Titrable acidity (0.03%); TVC (16.2 ×102 cfu/g/ml); TC (12.8×102 cfu/g/ml) and yeast and moulds (11.9×102). The mango fruits also showed similar trends in variation of chemical and microbiological quality. With the exception of %Brix which differed significantly ($P \leq 0.05$), there was no significant differences in pH and titrable acidity of fruits from both certified and non-certified farms ($P \geq 0.05$). There were statistically significant differences in total coliform, yeast and moulds and total viable counts ($P \leq 0.05$). 60% of the respondents indicated that there was a difference in the safety and quality of certified and non-certified fruits whilst 40% stated otherwise indicated that there was no difference. This study accentuates the need for the MoFA regulatory bodies to set standards that will ensure that fresh fruits are safe for consumption, by encouraging farmers to adopt GLOBALG.A.P or any other food safety standards and farmers should be monitored to ensure they adopt G.A.P. also adopt good agriculture practices in order to reduce microbiological contamination of pineapple and mango fruits.

Contents

List of Tables

List of Figures

 List of Plates

APPRECIATION

My greatest gratitude goes to the almighty God for his divine protection, wisdom and guidance throughout my life and during the entire study.

My appreciation also goes to my supervisor Dr. Herman E. Lutterodt for his constructive critics, guidance, corrections and significant contributions made during the entire execution of the thesis.

I wish also to express my heartfelt gratitude to laboratory technicians of the Food Science Laboratory, University of Ghana, Legon, for their immense contribution during the laboratory analyses.

I also wish to thank my husband, Mr. Kofi Agyapong for the financial, physical and emotional support during the entire study.

Finally I say thank you to all my friends and families for their prayers, encouragement and inspiration, God bless you all.

CHAPTER ONE

INTRODUCTION

1.1 Background of study

Standards have been increasingly accepted as a significant tool for enhancement of market integration and reduction of poverty for small scale producers in developing countries. The creation of environmental and social standards started in the 1900's. Local non-governmental organization (NGO's) and private organizations as well as industry organizations contributed immensely to the creation of these standards (Cashore, 2012).

The promotion of voluntary standard for market access by smallholder farmers started with the lunch of the Fair Trade Label. This certification label gave producers a minimum selling price for their commodities and provided a premium for community development programs which the group members played significant roles (Author et al., 2010).

A recent initiative aimed to improve standards by private processors such as Starbucks, Sara Lee, Nestle and Kraft promoted under the SAN/RA, UTZ Certified and Café Practices focus on enhancing the production and processing techniques to better improve quality and efficiency of fruits (Hobbs, 2010)).

Although public and generic private standards were initially launched to guarantee minimum requirements for international trade and delivery to wholesale and retail outlets, voluntary and private standards have become more important to reinforce the competitive of small holder producer groups in international value chain (Henson, 2006). These standards usually are presented as voluntary standards but they are as results of pressure from key players, stakeholders among others which have to be adopted by firms or farms (Turcotte et al., 2007).

Governmental agencies, non-governmental organizations (NGOs), international bodies and donor agencies have implemented and promoted globally good agricultural practice(GAP) farm

production and its component techniques as a rural developmental tool for improving the productivity of small-scale farmers, addressing food insecurity, and increasing farmers' income and their livelihood as a whole (Adebiyi, 2014). Specifically, GLOBALG.A.P certified pineapple and mango production are the areas that have received much attention among the non-traditional export crops in Ghana. This is because globally certified pineapples and mangoes have high demand in the export and domestic markets (Adebiyi, 2014). The promotion of certified pineapple and mango produce will also enable farmers to integrate into the competitive niche market, which will improve the livelihood conditions of smallholder farmers through export earnings and price premiums (Adebiyi, 2014).

Studies conducted in Ghana have proved that certified pineapple and mango from good agricultural practice farms are more profitable and have significantly better chemical and microbiological quality compared to conventional production, maximize cost-effectiveness and reorient agricultural commodities towards areas of market demand (Adebiyi, 2014; Champell, 2006). Champell (2006) reported that, on average a farmer cultivating one acre of certified pineapples in Ghana and practicing good agricultural practice(GAP) obtains a profit of GH¢1,710 whereas the conventional farmer obtains a profit of GH¢780 per acre. This indicates that the certified pineapple farmer obtains GH¢ 930 more profit than farmers that do not practice good agricultural practice.

A survey by Erel et al. (2007) in Ghana, revealed that margins for smallholder certified producers linked to fresh pineapple and mango market were quite high, ranging from US$1,369 to US$5, 522 a year, with an average gross margin of US$1, 800 in a normal production year. Gross margins in the range of US$1, 800 per acre and higher were indicated as high enough, and likely sufficient, for a smallholder pineapple and mango farmer to emerge from poverty, even with only one acre of certified pineapple and mango production (Baah et al., 2016).

The World Health Organization (WHO) and Food and Agricultural Organization (FAO) have set quality guidelines for fruits meant for human consumption and recommended that biological and chemical parameters of fruits should fall within acceptable limits for safety. To safeguard the health of people and to reduce to the barest minimum the consumption of quality fruits, it is necessary that the quality of fruits should be monitored in view of finding solutions to challenges associated with it.

This study therefore seeks to find out whether there is a significant difference in terms of the microbial and chemical quality of pineapple and mango fruits obtained from globally GAP certified and non-certified farms.

1.2 Problem Statement

There have been a lot of concerns now about the safety and quality of foods most especially fruits and vegetables. And this is increasingly dominating in international debates. For small holders of Non-traditional exports (NTEs) to have foreign earnings which may translate into community development and improved standard of living, quality and safety standards becomes pre-requisite to address. Henson, (2006) emphasizes that the competiveness among producers in developing countries will be negatively influenced as a result of the imposition and proliferation of stringent food safety standards.

The rate of growth of land area under certified production, which includes certified pineapple and mango production have been slow over the years (Nkansah et al., 2010). For instance, the rate of growth of land area under certified mango in Ghana increased by 71.5 % from 2003 to 2006, but reduced by 28.23 % from 2006 to 2008. The rate of growth has continued to reduce, by 5.34 % from 2008 to 2012, indicating that the number of farmers converting to certified GLOBALG.A.P production is decreasing (Baah et al., 2016). Mausch et al. (2006) stated that the growth of certified good agricultural practice farming is based on the cumulative impact of the decisions of individual farmers to adopt certified farming.

According to Adebiyi (2014), the environmental situation of the community or region such as information systems in the area, farmer networks and cultural proximity to traditional agriculture where certified farming production is being promoted may affect the development of the certification in the Agricultural sector in Ghana. Thus, it is obvious there are some unknown factors that may prevent farmers from adopting a GLOBALG.A.P certified mango and pineapple production system from among the other production systems in Ghana. For example, rural poor communities in Ghana experience circumstances, such as difficulties in acquiring land, weak producer organizations, inadequate extension staff, poor infrastructure and lack of access to credit and markets that may influence smallholder farmers' choice of adopting a certified production system (MoFA, 2007).

Despite the clear benefits and the effort from stakeholders to encourage and disseminate the use of GAP certified production as a tool for improving small-scale farmers' livelihood, statistics indicate that a small fraction (0.2 %) of agricultural land is under certified production. Various researchers in developed countries, and a few in developing countries, have endeavored to conduct research on the importance of different factors influencing farmers' decisions to adopt GLOBALG.A.P certified mango and pineapple (Erel et al., 2007; Pongvinyoo, 2014). These research studies have focused more on developed countries, with little consideration given to sub-Saharan Africa, and Ghana in particular.

Ghana Standards Authority and the Ministry of Food and Agriculture (MoFA) are the regulatory bodies for food related standards in the country. Currently, there are no food safety criteria for compliance by farmers in Ghana. Ghana therefore adopt the international and private food safety standards such as the GLOBAL G.A.P and organic certifications. GLOBALG.A.P certification although undertaken by some farms and some farmer groups are not many in Ghana due to the obvious challenge of criteria requires by the body before

certification (Mausch et al., 2006). These therefore make GLOBAL G.A.P. the most common standard in the fruits and vegetables industry in Ghana.

Studies conducted by FAO revealed that about 45% of farms are not globally certified and not practicing good agricultural practices and lack the requisite safety standards (FAO, 2012).

Some research studies have been conducted on pineapples and mangoes in Ghana (Baah et al., 2016; Adebiyi, 2014). However, most researchers have focused on conventional mango and pineapple production. Little study have been conducted on the chemical and microbiological safety and quality of fruits in relation to GLOBALG.A.P certification such as pineapples and mangoes therefore creating a theory gap for investigation since mango and pineapples are among the fruits consumed by most people in Ghana and also for export.

1.3 Justification

Most farms in the Akuapim South and Yilo krobo are not managed with the best agricultural practices in Ghana. This may partly be due to improper best farming practices and management challenges. Unfortunately, published literature on chemical and microbiological safety of poorly managed farms and safety standards of fruits in Ghana is limited. The fact that very little analysis has been conducted on chemical and microbiological quality requires the need to analyze its content for safety. The findings of this research will provide relevant information on the differences in chemical and biological quality of mango and pineapple fruits obtained from globally certified fruits and Non GLOBALG.A.P certified fruits. The findings will also help relevant authorities or food certification bodies such as the Ghana Standards Authority, Food and Drugs Authority and the Ministry of Food and Agriculture (MoFA) to provide comprehensive guidelines for food safety and practice of good agriculture practices.

1.4 Aim of study

The aim of the study is to determine the impact of GLOBALG.A.P certification on the quality and safety of fresh pineapples and mangoes.

1.4.1 Specific objectives

- To determine the levels of some chemical parameters (pH , titratable acidity, %brix) of pineapple and mango fruits produced from GLOBALG.A.P certified farms and non -certified farms.
- To determine the total plate count, total coliforms, yeast and moulds in pineapple and mango fruits produced from GLOBALG.A.Ps certified farms and non -certified farms.
- To assess farmers' knowledge and perception on best farm practices.

1.5 Research questions

- What are levels of the chemical parameters (pH, tratable acidity and %Brix) of pineapple and mango sample fruits produced from GLOBALG.A.Ps and non -global certified farms?
- What are the levels of microbiological parameters (total plate count, total coliforms, yeast and moulds) in pineapple and mango fruits produced from GLOBALG.A.Ps and Non global certified farms?
- What is the knowledge and perception of farmers on best farm practices in the municipality?

1.6 Hypothesis

Null hypothesis (Ho): There is no significant differences in microbiological and chemical quality between mango and pineapple fruits obtained from GLOBALG.A.P certified farms and non -global certified farms.

Alternative hypothesis (H1): There is a significant difference in microbiological and chemical safety quality between mango and pineapple fruits obtained from GLOBALG.A.P certified farms and non -global certified farms.

CHAPTER TWO

LITERATURE REVIEW

2.1 General review of certification

Certification in the fruit and vegetable industry is increasingly growing and the certification status of a producer or producer group to a large extent determines where and which volume of the produce can be exported or marketed. Mangoes and pineapple not only provide human beings with nutritious and healthy foods but also a form of income generation for its producers in many countries. According to Sarpong (2006), when consumers have high income and the market have a wide range of choice for produce, the quality of the fresh fruit has a decisive effect on its value. The quality of fresh fruits is dependents on the selection of the planting material, the good agricultural practices, pest management, harvesting, handling and storage (Mawuli et al., 2013). Ghana like many other tropical countries have not been able to use modern and advanced technologies owing to cost to manage them.

2.2 Origin, production, distribution and uses of pineapple

2.2.1 Origin and distribution of pineapple

It is generally agreed that pineapples originated from Brazil and Paraguay in South America. They were first of all discovered by some Europeans on the Caribbean Island known as Guadeloupe or recent times. It was believed by historians that Christopher Columbus and his crew members were the first Europeans who may have tasted it. By the end of the 16th century, Portuguese and Spanish explorers introduced the fruits into many of their Asian, African and South Pacific Colonies/countries where pineapples are still being cultivated. Okimoto (2008), however stated that the Tupi-Guarani Indians domesticated the fruit from Ananasguaranticus (A. comosusvarananassoides) and it gradually migrated to other parts of the world.

Ghana is the fifth largest African - Caribbean - Pacific exporter of fruits and vegetables and second largest African exporter of pineapples to the EU (COLEACP, 2010; Natural Resources Institute (NRI), 2010). According to Sefa-Dedeh (2005), the most developed sector in Ghana has been the pineapple industry. According to Anderson et al. (2010), countries are seeking

further liberalization of national markets because of the attractive results in terms of poverty and in quality reducing effects of trade policy reforms.

2.3 The Pineapple industry in Ghana

Pineapple dominates the world trade of tropical fruits, although other fruits have gained market share. Statistics from 2000 indicate that pineapple trade took 51 % from a total of 2.1 million tons of the whole fruit market with mangoes taking the second place, with 21.7 %. Pineapple is the best positioned fruit since its trade is oriented to developed countries as Japan, the USA and the European Community (Coveca, 2002). Consequently, during the past decade world production of pineapple has increased at a rate of 1.9% per year, despite the occurrence of unfavorable weather and economic situations (FAO, 2004).

Ghanaian firms began exporting the Smooth Cayenne variety of fresh pineapple to Europe – which was the major destination then by air in small quantities in the mid-1980s by sourcing from smallholder farmers in the Akuapim South District in Ghana. These smallholder farmers initially supplied the Nsawam Canneries Ltd, a Government owned fruit processing firm engaged in canning pineapple juice for the local and export markets. The early 1980s saw the development of commercial indigenous farms by Ghanaian entrepreneurs from diverse professional and business backgrounds (FAO, 2007).

Ghana has, over the period, been the largest exporter of fresh pineapple by air due to this distinct advantage. The industry experienced growth from 1994 to 2004 especially from 1999 to 2004 at a cumulative annual growth rate of 172%. This resulted in increased market share of fresh Ghanaian pineapples in Europe from 7-8% in 1999 to its highest level in 2004 of 10%.

The most developed horticultural sector in Ghana has been the pineapple industry (Sefa-Dedeh, 2005). During the period 2000-2004, horticultural products, led by pineapple, was the biggest contributor to agricultural NTEs, ranging from 36 to39 %, and accounting for about 36% of the

total value of export earnings (Kasalu-Coffin et al., 2005). At present, the concentration of the cultivation of the crop is concentrated in the southern part of the country. It is mostly produced in the Eastern, Volta, Central and Greater Accra regions of the country (Mawuli et al., 2013).

2.4 Agricultural practices in pineapple production.

Land preparation

According to Mawuli et al. (2013), the purpose of land preparation is to ensure proper establishment of the plant since pineapple has superficial root system with majority of the roots localized in the upper cm of the soil and therefore proper land preparation is therefore important for high productivity.

This is the first stage in the production process. It is done when the sustainability of the land for cultivation has been ascertained by physical and chemical soil analyses. This stage includes land clearing, field layout and bed design (Hepton, 2003).land preparation is crucial since it affect the quality of the produce. As righty said by Hepton (2003), getting it rightly done from the preparation stage goes a long was to improve the quality of it.

Planting and Propagation

Once the basic tillage operations have been performed, raised planting beds may be formed as there are known economic advantages (Hepton, 2003). Poksinska et al., (2002) indicated that pineapple is vegetatively propagated from planting materials that are obtained from various parts of the plant. These are identified according to the part of the plant on which they are found.

Planting materials for pineapples include crowns, suckers, slips and nursery shoots but in Ghana, suckers are the most used. Seeds can be used but they are hard and slow to germinate (Morton, 1997). Planting material may be bought from a reputable farmer or planting material producer. Suckers may be harvested from healthy mother plants from one's own farm. The

selection of the planting material is a very important stage as far as the quality of the fruit is concerned. Selecting the best planting material will help avoid export defects such as “missing eye, sleeveless and double crown”. It may be important for the farmer to keep a sucker production plot for generation suckers for planting (Mawuli et al., 2013).

Planting is usually done in double rows with spacing of 60 cm x 30 cm with 90 cm path for Singapore Spanish cultivar, and 50 cm x 30 cm with 100 cm path for Smooth Cayenne (FAO, 2004). Depending on a number of factors such as such as the environment (especially, solar radiation) and nutrition, plant growth and intraspecific competition for available resources, the planting density may vary from as low as 29000 plants per hectare to as high as 86000 plants per hectare (Hepton, 2003). According to Mawuli et al. (2013), planting uniform sized suckers on the same ridge must be ensured to get similar sized fruits which is crucial in packaging for export.

Cultural practices

Pineapple like all other crops requires good agricultural practices which affect the quality of it. Weeding, fertilizer application, pest and disease control, floral induction and de-greening are the major cultural practices done on farm. Weeding and general sanitation of the farm is very crucial as far as the safety and quality of ant fruit is concerned. Unweeded farm habours pest which later affect the suckers or the fruits. Bose and Mitra (2000) reported on the serious problems weeds pose on pineapple especially in the rainy season. Okimoto (2008) added that weeds can have devastating effect on yield. Under severe weed problems, plant yield can be reduced up to 83%.

Pineapple has high requirements for nitrogen (N), potassium (K), and iron (Fe), and relatively low requirements for phosphorus (P) and calcium (Ca) (Evans et al., 2008).For the first five months after planting, less fertilizer is required; requirements increase sharply afterward and

peak at two to four months before floral initiation. P and Ca are usually banded in the plant line during bed preparation (Bartholomew and Malezieux, 2003). It is very crucial the various proportion of fertilizer are used and at the appropriate timing which if done otherwise go a long way to affect the taste of the fruit.

2.5 Uses of pineapple

The majority parts of pineapple are edible. The fruit contains 81.2 – 86.2% moisture and 1319% total solids of which sucrose, glucose and fructose are the main components. Carbohydrates represent up to 85% of total solids whereas fiber is made up of 2-3%. Citric acid is the most abundant of the organic acids. The pulp has very low nitrogenous compounds, lipids and ash content (0.1%). 25-30% of the nitrogenous compounds are true protein. (Dull, 2001). Fresh pineapple contains minerals such as Calcium, Chloride, Potassium, Phosphorus and Sodium. The table below shows the overall composition of fresh pineapple.

Table 2.1. Pineapple percentage composition

Component	% Wet basis
Brix	10.8 – 17.5
Titratable acidity (as citric acid)	0.6 – 1.62
Ash	0.3 – 0.42
Moisture	81.2 – 86.2
Fiber	0.3 – 0.61
Lipids	0.2
Esters (ppm)	1 – 250
Pigment (ppm carotenes)	0.2 – 2.5
Total Nitrogen	0.045 – 0.115
Protein	0.181

Soluble Nitrogen	0.079
Ammonia	0.010
Total amino acids	0.331

Source (Dull, 2001)

Pineapple is also a great source of vitamin C and is usually consumed when fully ripen as juice or in cut pieces. The fruit can be eaten when dried and also as part of fruit salad. The diagrams below show different forms of ripe pineapples consumption. The quality of the fruit has an effect on the taste of the fruit. Very acid fruit taste very sour and uncomfortable to eat.

Plate 2.1 Sliced pineapples ready for consumption (FAO, 2003)

Plate 2.2 Pineapple in juice form (FAO, 2003)

According to Collins (1999), the by-products from pineapple culture, canning and juice extraction has been encouraged for feed production. The leaves he says can be used in three forms; fresh, dried and in silage.

Pineapple also improves digestion, regulates stomach acidity, aids in detoxification processes, the neutralization of free radicals and blood clots, as an aid in the treatment of rheumatoid arthritis, reduction of sciatica symptoms, collagen production, weight control and in the treatment of albuminuria. Evidence of these claims was generated from studies made in the US and Europe (Coveca, 2002).

2.6 The ecology of pineapple

2.6.1 Climatic requirement of pineapple

According to Bartholomew and Malézieux (2004), pineapple is cultivated mainly in areas of 30º North and south latitudes with some areas considered marginal for various reasons. It can also grow in elevations from 1,100m above sea level as long as the area is free from frost and has a high atmospheric humidity and average rainfall of 760 – 1000mm (Ficciagroindia, 2007). The most important ecological factors in pineapple production temperature and says that the crop thrives well in temperatures between 20-36º (Mawuli et al., 2013).

There is a direct relationship between fruit weight (quality) and solar radiation intensity. According to Nakasone and Paul (1998), the rule of thumb is that yield decreases about 10% with every 20% decrease in solar radiation. There exist variations in rainfall in the areas where pineapples are grown. Pineapples are produced under a range from 600mm to over 3500mm annually, with optimum for good commercial production being from 1000-1500mm (Nakasone and Paul, 1998). According to Mawuli et al. (2013), the crop thrives best with rainfall of 600 – 4000 mm/yr and can make use of dew for growth and development.

2.6.2 Soil Conditions

Maximum production potential is attained for this crop when it is planted on light to medium texture soils that do not have flooding problems, mildly acidic (pH 4.5 – 5.5). A good seeding bed is obtained by proper cutting, burning and/or blending of harvest by-product, plowing, soil revolving and drainage (FAO, 2004). The crop is able to grow on a variety of soils including poor soils. It is however sensitive to water logged soils. Subsequently good drainage and aeration are important. The acidity of the land has a great effect on the pH of the fruits at large. Generally, a pH range of 5.0-6.0 is considered best for pineapple and the flavor quality of pineapple on light soils is considered superior to that grown on other soils. However, pineapple can quite grow adequately on sandy and loamy soils rich in humus (Ficciagroindia, 2007).

2.6.3 Pest and Diseases of Pineapple

Pineapple is affected by a lot of pests, including nematodes (Rotylenchulus, Meloidogyne, Pratylenchus, Ditylenchus, Helicotylenchus), insects (scale, mealybugsand ants) symphilids, mites and rodents and diseases such as Phythophthora rot, Fusarium stem rot, and a host of others (Evans et al., 2002). The occurrence of these disease and pest according to Rohrbach et al. (2003), depends largely on environmental conditions, the susceptibility of the cultivar and the presence or absence of organism. He added that high population densities of pineapple pests and diseases occur at different times in the crop's life and therefore have varying impacts.

Donkor and Abgoka (1997) identified some of the various constraints in the production of pineapples in Ghana and the prominent among them were major pest and diseases which they indicated affect how safe the fruit will be for consumption and for export. They added that it was important that pest and disease are prevented to ensure the safety, quality and economic value of the crop. According to Rohrbach et al. 2003, Phytophthora heart and root rots are limited to areas with fine-textured soils with high pH values and wet environmental conditions.

2.6.4 Maturity requirements

The pineapple must have reached an appropriate degree of maturity and ripeness in accordance with criteria proper to the variety and to the area in which they are grown and the soluble solids content of the fruit flesh should be at least 12% Brix (WHO, 2006; UNECE Standard FFV, 2012). It adds that the % Brix affects the taste and how long the fruit may stay on the shelves which is very crucial for export and for sales at supermarkets. It goes on to add that the colour can be green provided the minimum maturity is met.

2.7 Origin, production, distribution and uses of mango

2.7.1 Origin and distribution of mango

Mango (Mangifera indica) is believed to be a native of southern Asia, especially Burma and eastern India. It spread early on to Malaya, eastern Asia and eastern Africa. Mangoes were introduced into Califonia (Santa Barbara). The crop according to McGovern and La Warre (2001), is indigenous to India. Cultivated in many tropical and subtropical regions and distributed widely in the world.

However, it is now found in all the tropical areas, as well as many subtropical regions of the world, attesting to its wide range of adaptability. It was introduced into Ghana in the early 1920's from the Sri Lanka, India and Trinidad (Addo-Quaye et al., 1993). There are a lot of varieties grown globally but the most common commercial varieties grown in Ghana include keitt, kent, haden, Erwing, Palmer and spring field (MOFA, 2008).

2.7.2 Botany of mango

According to McGovern and LaWarre (2001), mangoes belong to the kingdom Plantae, division Angiospermae, class Magnoliopsida, order Sapindales, family Anacardiaceae, genus Mangifera and species Indica, consisting of numerous species of tropical fruiting trees in the flowering plant family.

According to Kaur et al. (2000), the mango tree is believed to have evolved as canopy layer in the tropical rainforest of Southeast Asia. Mature trees attain heights of up to 30 meters and can survive for more than hundred years.

The pollination is done by insects, in particularly flies. They are made up of both male and female flowers which when pollinated produces fruits. Wind, thrips, bees, insects, flies, etc can bring about the pollination (Pope, 2009). The fruit is a succulent drupe with fleshy mesocarp and stony endocarp. The immature fruit is green, hard and sour while the mature fruit is yellow, orange, succulent and sweet with a very strong smell (Purseglove, 2007). Fibres are more pronounced in fruits grown with hard water and chemical fertilizers. The mango fruit matures in 100-150 days after flowering.

The fruit is 60-70 percent flesh, 11-18 percent skin, and 14-22 percent seed, depending on cultivar, with flesh being 20 percent dry matter. Most of the mangoes produced are marketed in the fresh state for consumption as a dessert fruit (Nakasone and Paul, 1998). In terms of shape it can be rounded, elongated, flattened, etc. and for the colour it is dependent on the variety. The colour may vary from green, yellow, orange to reddish-purplish. For export into different markets, the right colour of the species must be attained to attract good price. When it is matured, it is usually firm and the pulp turns yellowish-orange but mostly juicy when matured.

2.7.3 Production of mango

Land preparation

Land preparation is of vital importance when growing mangoes and this involves clearing of the vegetation, stumping, ploughing and harrowing where necessary (Nkansah et al., 2013). They added that there are three methods of land preparation as far as mango orchard establishment is concerned. The methods they say are; Non-mechanized land preparation which

involves clearing of the undergrowth, felling of trees, de-stumping and gathering of debris. The second method is the Semi-mechanized preparation which involves clearing the undergrowth, felling of the trees, de-stumping followed by ploughing and harrowing before planting of the seedlings. The third is the mechanized culture involving land clearing by the use of earth moving equipment such as bulldozers to fell and move trees and vegetation without removing the top soil. Planting can follow with or without ploughing or harrowing (Nkansah et al., 2013). How good or bad the land is prepared shows how the fruit will thrive and the quality of the fruit that will be harvested (Morton, 1997).

Planting and Propagation

The planting material of mango can be raised by one or two methods. Planting materials can be raised directly from seeds or seedlings raised as rootstock and budded or grafted with scion or bud wood obtained from mother plants with desirable qualities and for the production of fruits of uniform quality, it is recommended that graftlings are used in the establishment of orchards which help for optimum growth (Nkansah et al., 2013). To acquire good quality seeds for uniform performance in the nursery according to Nkansah et al. (2013), it is necessary to de-husk stones prior to sowing. De-husking (figure 4) involves the removal of the cotyledon or kernel from the shell using appropriate tools and after de-husking, discard dead, damaged, diseased and malformed seeds.

Spacing of mangoes during planting according to Nkansah et al. (2013) is dependent on the soil fertility, climatic conditions, cultivar and the management system to be adopted. They have indicated that the recently recommended spacing is either 10 x 10 m, 10x14 m or 14x14 m. however this requires intensive management system. Alternatively, mangoes can be planted in hedgerows – it is a relatively new plant establishment technique in mango culture. It is very crucial that the right spacing for planting is followed which affect the plant density and the quality of the fruits as well (Morton, 1997). Operations such as weeding, fertilizer application

and spraying require that the workers move within the orchard with ease. This is not possible or becomes difficult when the trees are planted haphazardly in the orchard and therefore the importance of lining and pegging to aid these cultural practices which affect the quality and the safety of the fruits (Nkansah et al., 2013).

2.8 Uses of mango

Mango is one of the most extensively exploited fruits for food, juice, flavour, fragrance and colour. In several cultures, its fruit and leaves are ritually used as floral decorations at weddings, public celebrations and religious ceremonies (McGovern and LaWarre, 2001). According to Evans, 2008, mango fruits are eaten raw and serve as an excellent source of dietary fiber, provitamin A and vitamin C (Evans, 2008). The fruit is rich in dietary fiber, Vitamin C, polyphenols, carotenoids, potassium, copper and 17 amino acids at good levels. The mango peels contain pigments that may have antioxidant properties, pro-Vitamin A compound: beta carotene (CTA, 2009). It is mostly consumed raw as dessert and it is processed into juices, ice cream, fruit bars, jams, chips and jellies (CTA, 2009, Hayes, 1996; Nakasone and Paul, 1998; Litz 1997; McCoy, 2007).

In Ghana, mango fruits are primarily consumed in the fresh state usually as dessert and sometimes as a fruit drink or juice. Consumers tend to prefer fresh fruits and vegetables rather than processed or canned food. A cup of sliced mango contains the following nutritional components. Mangoes also contribute copper, calcium and iron to the diet as well as antioxidants such as zeaxanthin and beta-carotene.

Table 2.2 Mango percentage composition

Component	%/gram
Calories	100g
Protein	1g
Fat	0.5g

Sugar	23g
Fiber	3g
Vitamins	35%
Folate	20%
Vitamin B-6	10%
Vitamin K and Potassium	8%

(Evans 2008)

According to Kochhar, 2007, the fruit is highly prized and all the parts of the tree from the roots to the leaves serve various purposes for mankind. He further indicates that the price is depended on the quality of the fruit. It has a rich, luscious aromatic flavour and delicious taste with a blend of sweetness and acidity.

2.9 Ecology of Mango

Climatic requirement of mango

The role of temperature in mango flowering cannot be over emphasized and its influence varies with the cultivars (Schaffer et al., 2004). Temperatures in the range of 24-30 °C are needed for best flowering; however, if there is enough provision of water during fruit development, then the tree may be able to withstand up to 48 °C. Flower deformation and loss of pollen viability can occur at low temperatures which affect the quality of the fruits even when they survive (Issarakraisila et al., 2002).

According to Nkansah et al. (2013), pollen viability declines at temperatures higher than 35°Cor below 15°C while continuously high day and night temperatures at flowering result in flower abortion. For the mango tree to develop and yield very well, it requires a tropical climate

with a marked cool and/or dry season because flowering and fruiting require the combined stresses of water deficit and low night temperature. In Ghana, these two stress factors synchronize during the harmattan period, from late November through early March (Nkansah et al., 2013).

Rainfall is one particular factor that influences agriculture in the tropics. For example, heavy rainfall can cause a considerable reduction in pollination or wash away pollens during flowering and fruiting which in effect reduces fruit set and maturation of fruits (Samuel, 2009). According to Nkansah et al. (2013), good rainfall distribution is crucial for tree development and fruit yield rather than total rainfall. An average monthly rainfall of 200-250mm with a dry period of 2-3 month preceding flowering is ideal for mango production.

Soil conditions

In selecting a site for mango production according to Nkansah et al. (2013), edaphic factors such as soil type, drainage, depth, fertility and pH are important factors to consider as these are affect the quality of the fruits. The soil condition affects the pH and acidity of the fruit. The acidity and alkalinity (pH) of the soil determines its biological activity including development and survival of microorganisms as well as the performance of plant roots (Nkansah et al., 2013). The authors add that the ideal pH for mango cultivation is between 5.5 and 7.0 where acidic soils can be improved by the addition of lime.

Pest and Diseases of mango

Production of mango in Ghana is challenged and attacked by many insect pest including mango mealybug (Rastrococcusinvadens William), mango stone weevil (S. mangiferae), fruit flies (Bactrocerainvadens Drew, Tsuruta and White), thrips (Selenothrips spp.), and tip wilters (Callimetropus spp.) (Braimah et al., 2007). The fruit suffers from several diseases at all stages of its life. All parts of the plant including the flower and the fruit are attacked by a number of

pathogens including fungi, bacteria and algae. These pathogens are the cause several kinds of rot, die back, scab, necrosis, blotch, spots, mildews etc. (Morton, 1997). Due to the acidity of raw fruits, the primary spoilage organisms are fungi, moulds and yeasts (Alzamoora et al., 2000b).

According to Brecht et al., (2010), mangoes are susceptible to many physical, physiological and pathological defects; some of the defects are of pre-harvest origin. These include anthracnose, insect damage, jelly seed, scab, scars, sunburn, misshapen and lenticels damage (Brecht et al., 2010). In addition to attack through the wounds, the organism can penetrate the fruit through the cuticle and natural openings of the fruit surface. The fungus often remains dormant on green fruits and develops as the fruit ripens and loses its natural resistance during handling and shipping. Mangoes exhibiting such defects are usually eliminated at the packinghouse, but anthracnose symptoms do not appear until the mangoes ripen, resulting in significant losses at destination markets and consumer homes (Brecht et al., 2010). Probably its greatest significance as a pest is to reduce the germination capacity of seeds greatly and to interfere with the export of fruit, because of quarantine restrictions imposed by importing countries (Bagle and Prasad, 2005).

The high temperatures and humidity in Ghana gives a very conducive environment for pest to proliferate and diseases to increase. Like many others tropical crops, the fruit is attacked by a number of pest and diseases and these may differ from region to region. According to Braimah and van Emden (2010), fruit borers, stone weevils, mealy bugs, scale insects, mites, fruit flies, thrips, twig, etc are the most common pest of mangoes across the world but in Ghana, the mango mealy bug, Rastrococcus invadens which was detected in the 1980's is an important insect pest. But currently, except for local pockets of resurging population, the mealy buys is largely under control. The stone weevil (Sternochetus mangifera (F)) is another pest of quarantine importance which farmers need to control. Farmers are battling with (Bactrocera

invadens) as another pest of quarantine importance. It is polyphagous and highly destructive to all its host plants, especially mangoes. Because of its wide host range. B. Invadens is one of the most important quarantine pest in the world.

The damage caused by these pest and diseases include fruit drop, blemished fruits, retarded plant growth, premature flowering, etc which results in reduction in quality and market value. If pest and diseases are not watched, they can build up and can cause a lot of damage to the farm. In Ghana, loses due to pest and disease is estimated to be over 60%. Producers are therefore being trained every now and then on the need to implement Good Agricultural Practices (GAP) on their farms to prevent pest infestation and to reduce the negative impact of pest and diseases (Nkansah et al., (2013).

Brecht et al. (2010) identified some of the defects caused by harvesting and postharvest handling as bruising, heat and chilling injury, internal flesh discoloration, sap burn, shriveling, uneven ripening, sunken shoulder areas and decay which affect the quality of the produce

2.10 Mango production in Ghana

Mangoes are grown on 87 different countries with India being the largest producer and exporter which accounts for 40% of the total output with Africa producing 9%. There are a lot of varieties grown globally but the most common commercial varieties grown in Ghana include keitt, kent, haden, Erwing, Palmer and Spring field (MOFA, 2007). Campell et al. (2002) indicates that these varieties except Erwing and Spring field but including Tommy Atkins were introduced into the country from Florida nearly 40 years ago.

According to Nkansah et al. (2013), in the early 1960's , several mango cultivars were introduced into the country and sent to the University of Ghana - Forest and Horticultural Crops Research Center (FOHCREC) – Kade, Crop Research Institute – Ejura, Agricultural stations of MoFA at Dodowa, Atebubu, Wenchi and Kintampo. Cultivars were then obtained

and planting materials raised onwards. Scions of these planting materials were obtained from the orchards established at Kade, Ejura, Dodowa, Kintampo and Atebubu.

The early development of export oriented mango cultivation started in the Southern Horticultural Belt (Somanya, Dodowa, tafi, Akrade, Sogakope, Weija and Ayikuma). Since 2000, several commercial plantations have been established in the forest-savanna transition (Kintampo, Wenchi, Techiman, Nkoranza, Ejura and Atebubu) and the Guinea Savanna (Tamale, Langbensi) zones (Nkansah et al., 2013). There is either one or two seasons for mango producers in Ghana. Those in the Southern belt have two seasons whilst those in the forestsavanna belt and some parts of the Guinea Savanna one season.

The Export Ghana Promotion Council has indicated that the potential to grow mangoes for commercial purposes was identified way back in the 1990's in the country (GEPC, 2007). Commercial production of mangoes started in the 1980's in response to a government policy on export diversification. This was mainly carried out as a secondary activity by some pineapple producers and exporters (Nkansah et al., 2013).

Mango is rapidly becoming one of the leading tree crops in the tropics and sub-tropics. The fruit can be eaten at any stage of development (immature, mature or ripe). There is a lot of local market for mangoes of late. Due to the numerous health education on the benefits of eating fruits, a lot Ghanaians have included fruits in their menu of which mango is usually part especially when the fruit is in season. A lot, unlike some years back when fruits were sold by wayside groceries, hawkers and market women, now due to tourist, more middle income Ghanaians, etc, fruits are major and mandatory stocking section for any major supermarket in Ghana. Supermarkets such as Koala, MaxMart, Shoprite, Game, Shop and Save, etc have no option than to stock fruits of which mangoes are part.

Apart from the fruit being eaten in the fresh state, it is also processed into many products and sold mostly in the internationally but some local sales are made as well. Some companies that process mangoes in Ghana are Blue Skies (Nsawam), Astec (Nsawam), Athena Fruits (Tema), Pinora (Asamankese), Pinella (Accra), ITFC(Tamale), HPW (Adieso), etc (Nkansah et al., 2013). Fruits can be processed into various products such as jellies, jam, juice, marmalades, canned slices, fresh fruits, dried chips, fruit concentrates and fruit leather. Green mangoes make excellent chutney (Hayes, 1996; Nakasone and Paul, 1998; Litz, 1997; McCoy, 2007). Large exporters usually own packing and treatment centers for preparing the fruits for export. They are therefore able to enforce quality, traceability, etc with regards to complying with the GLOBALG.A.P. Standard.

2.11 The mango industry in Ghana

It was estimated in 2005 that the world's production of the mango was 28.51 million tons and of this Africa produced 2.5 million tons accounting for about 10% fresh fruits and 11% of processes fruits (Evans, 2008). The crop is targeted as the next non-traditional export which is expected to fetch the highest foreign exchange replacing cocoa in Ghana since the country's production is reported to have increased from 1200 tons in 2007 to about 2000 tons in 2008 (Quartey, 2008). The export of 857.57 tons in 2008 was valued at US $521,820 (ISSER, 2009). This significant export volume of mango from Ghana to the European and Asian markets far exceeds the demand (Avah et al., 2008).

Mango is seen as one of the commodities in Ghana with the potential of replacing cocoa as the nation's cash crop. Over the years there has been widespread interest in the cultivation of the crop not only by development agencies under various environmental protection and poverty reduction programmes, but also by private individuals and companies for export (Avah et al., 2008). The Centre for the Promotion of Imports from Developing Countries Market Survey (CPIMS, 2008) reported that the mango fruit is one of the most highly esteemed fruits of the

tropics. The importance of mango to many Ghanaians is epitomized in the description of the crop as ʾGolden true, 'next cash crop, ʾgold mine', Ghana's future, amongst others (Avah et al., 2008). Mangoes account for approximately 50% of all tropical fruits produced worldwide (FAO, 2004).

Irrespective of the opportunities of favourable climatic condition and low labour cost leading to the low production cost, Ghana is unable to take advantage due to the uncompetitive state of the industry. For example, a report on a baseline study on the mango industry in Ghana indicated overwhelmingly among other challenges that mango farmers in Ghana have difficulty in determining when to harvest fruits for the export and local markets (Abu et al., 2011). Litz (2003) reported lack of simple and reliable methods for determining the stage of fruit maturity also affects quality. One of the major problems currently restricting international trade in mangoes is the variation in physiological maturity in a single consignment (Mitra, 2007).

2.12 Safety and quality issues in the horticultural industry

There have been a lot of concerns now about the safety and quality of foods most especially fruits and vegetables. And this is increasingly dominating in international debates and also the local market. Consumers have been conscious of the safety of the fresh fruits and vegetables that are consumed Ghana do not have any food safety standard as at now which regulate and monitor the way fruits and vegetables are produced, handled and processed although Ghana Standards Authority and the Ministry of Food and Agriculture (MoFA) are the regulatory bodies for food and relate issues in the country. For these small holders of NTEs to have foreign earnings which may translate into community development, improved standard of living, etc, they are confronted with quality and safety standards serving as a pre – requisite for entering into some global markets. Fox and Vorley (2006) emphasizes that the competiveness among producers in developing countries will be negatively influenced because of the imposition and proliferation of stringent food safety standards.

According to Sefa -Dedeh (2006), the horticultural industry has considered strategies for quality assurance and food safety as components in the normal operations of the actors therefore the concept of Ghana GAP is evolving towards a national quality management system. The author adds that approach taken is a gradual mainstreaming of best practices in Ghanaian horticulture and benchmarking with other protocols. It is expected to guide issues on quality safety and traceability. Ghana GAP is another public-private partnership to improve safety and quality of horticultural produce from Ghana.

2.13 Certification schemes in Ghana

A number of certification schemes exist in the agricultural sector. Standards exist for different crops and different exporting and importing countries. The figure below shows some of the standards that are used in the agricultural industry.

Plate 2.3: Some certification standards

The cocoa sector does have the most certification standards which include Sustainable Agricultural Standard/Rainforest Alliance, Fairtrade and UTZ Certified. These certification schemes of course have been necessitated because of consumer demands. In Ghana, the

Ministry of Food and Agriculture (MoFA) and Ghana Standards Authority are the regulatory bodies for food standards and related issues. Currently, there are no domestic food safety standards compliance criteria followed by farmers. Therefore, the common one is the international and private food safety standards such as the Global working group for Good Agricultural Practices (GLOBALG.A.P.) and organic certifications (Baah et al., 2016). Organic certification although undertaken by some farms and some farmer groups are not many in Ghana due to the obvious challenge of alternative cure for pest infestation other than using synthetic pesticides thereby making GLOBALG.A.P. the most common standard in the fruits and vegetables industry.

2.14 GLOBALG.A.P. Certification in Ghana

GLOBALG.A.P is the global appropriate cultivation methods for the farmers to conduct food safety. It is the appropriate on-farm into farm gate cultivation management methods included, farm inputs selection, farm management, until post-harvest management. GAP aims to encourage the farmers to produce the safety agricultural products for the consumers (Pongvinyoo et al., 2014). The Ghanaian horticultural industry has developed programmes to build local capacity in the production and quality management to assure the delivery of safe produce as reported by Sefa – Dedeh, (2006) due to the increasing expectations for safe produce by consumers. He further stated that GLOBALG.A.P certification of farms has been on going in the Ghanaian horticultural industry and over 60% of major exporters are currently GLOBALG.A.P certified and many more are in the process of being certified.

Therefore, the common one is the international and private food safety standards such as the Global working group for Good Agricultural Practices (GLOBALG.A.P.) and organic certifications. Organic certification although undertaken by some farms and some farmer groups are not many in Ghana due to the obvious challenge of alternative cure for pest

infestation other than using synthetic pesticides thereby making GLOBALG.A.P. the most common standard in the fruits and vegetables industry.

Program for Competitive Export Economy (TIPCEE) in 2005 collaborated with Ghana Standards Board assisted pineapple, pawpaw and medicinal plants farmers in obtaining GLOBALGAP group certifications (Option II). TIPCEE also participated in the creation of enabling environment with respect to policy and regulatory issues to boost private sector opportunities for exports (TIPCEE, 2008). Another intervention was German Technical Cooperation's Market Oriented Agriculture Program (GTZ-MOAP) which commenced on April 2008 and ended December, 2011. MOAP focused on improving the capacity of agricultural producers, processors and other actors in the agricultural sector to compete in national, regional and international markets (MOAP, 2009).

According to Baah et al. (2016), farmers are finding it difficult to comply with GLOBALGAP standards which are continuously subject to review taking into consideration current technological and market dynamics. Tyers and Anderson (2002), have indicated that anything destabilizing food market forces is of fundamental concern to the people and their industry. Because of this, Baah et al. (2016) says that some farmers may want to quit GLOBALGAP certification and produce pineapple only for the domestic market which does not require GLOBALGAP certification. It was of no wonder when the number of registered pineapple farmers in the municipal area fell from 10,837 in 2009 to 3,753 (about 65 percent decline) as at the year-end 2010 (MoFA, 2007).

Such developments will not auger well for Ghana's competitiveness in the global fresh pineapple market which could lead to a decline in foreign exchange earnings and retard economic growth (NRI, 2010).

2.15 The GLOBALG.A.P standard

GLOBAL G.A.P. (formerly EUROPGAP) is a set of good agricultural practices standard pertaining to the safety of plant and animal protection, worker health and safety (Hobbs, 2010). It was established by a consortium of food retailers in Europe as a system of self – appraisal certification by horticultural producers (Rice et al., 2000). The goal of GLOBALG.A.P is to transform grower's attitude towards food production by imposing a performance standard with defined criteria to follow in order to render production processes safe (GLOBALG.A.P, 2011). According to Kariuku (2006), complying with such food safety standard is always a chance for farmers in developing countries. Food and Agriculture Organization (FAO, 2006) noted that particularly for both variable and long -term inputs, GLOBALG.A.P. Compliance entailed costly investments to the fresh fruits and vegetable sector.

GLOBAL G.A.P. standard is the most important standard in export horticulture in the international produce market (Henson et al., 2011). The standard implementation in the mango and pineapple industry is an interesting thing to study because GLOBAL G.A.P standard has become mandatory for fresh fruits to be exported to the European Union (EU) (Bain, 2010).

The standard is not mandated by the laws of Ghana and therefore remains voluntary but the reality is that complying with the GLOBALG.A.P. requirements have become an "entry ticket" into EU (Campel et al., 2006; Fox and Vorley, 2006). Although the GLOBALG.A.P Standard is not mandated by law, it is evident that it is very crucial for access into the EU market. Producers have two options to opt for in order to get GLOBAL G.A.P Certification. They can either choose to go for it individually (option 1) or as a producer group (option 2). With the option one, the farm has its certificate to itself whilst with the option 2 the whole group has one certificate. Therefore, group members are obliged to sell through the group. Most farmers usually go for the group certification.

GLOBAL G.A.P established practical manuals that have been promoted by governments especially in ASEAN countries including Thailand (Bayati, A. & Taghavi, A., 2007). The Ministry of Agriculture and Cooperatives (MOAC) first instituted GAP under its Agricultural Commodity Standard on Good Agricultural Practice for Food Crops in 2003 (MOFA, 2007). Since then, the Agricultural Standards Committee has revised some standards for better acceptance in terms of both quality and safety of Thai agricultural products (Salunkhe, 2011). This is to keep up with rapidly changing global standards and to improve product competitiveness in the world market (Bayati, A. & Taghavi, A., 2007)).

Baah et al. (2016) studied on the lychee cultivation in northern Thailand. They found that GAP farmers used lesser pesticides than ordinary farmers, while there was not much difference as regards income between both. This was because GAP can improve farm practices and management. According to their study. The GLOBALG.A.P has also improved farmer's knowledge and vision to improve quality affecting their farm structure. (Avah, 2008) reviewed GAP for mango commodity and found that the farmer's produce was free from pest infestation and were of good quality after they had implemented GAP standard on their individual farm. Valuable markets were available for those farmers who were certified as GAP farmers. The study argued that farmers' market accessibility was changed by their product quality improvement after GAP implementation. High quality product markets searched for the GAP certified products.

Ghana has the National Technical Working Group who gave interpretation to most of the control points of the GLOBALG.A.P standard version 4. This gives guidelines for implementation and clear interpretation for auditors. This shows clearly that as a nation, although the GLOBALG.A.P standard is not mandated, deems it as a crucial standard in the horticulture industry. This became a normative document and was approved for use. Even

though GLOBALGAP is a private standard, its implementation has become a necessity in obtaining access to the European and other major international markets (Graffham et al., 2007).

GLOBALG.A.P standard is the most important standard in export horticulture in the international produce market (Henson et al., 2011). The GLOBAL G.A.P. standard implementation in the mango and pineapple industry is an interesting thing to study because GLOBALG.A.P standard has become mandatory for fresh fruits to be exported to the European Union (EU) since 2007 (Bain, 2010).

In this paper, emphasis will be placed on the private GLOBALG.A.P standard adopted by small scale farmers of fresh mangoes and pineapples in Ghana. Because of the labor intensiveness of the production on mangoes and pineapple and the high capital income generated, it may contribute to poverty reduction (Lumpkin et al., 2005). The many literature shows that GLOBALG.A.P is very important in the fruits and vegetable industry. To the external that even market women who get fruits from the farmers to sell in the various markets are always eager to get fruits from certified farms. In the market places such as the Madina and Kasoa markets in Ghana, the market women distinct their fruits from the others that are not from certified farms. They actually use this as a marketing tool.

2.16 Quality Evaluations

According to Litz 2003, when the consumers have high income and the market provides a wide choice of produce, the quality of the fruit has a decisive effect on its value. Swiader et al. (2012) states that the quality of fresh fruit is a combination of characteristics, attributes and properties that give a commodity value to human for food. This connotes that the individual(s) is the one defining the quality attributes and therefore they may vary from one person to the other.

Zuniga – Arias et al. (2007) also suggests that the different attributes included in the concept of quality depend on the relevant actor who is acquiring the product. Major actors participating in the valuation of food quality for the export market according to the authors are producers,

processors, exporters, importers, wholesalers, retailers and consumers, while external agents like voluntary agencies and the government may influence these perceptions.

According to Kader (2008), quality is the degree of excellence or superiority of fresh fruits and their products is a combination of attributes, properties, or characteristics that give each commodity value in terms of human food. The author further explained that the importance of each quality component depends on the commodity and its intended use and may vary amongst producers, handlers and consumers.

2.17 Mango quality parameters

According to Wills et al. (2008), the important quality components for producers, exporters/distributors and consumers are appearance; including size, colour, shape, condition (such as freshness) and absence of defects; texture and firmness; flavour and nutritive value. The producer, intermediate persons/mediators and consumers have different quality attributes they look out for in a fruits. According to Akurugu (2011), producers and processors commonly give preference to profit attributes, like higher yields, suitability for mechanical harvesting and industrial preparation, and resistance against plagues and diseases. Consumers according to Swiader, (2012) are concerned about the appearance, price, and table quality including texture, flavour, colour and nutritional value.

Further mango flavour quality is influenced by the cultivar, maturity stage at harvest, postharvest handling procedures and environmental conditions (avoiding mechanical damage and chilling injury), and ripeness stage at the time of eating the mango. (Kader, 2002). Kader (2002) reported that the quality performance of mango fruit is based upon the external and internal quality attribute. The external attributes include the weight of the mango fruit, the presence of black spots, latex and damages. The internal quality attributes include the presence of mango fly, flesh maturity (based on flesh colour), internal damages, pH and % Brix of fruit juice. Kader (2008) further asserts that mango quality indices include uniformity of shape and

size, freedom from decay and defects, skin colour that is characteristics of the cultivar, flesh colour, flesh firmness (juiciness, fibre content), and flavour (sweetness, acidity, aroma intensity).

2.18 Quality assurance

According to Litz (2003), the purpose of post-harvest handling is timely delivery of a product that closely matches buyer specifications and complies with mandatory regulatory requirements. Satisfying the customer is the undergirding quality assurance which aims to produce a product of the desired standard, encouraging regular, large and more frequent purchases and brand loyalty (Litz, 2003). To be able to expand and maintain the market niche as export market is becoming increasingly competitive, quality assurance can be the vital strategy to do this (Bunt and Piccone, 2004). Mitra (2007) maintains, however, that in general terms, quality infers some degree of excellence, giving the customer satisfaction. Thus, quality assurance is a management system for controlling quality through establishing operational procedures involving the integration of the processes, services and people concerned with the product (Mitra, 2007).

Lindror and Prussia (2003) indicated that ensuring a consistent supply of good quality fruit/produce is made difficult by the natural variation found in horticultural crops. The author further stated that controlling quality is often regarded simply as a job for quality control, which in many instances is an inspection–oriented procedure whereby materials and procedures are inspected entering and leaving the pack house. This kind of quality control according to Lindror and Prussia (2003) is very narrow and only picks up errors and poor quality: it does little to rectify inconsistencies or to prevent them.

All agricultural practices should be on schedule and well managed according to Mawuli et al. (2013) in order to produce high quality fruit. The subjective on the other hand has to do with evaluation and appearance of the end product packed ready for export, which takes into consideration the uniformity of colour, size, number of units and the conditions for packaging. According to Nartey 2011, from a regulatory or consumer protection point of view, "quality" refers to the basic objective requirements which must be met under existing laws and regulations to ensure that foods are safe, not contaminated, adulterated or fraudulently presented. Safety requirements for foods are neither optional nor negotiable.

2.19 Organizations, institutions and agencies involved in food safety in Ghana

For a comprehensive food system involves the dynamic interdependence of a number of players such as government authorities, private sector partners, including farmers and other producers, processors, marketers and distributors, consumers, organizations or institutions specialized in scientific and technological research, education and information (FAO, 2004). The players according to the paper have independent functions and the system but be construed so as to provide a framework for the development of strong partnership, co-ordination and cohesive of actions, communication and collaboration among public and private interests. According to Nartey (2011), partnerships functions in an open and transparent process. Partners must have clear delineation of responsibility and the authority to make decisions for meeting their responsibilities. They must have, or be given, the resources to effectively participate in the institutional debate and to work effectively (Nartey 2011).

The Ghana Standard Authority and the Food and Drugs Authority are the two major regulatory institutions in Ghana with the responsibility of ensuring the safety and quality of food and other products that we consume. Other regulatory institutions include; the Environmental Protection Agency (EPA) responsible for the regulation of the importation of chemicals of all forms including pesticides for agricultural purposes; Plant Protection and Regulatory Service

Divisions (PPRSD) of the Ministry of Food and Agriculture (MOFA) also mandated to ensure the appropriate use and sale of agro-inputs especially agrochemicals (Nartey 2011).

Food and Drugs Authority

According to Nartey 2011, the food and drugs authority has two main divisions. These he says are the inspectorate drugs and inspectorate foods. These operations are guided by the Foods and Drugs law, which has various sections which deals with various aspects of food safety and security. These provisions of the law according to Nartey 2011 are made to ensure that the health of the citizenry is safe enough to impact positively on the productivity of the nation. The author adds that the authority is to ensure that all manufactured food product meant to be eaten are safe and devoid of unacceptable level of material that are harmful to human health. They are also to make sure that food industries and drug manufacturing industries maintain acceptable standards to promote good health of the citizenry. Occasionally, they carry out awareness creation activities to educate the general public about food safety issues to enable consumers to make informed decisions (Nartey, 2011).

Ghana Standards Authority

The Ghana Standard Board (GSB) now Ghana Standard Authority (GSA) was established by NRCD in 1973 and was solely vested with the responsibility for preparing standards for products and processes for ensuring compliance with government policies on standards. Methodology, Standardization, Testing and Quality Assurance of both locally manufactured and imported products are complied with throughout the country (Nartey, 2011). The author added that besides safety, quality attributes include: nutritional value organoleptic properties such as appearance, colour, texture, taste; and functional properties. Consumers, the food industry and government regulators are also concerned with these quality criteria.

Because of the responsibility of ensuring the safety and quality of products of which fruits and vegetables are no exception, the authority works in collaboration with other agencies like Food Research Institute (FRI), Food and Drugs Authority (FDB), Plant Protection Regulatory Services Directorate (PPRSD) and the Vegetable Producers and Exporters Association of Ghana (VEGPAG) to develop standards for most importable vegetables and fruits and these standards for quality are to ascertain that foods are safe and meets the expectations of the consumer (Nartey 2011).

The authority may also organize seminars, workshops and talk shows to create awareness and educate the general public on quality, standards and safety of food (GEPC, 2007).

Plant Protection and Regulatory Service Directorate (PPRSD)

The Plant Protection and Regulatory Service Directorate (PPRSD) of the Ministry of Food and Agriculture was established in 1965 by an Act of parliament "The prevention and control of pest and diseases of plants Act, 307" and the pesticides control and management Act (Act 528, 1996). According to the guidelines for the National Plant Protection Policy (Ministry of Food and Agriculture, 2007), the division was nationally mandated and given capacity to organize, regulate, monitor, implement and co-ordinate the plant protection services need for the country in support of sustainable growth of agriculture in the country.

Gerken and Suglo (2002) have suggested that, government intervention in crop protection faces a policy dilemma. The objectives of increasing agricultural production should be reconciled with an effective control of negative external effects. The authors explained that the availability of inputs such as pesticides should be improved and the current bias towards chemical pesticides should be counter balanced by the introduction of alternative crop production strategies.

2.20 Summary

Certification and for that matter GLOBALG.A.P certification has become a necessity for the fruit and vegetable industry in Ghana to gain access to the European market. Farmers implementing these Food safety standards are to ensure that the produce are safe and of good quality for consumption and export.

CHAPTER THREE

MATERIALS AND METHODS

The chapter discusses the materials and methods used in carrying out the research from sampling of the farms. These include the sample size, sampling procedure, the methods and instruments for data collection, interviews and data processing and analysis.

3.1 Materials

3.1.1 Overview of the research design

The research employed field studies, observation and laboratory analysis. In the field studies, survey was used in gathering data and information from farmers in the study area, observations in the farms the facilities (chemical store, fertilizer store, parking area, farm, etc) were done where the enumerator observed the conditions of those facilities and scored accordingly. Laboratory analysis to find out the chemical and microbiological safety of the fruits were determined. The chemical analysis takes into account titratable acidity, pH and % Brix whilst the microbiological analyses considered total plate count (TPC), yeasts /moulds, and total coliforms (TC).

3.1.2 Study Area

The study area for the pineapple was Akuapem-South Municipal area which is a leading producer of non-traditional export crops like pineapple, pawpaw and pepper. Pineapple is the leading crop produced in the municipal area and accounts for the largest share of pineapple

exports from Ghana with large number of smallholder farmers (Baah et al., 2016). In 2010, the municipality produced 23.055 metric tons of pineapple which constituted about 53 percent and 38 percent of total pineapple exports and national output respectively (MoFA, 2009). The study area for the mango was in Somanya in the Yilo Krobo district. This district produces a lot of mangoes which is exported, supplied to processing companies for processing primarily for export and sometimes local (MoFA, 2009).

For the pineapple, the farmers were selected from Fotobi Pineapple Farmers Association whilst that of the mango was selected from Yilo Krobo mango farmers Association. Yilo Krobo mango farmers Association was selected for this study because it was the only group which had been certified with the current version (July version 5) of the GLOBALG.A.P standard in Ghana (www.tradehub.com) as at the time the sample was being taken and they had been audited for several years against the GLOBALG.A.P standard. Fotobi Pineapple farmers Association is also a farmer group that has been audited against the GLOBALG.A.P standard for more than fifteen several years (MOFA, 2009).

3.1.3 Sample size and sampling procedure

The study selected a sample of one hundred and twenty respondents. Since the study seeks to compare fruits from both certified and non-certified farms, sixty respondents each were selected from mango and pineapple farmers. Out of the sixty, thirty were certified farmers and the other thirty being non-certified farmers. These respondents were selected using stratified sampling technique. This sample was based on the number of non-certified farmers who were willing to be part of the studies because the same number of respondents had to be selected for both certified and non-certified farms. Farmers were selected randomly based on the risk their farms may pose to the group and their compliance to the GLOBALG.A.P standard. Risk farmers such as those who have large areas under production, workers, irrigation facilities,

those who have animals on their farms, and those who have never been selected for external audits were chosen. The non-certified farms were selected randomly from the catchment area. They were the farms that were available and had fruits to be part of the study.

A total of ten farms were purposively selected for this study. Five each for mango and pineapple farmers. Out of the ten farms, five were GLOBALG.A.P certified farms whilst the other five were non-certified farms. This sample size was chosen because of the following reasons; first of all, Yilo krobo mango farmers' association members in the group are homogeneous in terms of their practices since they receive similar trainings and similar inspectors inspect their farms. Also the pineapple farmers were also sampled from a farmer group who have similar characteristics. This makes the sample taken to be a representative of the farmers groups. Both groups have both certified and non-certified members. The non-certified farmers are not presented for audit but have all the other benefits the certified members get from the group in terms of training, inputs, technical support among others.

3.1.4 Fruit sampling from farms

Ten fruits were picked from each farm from the five farms selected. The sample of ten fruits was taken because that is the number of fruits that are taken from a batch of fruits for analysis by the exporters or processors such as Blue skies and HPW. On the farm, the fruits were randomly picked from all the plots in the farm. The number of fruits per plot was determined by the size of the plot. The largest number of fruits was picked from the biggest plot. One fruit was randomly picked from a tree but attention was paid to trees bordering non-certified farms. This was to help get the ten fruits from different trees. Therefore, a total of forty fruits were randomly selected for the quality assessment or examination. To reduce variation and to obtain consistent data, it was essential that all measurements were limited to or taken on freshly harvested physiologically matured fruits. For the facility assessment, the same number of farms that were selected for the quality assessment was used of which each was assessed two times,

therefore a total of twenty facilities were assessed. The harvested fruits were packed in clean plastic crates and put in an ice chest and immediately transported from the field to the laboratory for the analyses. Major contamination during packing and transportation was taken into consideration to ensure that there was no cross contamination from the holding materials and the vehicle.

3.1.5 Materials used for the studies

GLOBALG.A.P certified and non-certified mango and pineapple fruits were the primary materials that were of concern with the study.

Survey

Questionnaires which had both close and open ended question were administered to both certified and non-certified farmers. The questionnaires are shown in the appendix of this document.

Observation

Observation of the producer's facilities was done through an observation guide and scores given. Each sampled farm was assessed twice by different assessors/observers to help get an accurate picture of the facility and also to prevent bias when only one assessor is used. The observation guide is shown in the appendix.

Laboratory analyses

The following media/chemicals and equipment were used for the laboratory analyses.

• Plate Count Agar (pH 7.0 from Oxoid Ltd., Basingstoke, Hampshire – England).

• Malt Extract Agar (pH 6.6 from Oxoid Ltd., Basingstoke, Hampshire – England).

• Lauryl Tryptose Broth (pH 6.8 from Oxoid Ltd., Basingstoke, Hampshire – England)

• pH meter (Model pHep3, μicropHep).

• Sodium Hydroxide Analytical Grade, GFS Chemicals, Inc, Columbus.

• Phenolphthalein, Analytical Grade Sigma Aldrich (Germany)

• pH meter (Model pHep3, μicropHep).

• Refractometer

• Electronic balance, Sartorius AG Germany, CPA623S

• Magnetic stirrer, Heidolph, Mr Hei-Standard

3.2 Methods

3.2.1 Survey

The prepared questionnaires (appendix IV) were administered to the sampled respondents for feedback by trained enumeration.

3.2.2 Observation

With the help of the observation guide, enumerators observed the facilities and farms of sampled respondents and gave scores. Two enumerators assessed each sampled facility to help prevent bias.

3.2.3 Determination of pH

The pH values give a measure of the acidity or alkalinity of a product. How the media was prepared is shown in Appendix VI.

3.2.4 Determination of titratable acidity

Titratable acidity gives a measure of the amount of acid present in the fruits. Titrable acidity is very important in exporting of fruits. How the sample and media were prepared for this is shown in the appendix.

3.2.5 Determination of % Brix

Brix is very important when taste and shelf life on the fruit is concerned. It gives indication on what can be consumed immediately and not especially with climacteric fruits like mango and pineapple.

3.2.6 Determination of total plate count (TPC)

This was done to determine the counts of bacteria in the media using the total plate method. The method used for ascertaining this is shown in the appendix of this document.

3.2.7 Determination of total coliforms (TC)

The aim of this was to find out the number of total coliforms in the sample fruits. Details of how it was done in as seen in the appendix section of this document.

3.2.8 Determination of Yeast and Moulds

As part of the microbiological analyses, yeast and mould were also tested in the sample fruits with the procedure shown in the appendix of this document.

3.3 Data Analysis and processing

Data collected for chemical and microbiological as well as the social survey were analyzed using Microsoft excel spreadsheet (Ver 2010). Statistical Package for the Social Sciences (SPSS) software version 20.0 was used to generate the means, standard deviation, maximum and minimum ranges for the various parameters and frequencies used in the data. Student t-test statistics at 95% confidence interval ($P<0.05$) was used to determine if statistically significant differences exist in chemical and microbiological quality of fruits between globally certified and non-certified farms. The chi -square test statistics was used to find associations between demographic characteristics of respondents and best farm practices. Statistical significance was accepted at $P\leq0.05$.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Social Survey

4.1.1 Demographic Characteristics of study participants

Both tables 4.1 and 4.2 shows that majority of males were engaged in the growing of the fruits both for certification and not. This could be due to the work load with these farming although some women employ the services of labourers. Both certified and non-certified farmers for both mango and pineapple had had some education but it is clear from both tables that the educational level of certified farms outnumber those from non-certified farm. There was a significant difference as has been indicated by Baah et al. (2016) that, certification requires a lot of record keeping and education plays a major role in being certified. The results indicated that there were no statistically significant differences in education level in agriculture, gender and years of farming practice of both the GLOBALG.A.P certified and non-certified pineapple and mango farmers (P>0.05).

Table 4.1: Background characteristics of pineapple farmers

Variable	**Certified {n (%)}**	**Non-certified {n (%)}**	**P-value**
Gender			0.324
Male	20(66.7)	25(83.3)	
Female	10(33.3)	5(16.7)	
Total	30(100)		
Educational background			0.04*
None	6(20)	14(46.7)	
Basic Education	8(26.7)	12(40.0)	
Secondary	12(40.0)	4(13.3)	
First degree	4(13.3)	0(0.00)	
Total	30(100)	30(100)	

Background education in Agriculture			0.132
None	5(16.7)	2(6.7)	
Basic	12(40.0)	13(43.3)	
Secondary	13(43.3)	15(50.0)	
Total	30(100)	30(100)	
Years in farming	0.245 **practice**		
6-10 years ago	9(30.0)	12(40.0	
11-15 years ago	13(43.3)	10(33.3)	
16-20 years	8(26.7)	8(26.7)	
Total	30(100)	30(100)	

*significant at P≤0.05

Table 4.2: Background characteristics of mango farmers

Variable	**Certified {n (%)}**	**Non-certified {n (%)}**	**P-value**
Gender			0.221
Male	18(60.0)	22(73.3)	
Female	12(40.0)	8(26.7)	
Total	30(100)		
Educational background			0.235
None	4(13.3)	10(33.4)	
Basic Education	12(40.0)	14(46.7)	
Secondary	10(33.4)	5(16.7)	
First degree	4(13.3)	2(3.2)	
Total	30(100)	30(100)	
Background education in Agriculture			0.132
None	3(10.0)	4(13.3)	
Basic	12(40.0)	10(33.4)	
Secondary	15(50.0)	16(53.3)	
Total	30(100)	30(100)	
Years in farming practice			0.245
6-10 years ago	12(40.0)	9(30.0)	
11-15 years ago	11(36.7)	15(50.0)	
16-20 years	7(23.3)	6(20.0)	
Total	30(100)	30(100)	

Regarding the selection of pineapple varieties for cultivation, both the certified and noncertified farmers prefer to grow MD2 and Smooth cayenne. Sugar loaf was the least variety grown by

farmers in both categories (Certified and non-certified farms). Figure 4.1 shows the preferred variety of pineapple grown by both certified and non-certified farmers. The certified farmers cited reasons for choosing these varieties because it is well patronized by consumers (76.7%) and meet export demands (66.7%) whilst the non-certified farmers grow because of its fast growing rate (72.5%) and well patronized by consumers (65.8%) (Figure 4.2). Similarly, the most preferred variety of mango fruits cultivated by farmers also include Kent (72.5%) and Keitt (65.8%) for both certified and non- certified farmers

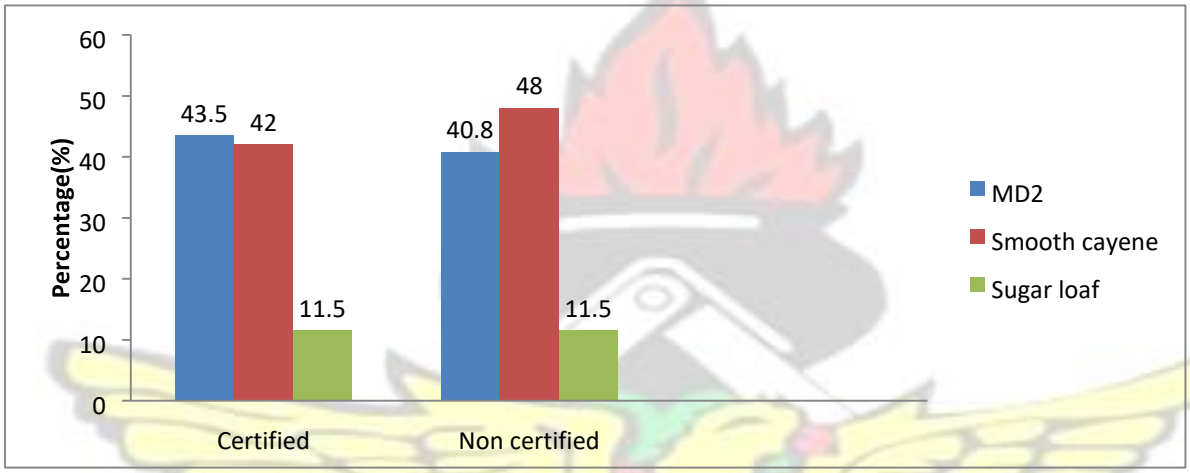

Figure 4.1: Variety of pineapple planted most

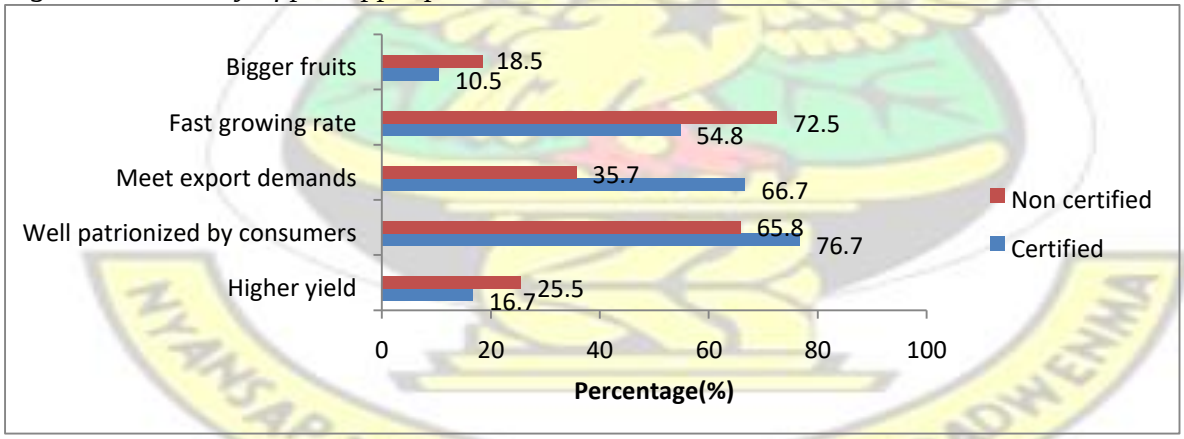

Figure 4.2 Reasons for planting preferred variety of pineapple and mango varieties

Figure 4.3 below shows the cultural practices used by both certified and non-certified pineapple and mango farmers in the control of weeds on their farms. The results showed that almost all the certified farmers use agro chemicals (100%) as compared to the non-certified farmers

(72.8%). The use of slashers /cutlasses was also more associated with non-certified farmers representing 88.5% as compared to certified farmers (65.5%).

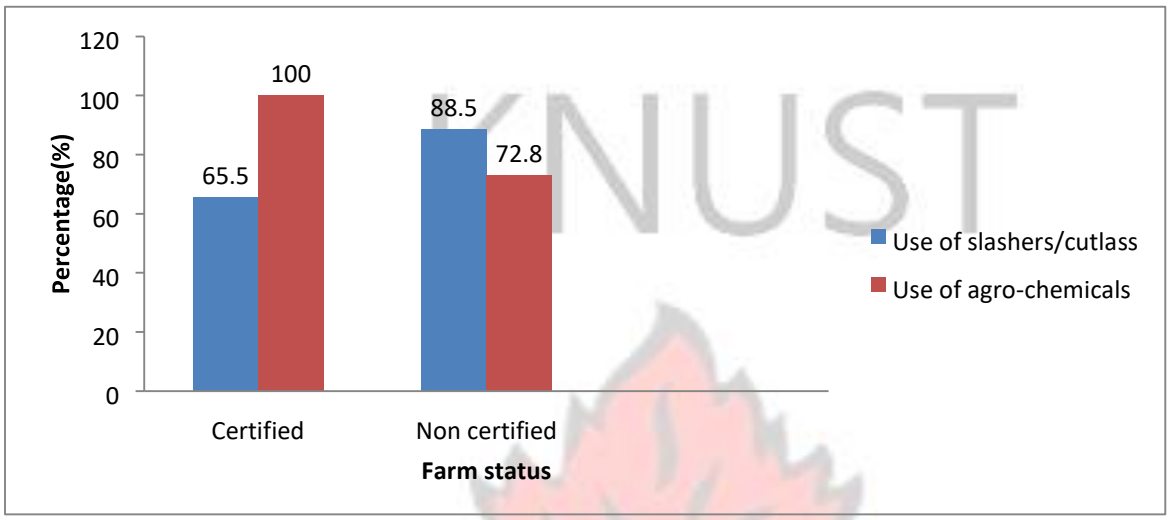

Figure 4.3 Method of weed control of mango and pineapple farmers

Concerning the control of pest on the farm, the results showed that, majority of the farmers use pesticides and cultural methods for both certified and non-certified farms. Certified farmers however use more pesticides compared to non-certified farmers. There was statistically significant differences in the methods used to control pest in both certified and non-certified farms mango and pineapple farmers ($p<0.05$) (Table 4.3)

Table 4.3 Method used to control pest on pineapple and mango farms

Variable	**Pineapple farm**		**P-value**	**Mango farm**		**P-value**
	Certified {n (%)}	**Non-certified {n (%)}**		**Certified {n (%)}**	**Non-certified {n (%)}**	
Use of pesticides	30(100)	14(46.7)	0.024*	25(83.3)	12(40.0)	0.031*
Biological methods	2(6.7)	18(60.0)	0.032*	5(16.7)	16(53.3)	0.012*
Cultural methods	21(70.0)	17(56.7)	0.243	22(73.3)	19(46.6)	0.321
Total	53	49		52	47	

*significant at P≤0.05

The results of the association between methods of pest control and demographic characteristics of the farmers revealed that famers who had secondary education in agriculture were more likely to adopt more pest control compared to those with basic education in both certified and non-certified farmers. With regards to the number of years of farming and pest control, those who had farming experience between 11-15years were more likely to use pest control methods (Table 4.4)

Table 4.4: Association between method of pest control and background characteristics

Variable	**Certified {n (%)}**			**Non-certified {n (%)}**		
	Use of pesticides	**Biological methods**	**Cultural methods**	**Use of pesticides**	**Biological methods**	**Cultural methods**
Gender Male	15(78.9)	2(33.3)	1(100)	12(63.2)	1(16.7)	5(71.4)
Female	4(21.1)	4(66.7)	0(0)	7(36.8)	5(83.3)	2(28.6)
Background education in Agriculture						
Basic	12(63.2)	2(33.3)	0(0)	10(52.6)	1(16.7)	1(100)
Secondary	7(36.8)	4(66.7)	1(100)	9(47.4)	5(83.3)	0(0.00)
Years in farming practice 6-10 years ago	6(31.6)	3(50.0)	0(0.0)	8(42.1)	2(33.3)	1(100)
11-15 years ago	8(42.1)	2(33.3)	1(100)	5(26.3)	3(50.0)	0(0.0)
16-20 years	5(26.3)	1(16.7)	0(0.0)	6(31.6)	1(16.7)	0(0.0)

When the respondents were asked whether they keep records on their farm, majority representing 95.4% of the certified farmers answered in the affirmative whilst only 52.5% also kept farm records (Figure 4.4).

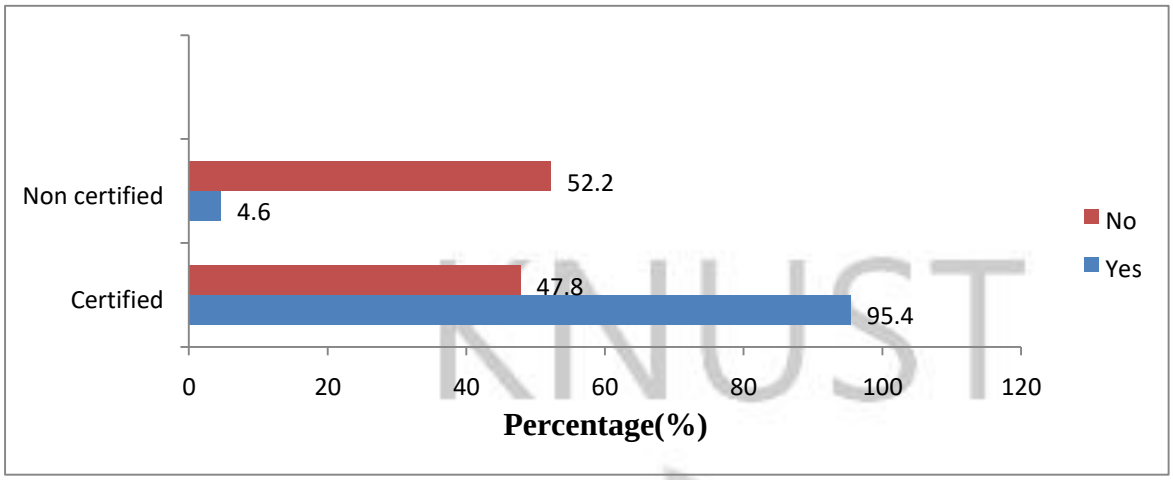

Figure 4.4 Records keeping of mango and pineapple farmers

The analysis showed that the most reported areas where farm records are kept were chemical application, fertilizer application and sales record. These accounted for 100%, 96.7%, and 70%% respectively among certified farmers whilst cultural practice (74.5%) and chemical application (74.5%) were also the most reported by the non-certified farmers. The least reported area where farm records was kept for both non -certified farmers were sales record representing 45%.

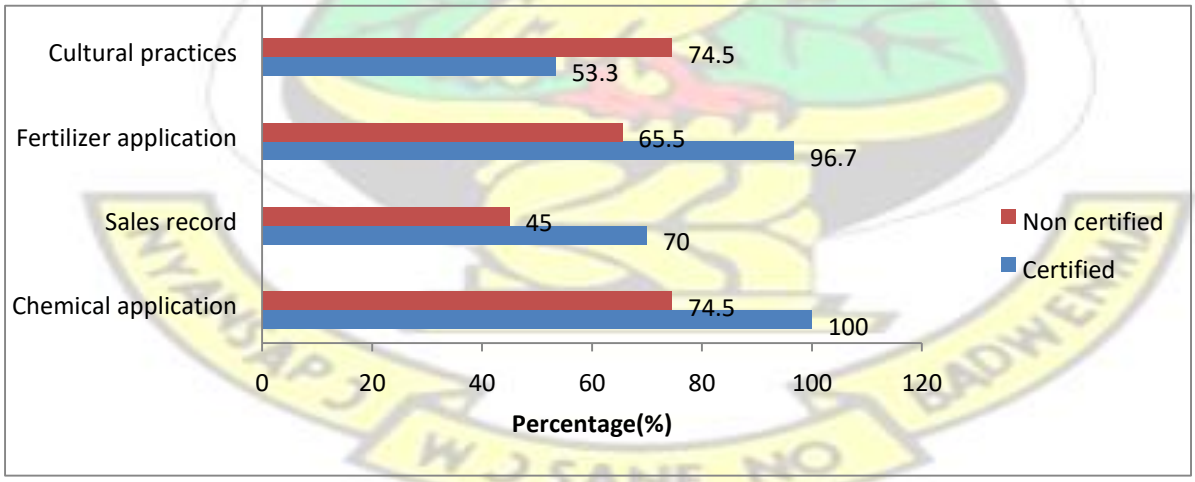

Figure 4.5 Areas of record keeping on farm for pineapple and mango farmers

The results showed that majority of the certified farmers observe a good hygiene compared to the non-certified farmers. Most certified farmers (75.9%) wash their hands with soap and water

before harvesting fruits indicating a good hygiene practice compared to non-certified farmers. There were statistically significant differences in hygiene practices between the certified and non-certified farmers with respect to washing of hands with water and washing of hands with soap and water (P≤0.05). However with respect to the wearing of gloves there were no significant differences (Table 4.5)

Table 4.5 What harvesters do before harvesting

Variable	Certified {n	Non-certified {n (%)}	P-value (%)}
Washing of hands with water	5(17.2)	15(46.7)	0.015*
Washing of hands with soap and water	22(75.9)	10(60.0)	0.028*
Wears gloves	2(6.9)	4(56.7)	0.352
Total	29	29	

*significant at P≤0.05

Figure 4.6 affirms the point that market access is the main driving force for GLOBAG.A.P certification in the mango and pineapple industry and without it, farmers cannot access some markets (Henson et al., 2011; Campel et al., 2006; Fox and Vorley, 2006; Graffham et al., 2007).

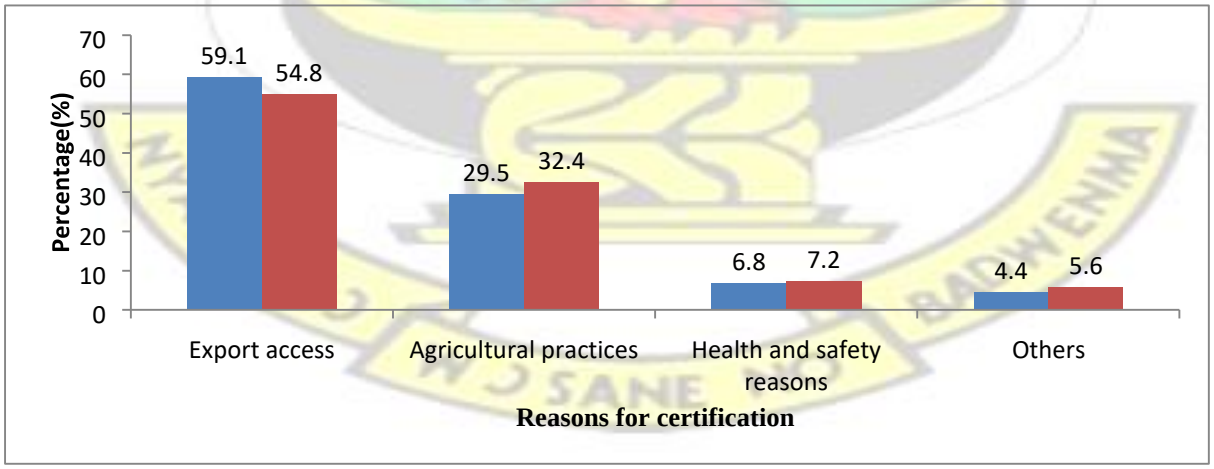

Figure 4.6 Reasons for GLOBALG.A.P. Certification of farmers

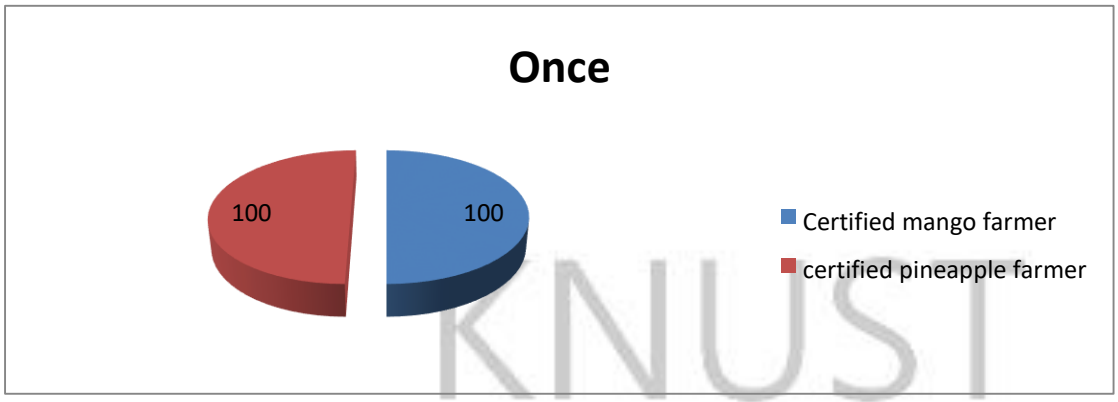

Figure 4.7 Number of times audited against the GLOBALG.A.P standard in a year

When the respondents were asked whether they were any non -conformities identified during audit 100% of the respondents answered in the affirmative. Figure 4.8 below illustrates the non-conformities usually identified by both certified mango and pineapple farmers during auditing processes. When the respondents were asked to indicate the state of non-conformities identified in the previous audit, the results showed that, farming practices and hygiene which bothers on safety and quality as indicated by Mawuli et al. (2013) are the areas nonconformities are identified. This of course could have a negative effect on the microbiological analyses carried out.

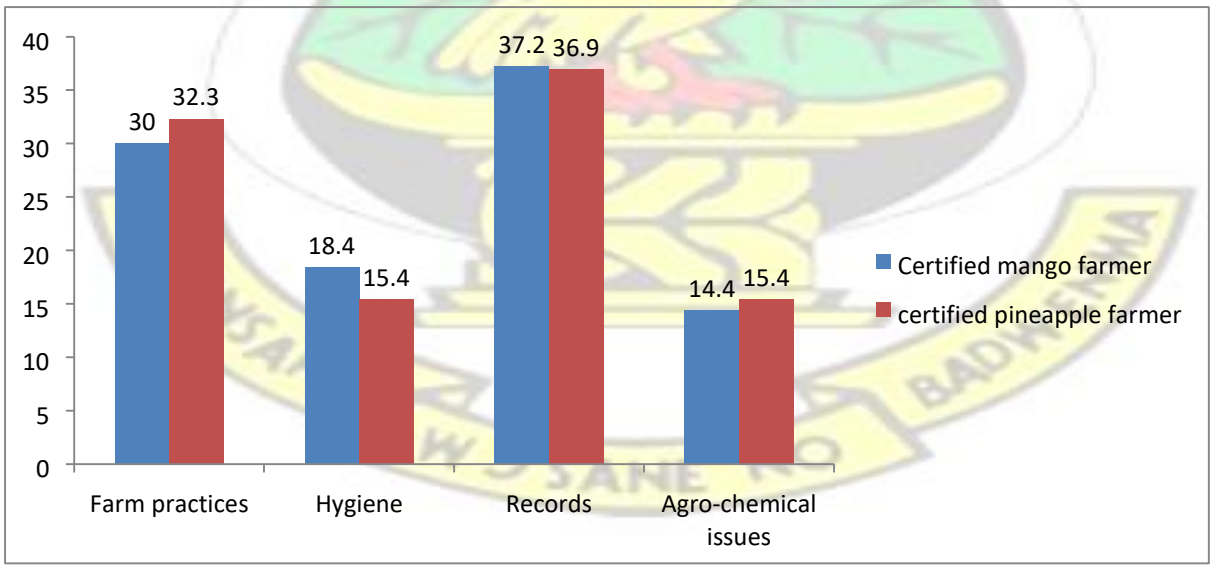

Figure 4.8 conformities usually identified by farmers during auditing

When the respondents were asked if they will like to opt out from GLOBALG.A.P certification, 20.7% answered in the affirmative whilst the remaining 79.3% were not willing to opt out. Of those who wanted to opt out cited reasons such as; local market is lucrative (50%) and requirements are many (50%).

When the respondent's views were ascertained whether there is any difference between fruits produced from certified farms from non –certified, approximately 60% answered in the affirmative whilst the remaining 40% indicated that there was no difference. Most of the reasons cited for the differences include; certified fruits are tested and conform to standards, free from chemicals and microbes and good agricultural practices.

4.2 Observational study

The observations done revealed that in terms of cultural practices, both certified and noncertified farmers were doing well. However, assessing facilities and issues related to hygiene, it was clear that certified farmers were ahead of non-certified farmers. This could be because of the trainings given to certified farmers and the constant inspections done by both internal and external inspectors (Table 4.6 and Table 4.7).

Table 4.6 Checklist assessment of farm practices for pineapple famers (n=10)

Parameter	**GLOBALG.A.P certified farms**			**Non-global certified farms**		
Field practice	Excellently done	Moderately done	Not done	Excellently done	Moderately done	Not done
Pruning	4	***4***	2	2	3	5
Weeding	3	5	2	2	4	4
Mulching	5	***2***	3	1	5	4
Protection from entry of poultry, cattle, ruminants	6	2	2	2	4	4
Chemical storage						
ventilation	4	3	3	2	5	3
Located away from food, harvesting materials and cleaning agents	6	3	1	4	4	2

Harvesting material storage area						
Cleanliness of storage area	7	2	1	4	3	3
Harvesting materials exclusively used for harvesting	5	3	2	3	4	3
Cleanliness of truck which may be used for harvesting	4	5	1	2	6	2
Harvesting and post-harvest activities						
Hygiene procedures and instructions	5	2	3	2	3	5
Hand washing facilities	4	5	1	2	4	4
Toilet facilities	4	3	3	3	2	5
Packing and storage area						
Cleanliness of the area	6	3	1	4	5	1
Protection from contamination	5	4	1	3	4	3
Physical separation of cleaning agents from fruits	5	3	2	3	2	5
Whether cleaning agents are food grade	4	4	2	2	4	4
Pest control	6	3	1	3	3	4
Records						
Agronomic records	5	3	2	2	2	6
Scouting records	3	3	4	1	1	8
Chemical records	4	3	3	2	3	5
Cleaning schedules	3	4	3	2	1	7

Table 4.7 Checklist assessment of farm practices for mango famers (n=10)

Parameter	**GLOBALG.A.P certified farms**			**Non global certified farms**		
Field practice	Excellently done	Moderately done	Not done	Excellently done	Moderately done	Not done
Pruning	3	4	3	3	4	3
Weeding	4	4	2	2	5	3
Mulching	5	3	2	3	4	3

Protection from entry of poultry, cattle, ruminants	7	2	1	4	2	4
Chemical storage						
ventilation	5	3	2	3	4	3
Located away from food, harvesting materials and cleaning agents	5	3	2	2	2	6
Harvesting material storage area		3				
Cleanliness of storage area	6		1	2	3	5
Harvesting materials exclusively used for harvesting	4	2	4	3	3	4
Cleanliness of truck which may be used for harvesting	6	3	1	3	6	1
Harvesting and post-harvest activities		3				
Hygiene procedures and instructions	5		2	4	3	3
Hand washing facilities	3	5	2	3	5	2
Toilet facilities	4	4	2	3	2	5
Packing and storage area						
Cleanliness of the area	5	3	2	4	4	2
Protection from contamination	4	4	2	2	5	3
Physical separation of cleaning agents from fruits	6	3	1	2	2	6
Whether cleaning agents are food grade	4	4	2	1	5	4
Pest control	5	2	3	2	3	5
Records						
Agronomic records	6	3	1	1	3	6
Scouting records	4	2	4	2	3	5
Chemical records	5	3	2	3	3	4
Cleaning schedules	4	4	2	2	3	5

4.3 Chemical parameters of the fruits

4.3.1 pH

Table 4.8 shows the mean pH values of both the pineapple and mango fruits from GLOBALG.A.P certified and non-certified farms. The students t-test statistics revealed that there was no statistically significant differences in pH between the fruits (pineapple and

mango) obtained from GLOBALG.A.P certified farms and that of the non-certified farms at 95% confidence level(P>0.05) (Table 4.10).

The mean pH of pineapple and mango fruits from both GLOBALG.A.Ps (GG) certified farms and non-certified farms were far above recommended limit for fruits meant for human consumption (5.5). The results of the pH obtained indicated acidic conditions. Nkansah et al. (2010) reported that pH values of fruits lower than 5.5 are considered too acidic for human consumption and can cause significant health problems such as acidosis and adverse effects on digestive and lymphatic system. Marketing and supply chains in many developing countries cannot distinguish between pH of GAP certified and non- GAP certified fruits through full traceability and uniqueness of GAP output (Pongvinyoo et al., 2014). The lower pH obtained for the fruits could be attributed to the fact that, most of the fruits probably had not reached its full maturity as pH of fruits increases with increase in ripeness. The soil condition according to (Ficciagroindia, 2007) be a contributing factor to this low pH observed in the fruits.

4.1.2 Percentage Brix

The value for the % Brix of the sample are shown in table 4.8. The student's t-test statistics revealed that % Brix of the both fruits from both GAP certified and non-certified farms differed significantly at 95% confidence level (P<0.05) (Table 4.10).

According to UNECE Standard and FAO (2012), maximum acceptable limit of %Brix in fruits should be at least 12%. With the exception of GLOBAL GAP certified pineapple and mango fruits whose maximum limit % Brix content was above and equal to the acceptable limit, all the rest were below the set limits. But the mean values from both certified and non-certified mangoes and pineapples were below the acceptable limit for consumption. Lower %Brix implies that the fruits are not ripen for consumption. This is good for fruits that will be exported since higher %Brix will affect the shelf life of the fruits but for the non-certified fruits, if they will be consumed right away then it's not good but for the market woman, it will help in will

help in improving the shelf life of the fruits that may stay for a long time on the shelf which is consumed fell below the recommended limit, both the non-certified pineapple and mango fruits were above the recommended limit. There were also statistically significant differences in % Brix of the pineapple fruits from both GAP certified and non-certified farms. The lower levels of % Brix recorded from mangoes and pineapples in non-certified farms could be attributed to the fact that the fruits might have ripped but have not reach appropriate degree of maturity hence a percentage decrease in its sugar content. Percentage Brix content of fruits is directly proportional to the ripening of fruits. This indicates that an increase in ripening leads to an increase in the sugar content of fruits (Neha and Tumane, 2011).

4.1.3 Percentage total acidity

From table 4.8, although the percentage total acidity of pineapple fruits was generally higher in the non-certified farms, the student's t-test statistics revealed that percentage total acidity of the both pineapple and mango fruits from both GLOBALG.A.P certified farms and noncertified farms was not statistically significant at 95% confidence level (P >0.05)(Table 4.10). Total acidity indicates how acidic or basic a fruit will taste. From the values it shows clearly that the fruit will taste acidic due to the lower values recorded. This is in agreement with the lower pH values recorded.

Table 4.8. Concentrations of chemical parameters in pineapple and mango fruits from GLOBALG.A.P (GG) Certified farms and Non-certified farms.

SAMPLE	**pH**		**% BRIX**		**% TOTAL ACID**	
	Pineapple	***Mango***	***Pineapple***	***Mango***	***Pineapple***	***Mango***
GG Certified						
GAPC1	4.25	4.82	12.50	11.20	0.03	0.01
GAPC2	4.72	4.65	11.28	10.45	0.04	0.03
GAPC3	4.29	4.78	12.00	11.00	0.02	0.04
GAPC4	4.18	4.39	13.00	12.00	0.04	0.02
GAPC5	4.14	4.76	10.00	9.00	0.03	0.05

	± 0.32	**4.68**±0.48	**11.76**±2.65	**10.73**±1.75	**0.03**±0.00	**0.03**±0.00
Mean						**4.32**
GG Non-Certified						
NGAPC1	4.48	4.23	8.0	7.00	0.03	0.02
NGAPC2	4.36	4.28	10.0	8.50	0.04	0.03
NGAPC3	4.28	4.10	9.23	9.48	0.04	0.02
NGAPC4	4.29	4.15	9.78	8.77	0.03	0.01
NGAPC5	4.62	4.34	8.56	9.58	0.03	0.03
Mean	**4.41**±0.28	**4.22**±0.12	**9.27**±2.34	**8.7**±1.2	**0.03**±0.00	**0.02**±0.00

4.2 Microbiological parameters

Various counts for the microbiological parameters are shown in Table 4.9 from the table it is seen that the values for the non-certified fruits are higher as compared to that of the certified fruits. The students t-test statistics revealed that there was statistically significant differences in total viable plate counts, total coliforms count and yeast and mould count between the pineapple and mango fruits obtained from GLOBALG.A.P certified farms and that of the noncertified farms at 95% confidence level($P<0.05$)(Table 4.10).

Table 4.9. Concentrations of microbiological parameters in pineapple and mango fruits from GLOBALG.A.P certified farms and non-certified farms.

SAMPLE	**Total viable count (cfu/g/ml)**		**Total coliforms (cfu/g/ml)**		**Yeast and moulds (cfu/g/ml)**	
	Pineapple	**Mango**	**Pineapple**	**Mango**	**Pineapple**	**Mango**
GG Certified						
GAPC1	4.8×10^2	1.1×10^2	4.3×10^2	4.5×10^2	7.7×10^2	8.2×10^2
GAPC2	4.0×10^2	1.5×10^2	2.5×10^2	4.0×10^2	6.5×10^2	7.7×10^2
GAPC3	2.7×10^2	2.9×10^2	3.0×10^2	6.0×10^2	7.7×10^2	6.5×10^2

GAPC4	4.0×10^2	5.3×10^2	2.8×10^2	5.3×10^2	8.2×10^2	7.7×10^2
GAPC5	3.9×10^2	4.8×10^2	3.2×10^2	4.8×10^2	5.8×10^2	6.5×10^2
Mean	***3.9×10^2 ± 15.5***	***3.1×10^2 ± 23.2***	***3.2×10^2 ±22.8***	***4.9×10^2 ±21.2***	***7.2×10^2 ±48.4***	***7.3×10^2 ±25.7***
GG Non-Certified						
NGAPC1	18.9×10^2	11.5×10^2	12.8×10^2	8.5×10^2	15.8×10^2	14.3×10^2
NGAPC2	15.4×10^2	9.5×10^2	10.6×10^2	6.0×10^2	10.0×10^2	9.8×10^2
NGAPC3	17.2×10^2	9.1×10^2	14.4×10^2	9.5×10^2	11.5×10^2	9.9×10^2
NGAPC4	15.4×10^2	8.6×10^2	12.8×10^2	8.9×10^2	9.8×10^2	12.8×10^2
NGAPC5	13.2×10^2	5.8×10^2	13.4×10^2	7.5×10^2	12.5×10^2	13.7×10^2
Mean	***16.2×10^2***	***8.9×10^2 ± 23.2***	***12.8×10^2***	***8.0×10^2 ± 28.9***	***11.9×10^2***	***12.1×10^2 ±32.4***

Yeast and moulds, total coliform and total viable counts were detected in almost all the samples of mango and pineapple fruits. For fruits to be considered safe for human consumption, Yeast and mould counts, coliform bacteria in the sample should be zero and the total coliform counts should not exceed 0 CFU/100ml (FAO, 2004). Results from the study showed high levels of total coliform, yeast and mould counts and total viable counts in both GAP certified and noncertified farms. However, the counts were significantly higher in non-certified farms compared to GLOBALG.A.P certified farms. The high coliform counts in the non-certified farms could be attributed to unhygienic farming practices such as such as not washing hands under running water and soap was gathered during the survey, which could have caused the introduction of coliforms. This high coliform counts therefore pose a significant health problem to the consumers of fruits and fall short of export requirement if not washed and treated well before consumption. The results showed that almost all the certified farmers use agro chemicals (100%) as compared to the non-certified farmers (72.8%). The presence of micro bacteria in fruits can be linked to a number of factors such as improper handling, use of contaminated water during washing, cross contamination from rotten fruits (Khalil, 2010). The social survey also revealed that the certified GLOBAL G.A.P. farmers receive support through

education/training, information updates, provision of farm inputs, facilitation of loans from banks and this may help in proper farm management options compared to Non-certified farmers hence higher microbiological parameters recorded for fruits obtained from non-certified farms.

Most fruit are acidic enough and have sufficient sugar to favor the growth of yeasts (Khalil, 2010). Moulds are generally considered to be the least important group of micro-organisms causing spoilage in fruit because of their limitation, inability to grow in the absence of air (AlHindi, 2011). According to a study conducted on the microbiological quality of fresh mango fruits in Dhaka city, the total fungal counts were in the range of 1.0×101 to 8.05×104 cfu/ml (Shakir et al., 2009) which is in consistence with the findings obtained for yeast and mould counts of this study. Fungal fruit infection may occur during the growing season, harvesting, handling, transport and post-harvest storage and marketing conditions, or after purchasing by the consumer (Al-Hindi et al., 2011). Fruits contain high levels of sugars and nutrient elements and their low pH values make them particularly desirable to fungal growth which in turn may result in their decay (Al-Hindi et al., 2011).

Yeasts (Saccharomyces spp., Candida spp., Hanseniaspora spp) and moulds (Cladosporium spp., Penicillium spp., Aspergillus spp., Botrytis spp.) according to Al-Hindi et al. 2011 are more favored as spoilage agents of fruit. The high yeast and mould counts obtained in this study might be attributed to the use of unhygienic farming surroundings, often swarming with flies and fruit flies, other insects and airborne dust.

Fruits may contain a significant amount of microorganisms. A quantitative analysis of samples for total viable count (TVC) in mango fruits revealed that the range for TVC were between 1.0 x 104 to 4.0 x 106 cfu/ml (Ankur et al., (2009). According to study conducted in Dhaka, Bangladesh, out of 114 freshly prepared mango fruit sample collected, 113 samples (99%) showed the presence of coliform bacteria (Shakir et al., (2009). The yeast count varied between 1.8-360×104cfu/1000ml whereas mould varies between 1.1-620×104cfu/1000ml. Coliforms

include the presence of total coliform (0.05- 45×104cfu/1000ml) which is in consistence with the findings of this study.

The mean total coliform count (TC) of the pineapple fruits from GLOBALG.A.P (GAP) certified farms ranged from a minimum of 2.8×102 cfu/g/ml to a maximum of 4.3×102 cfu/g/ml with a mean value of 3.2×102 cfu/g/ml whilst that of the Non-certified farms also ranged from 10.6×102 cfu/g/ml to 14.4×102 cfu/g/ml with mean value of 12.8×102 cfu/g/ml. This is an indication that the total coliform counts for pineapple fruits obtained from non-certified farms was significantly higher than the certified farms. The results obtained was lower than total coliform counts of the work of Lewis et al., (2006) who reported that coliforms count varied between 0.8-22.2×104cfu/g/ml in pineapple fruits. Total coliform counts of the non-certified farms of this study confirms the work of Lindror and Prussia (2003), who reported that the total coliforms count in pineapple fruits was in the range 10.5×102 cfu/g/ml to 16.4×102 in almost all the samples tested. The most likely mechanisms by which fruits become contaminated with pathogenic microorganisms are through direct contact with animal or human faeces, or indirect contact with contaminated water, soil, or infected food handlers (Biljana et al., (2013).

Different freshly fruit contain significant amount of microorganisms. In a previous study, Shakir et al., (2003) demonstrated that the mean total coliform (microbial load) showed the presence of bacteria in all the freshly pineapple fruits was in the range of 3.00x102 to 9.60x108 which is significantly higher and not in consistence with the findings of this study.

The mean total viable count of pineapple fruits for both mango and pineapple fruits obtained from certified farms was significantly lower compared to that of the non-certified farms. This difference could be attributed to the persistence use of agrochemicals such as pesticides and good hygiene practices on the certified farms. In a study conducted in Kolkata city in India, mango fruit samples collected from most GAP certified farms showed that total viable counts were high ranging from 265-700×104 cfu/1000ml. According to the study, GAP provided both

economic and non-economic benefits for the farmers. However, the linkage between both incentives was not classified in terms of direct or indirect benefits. GAP also provided the knowledge and appropriate farm cultivation methods therefore; the appropriate farm methods might be direct incentive to increase market access opportunities for farmers.

The existence of pathogenic bacteria in fresh fruit and vegetable products has been reported by Alzamoora et al., (2000b) which include Listeria monocytogenes, and Escherichia Coli 0157:117 (E. coli). These bacteria are found in both fresh and minimally processed fruit and vegetable products.

The mean total viable count, yeast and moulds and total coliform of pineapple and mango fruits sampled from non-certified farms was significantly higher compared to that of the certified farms. This difference could be attributed to the persistent use of agrochemicals such as pesticides and good hygiene practices on the GLOBALG.A.P certified farms. The levels of the microbiological parameters such as yeast and moulds, total viable counts and total coliform counts far exceeded the FAO standard limit for fruits meant for human consumption and export requirement.

Table 4.10 Differences in chemical and microbiological parameters of pineapple and mango fruits from GLOBALG.A.P certified farms and non-certified farms.

Parameter	**t-value**		**p-value**	
	Pineapple	***Mango***	***Pineapple***	***Mango***
pH	2.1	3.2	0.08	0.10
% Brix	8.0	6.8	0.03*	0.04*
% Total acidity	9.2	8.5	0.25	0.32
Total viable count	58.4	45.8	0.02*	0.01*
Total coliform count	75.1	68.3	0.02*	0.00*
Mold and Yeast count	44.2	38.9	0.01*	0.02*

*significant at $p \leq 0.05$

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

An investigation was conducted to determine the impact of GLOBALG.A.P certification on the quality and safety of fresh pineapple and mangoes in the Akuapim South and Yilo Krobo Municipality. Chemical and microbiological quality of selected pineapple and mango fruits sampled from GLOBALG.A.P certified farms and non-certified farms were assessed to find out the potential quality of the fruits. The results showed that, the percentage Brix of the fruits was generally lower in the non-certified farms compared to certified farms throughout out the entire study period. The pH was generally acidic in mango and pineapple fruits from both GLOBALG.A.P certified and non-certified farms and revealed no statistically significant differences ($P \geq 0.05$). The microbiological analyses indicated the identification of microbes in the sample (both certified and non-certified) although the quantities were higher in the

noncertified that the certified fruits. The social survey affirmed that the lack of adhering to strict handling practices and lack information on the same could be the reason for the various level

The findings of this study will be useful for all stakeholders in the fruit and vegetable industry. It is important that our regulatory authorities keen on how our fresh fruits are produced for consumption and set standards for locally consumed fresh fruits. The finding gives information to consumers on the safety of fresh fruits bought from the local market. Processing these fruits will be of good to them before consuming them. Also further research can be followed up on this study to take into consideration other locations in the country to ascertain the generality of the findings.

5.2 Recommendation

Based on the findings of the study, some effective measures were recommended. These suggestions will ensure efficient management of farms by farmers in order to improve the safety and quality of their farm produce.

- As the importance of safe-guarding quality of fruits has become widely recognized, standards regarding the certification of farms and good agricultural practices should be encouraged. This can be achieved by advising and educating farmers to adopt GLOBALG.A.P certification.

- The Ministry of food and Agriculture (MoFA) and other food certification bodies must ensure that most farmers adopt certification by practicing good agricultural practices (GAP) in order to enhance fruit safety and quality.

- The District Assembly should educate the farmers on best agricultural practices and the need to keep their farming surroundings clean most especially the use of required pesticides.

- Farmers who have received training on good agricultural practices should endeavor to put them into practice.

- Pineapple and mango fruits were contaminated with total coliforms, yeast and moulds and total viable counts and therefore farmers should resort to treatment processes before selling the fruits to consumers or for export purposes.

REFERENCES

Abu, M., Olympia, N. S., Darko, J. O., Adu-Amankwa, P. and Dadzie, B. K. (2011). The mango industry in Ghana. Ghana Journal of Horticulture. In press.

Addo-Quaye, A. A.; Saah, M. K.; Tachie-Menson, Adams, I.; Tetteh, J.P.; Rockson-Akorly, V.K. and Kitson, J .E .S. (2003). General Agriculture for Senior Secondary Schools. H. Gangaram and Sons, Bombay, India.

Adebiyi, A.J. (2014). Organic agriculture development strategies in Tunisia and Uganda: Lessons for African organics. Graduate Theses and Dissertations. Paper 13932. Iowa State University, Centre for Development and the Environment University of Oslo Blindern, Norway.

Akurugu G. K. (2011). Evaluation of post-harvest handling and marketing of mango (Mangiferaindica) in Ghana (Acase study in Northern region).

Al-Hindi, RR., Al-Najada, AR., Mohamed, SA. (2011). Isolation and identification of some fruit spoilage fungi: Screening of plant cell wall degrading enzymes. Afr. J. Microbiolo. Res. 5(4): 443-448.

Alzamoora, S. E; P. Cerruti; S. Guerrero and A. Lopez-Malo. (2000b). Fruits and Vegetables: An overview on Social-Economic and Technical Issue. Food and Agricultural Organisation of U.N.O. Rome.

Anderson, K., Cockburn, J. and Martin, W. (Eds) (2010). Agricultural Price Distortions, Inequality, and Poverty, World Bank, Washington, DC.

Ankur, N., Titarmare, S., Pranoti, D., & Suchitra G. (2009). Microbiological Analysis of Street Vended Fresh Fruit and Vegetable Juices in Nagpur City, India. Int. J. Food Safety. 11: 1-3.

Author, U.S. (2010). The Impact of Forest Certification on Firm Financial Performance in Canada and the. Source Journal of Business Ethics Journal of Business Ethics, 96(96). Available at: http://www.jstor.org.

Avah, V., Dzamefe, W., Narh, E., Abakah, J. K. and Eshun, E. A. (2008). Value chain analysis for mango; Southern Horticultural Zone, Ghana.

Baah Prince Annor Akwasi Mensah-Bonsu John Baptist D. Jatoe , (2016),"Compliance with

GLOBALGAP standards among smallholder pineapple farmers in Akuapem-South, Ghana", Journal of Agribusiness in Developing and Emerging Economies, Vol. 6 Iss 1 pp. 21 – 38

Bagle, B.G. and Prasad, V.G. (2005). Studies on varietal incidence and control of stone weevil, Sternochetus (Crytorrhynchus) mangiferae Fabricius (Coleoptera: Curculionidae). Indian Journal of Entomology 47: 362–364.

Bain, C. 2010. Governing the global value chain: GLOBALGAP and the Chilean fresh fruit industry. International Journal of Sociology of Agriculture and Food 17(1): 1-23.

Bartholomew, D.P. and Malézieux, E. (2003) Pineapple. In: Schaffer, B. and Anderson, P. (eds) Handbook of Environmental Physiology of Fruit Crops, Vol. II. CRC Press, Boca Raton, Florida.

Bayati, A. & Taghavi, A., 2007. The TQM Magazine The impacts of acquiring ISO 9000 certification on the performance of SMEs in Tehran. The TQM Magazine International Journal of Quality & Reliability Management Iss Hongyi Sun International Journal of Quality & Reliability Management, 19(2). Available at: http://dx.doi.org/10.1108/09544780710729980.

Biljana, M., Mihajlovic, D., Brent D., Hélène C. & Jeff, F. (2013). Qualitative Microbiological Risk Assessment of Unpasteurized Fruit Juice and Cider Bureau of Microbial Hazards, Food Directorate, Health Products and Food Branch, Health Canada, Ottawa, ON, Canada.

Braimah, H. and van Emden, H. F. 2010. Prospects and challenges for sustainable management of the mango stone weevil, Sternochetusmangifera (F) (Coleoptera: Curculionidae) in West Africa: a review, International Journal of Pest Management 56 (2) 91-101.

Brecht J. K.; S.A. Sargent; A.A.Kader; E.J. Mitcham and F.Maul (2010). Mango. Postharvest Best Management Practices Manual. National Mango Board. Davis. UC. USA.

Bunt, C. and Piccone, M. (2004). Quality assurance: a total approach. In: Champ, B. R., Highley, E. and Johnson, G. I. (eds) Postharvest Handling of Tropical Fruits. ACIAR Proceedings 50.

Campbell, H., G. Lawrence, and K. Smith. 2006. Audit cultures and the antipodes: the implications of EurepGAP for New Zealand and Australian agri-food industries. Emerald Group Publishing Limited 12: 69 - 93.

Campbell, R. J., Ledesma, N. and Campbell, C. W. 2002. Tropical Mangoes, Fairchild Tropical Gardens, 1001, Old Cultivar Road, Coral Gables, Florida 33156-4296.

Cashore, B.: 2012. 'Legitimacy and the Privatization of Environmental Governance: How NonState Market Driven (NSMD) Governance Systems Gain Rule Making.

Centre for the Promotion of Imports from Developing Countries Market Survey (2008). CBI Market Information Database, www.cbi.eu/disclaimer. Profound Advisers in Development in Collaboration with R. Albion hugs. DA Rotterdam, the Netherlands.

COLEACP (2010). "European African Caribbean Pacific Liaison Committee", COLEACP/PIP/ Editor C. Quicland, S. Ruede la Conderi – Centra 342 RUNGIS Cedex France, available at: www.coleacp.org (accessed October 20, 2011).

Collins, J.L. 1999. History, taxonomy and culture of the pineapple. Economic Botany 3(4):335

Coveca. 2002. Comisionveracruzana de comercializacionagropecuaria. Gobiernodel Estado de Veracruz, México.

C .T .A. (2009). Mangoes-A juicy process. Spore 140.11

Donkoh, F. and Agboka, D. (1997). Constraints to pineapple production in Ghana. Acta Hort. (ISHS) 425:83-88 Available from http://www.actahort.org/books/425/425_8.htm

Dull, G. G. The pineapple: general. In: A. C. Hulme (Ed.). (2001). The biochemistry of fruits and their products, Academic Press, New York. vol. 2.

Evans, E. A. (2008). Recent Trends in World and U.S. Mango Production, Trade and Consumption. Electronic Data Information Source UF/IFAS Extension Publication # FE718. http://www.edis.ifas.ufl.edu/fe718. Accessed 20/05/2014.

Erel, E. and Ghosh, J.B. (2007). "ISO 9000 implementation in Turkish industry", International Journal of Operation & Production Management, Vol. 17.

Ficciagroindia (2007). Pineapple production Guidelines (India). Retrieved July 9, 2007 from http://www.ficciagroindia.com.

FAO (2003). Development of a framework for good agricultural practices. Available at: http://www.fao.org/docrep/meeting/006/y8704e.htm.

FAO (2012). Codex general standard for fruit juices and nectars CODEXSTAN 247-2005

FAO (2004). FAO Production Year Book: FAO Statistics Series, Rome: Food and Agriculture Organization. 142 (51): 151–173.

Food and Agriculture Organization (2004). "The market for non-traditional agricultural export", FAO Commodities and Trade, Rome. available at: www.fao. org/documents/show_cdr.asp?url_file¼docrep./0071y544

Food and Agriculture Organization (FAO) (2007). "Technical brief, rural infrastructure and agro-industries", FAO, Sectacdoma.

Fox, T. and B. Vorley. 2006. Small producers: constraints and challenges in the global food system. Ethical Sourcing in the Global Food System 163-77.

Graffham, A., Karehu, E. and MacGregor, J. (2007), "Impact of EurepGap on small-scale vegetable growers in Kenya", Fresh Insights No. 6, Natural Resources Institute, Kent, available at: www.agrifoodstandards.net (accessed June 15, 2011).

Gerken A. and Suglo V. (2002). Crop protection policy in Ghana; Pest management in West Africa Number 3, January. Food and Agriculture Organization Regional office for Africa.

Ghana Export Promotion Council (GEPC, 2007). Ghana export to Europe breaks the 1000ton mark in 2007. G.E.P.C. Report 2007. Accra.

GLOBALGAP (2011). "Global working group for good agricultural practice, control points and criteria, integrated farm assurance; fruits and vegetable regulations", GLOBALGAP c/o FoodPLUS GmbH, Cologne, available at: www.globalgap.org (accessed March 13, 2012). Henson, S. (2006). "The role of public and private standards in regulating international food markets", paper presented at IATRC Summer Symposium Food Regulation and Trade: Institutional Framework, Concepts of Analysis and Empirical Evidence, Bonn, Germany, May 28-30, 2006.

Henson, S., O. Masakure and J. Cranfield (2011). Do Fresh Produce Exporters in Sub-Saharan Africa Benefit from GlobalGAP Certification? World Development 39(3): 375-386

Hepton, A. (2003). Cultural system. In D.P. Bartholomew, R.E. Paulle and K.G. Rohrbach (Eds.), Pineapple: Botany, Production and uses (pp. 1-12). New York: NY: CABI publishing.

Hobbs, J.E. (2010). "Public and private standards for food safety and quality: international trade implications", Centre Journal of International Law and Trade Policy.

Institute of Statistics, Social and Economic Research (ISSER) (2009). The State of the Ghanaian Economy in 2008. Institute of Statistics, Social and Economic Research (ISSER), University of Ghana, Legon, Ghana.

Issarakraisila, M., Considine J. A.; and Turner D. W. (2002). Seasonal effects on floral biology and fruit set of mangoes in warm temperature region of Western Australia. ActaHorticulturae 321: 626.

Kader, A. A., (2008.) Mango quality attributes and grade standards: A review of available information and identification of future research needs. [Online]. Available at: http://www.mango.org/en/industry/researchprogram/quality-standard-research-and-analysis.aspx [accessed 2 September 2009]

Kariuku, L.N. (2006). “Participation of smallholders in international trade,Kenya national federation of agricultural producers (KENFAP)”, in Ruben, R., Slingerland, M. and Nijhoff, H. (Eds), Agro-Food Chains and Networks for Development, WageningenURFrontis Series, Springer.

Kasalu-Coffin, E., Bedinger, T. and Dosso, H. (2005). “Export marketing and quality awareness project”, appraisal report, African Development Fund, Tunis Belvedere.

Kaur, A., Ha, C.O., Jong, K., Sands V.E., Chan H.T., Soepadmao E., and Ashton P.S. (2000).Apomixis may be widespread among trees of the climax rain forest. Nature, 440-442.

Khalil, K., Lindblom, G.B., Mazhar, K., & Kaijser, B. (2010). Flies and water as reservoirs for bacterial enteropathogens in urban and rural areas in and around Lahore, Pakistan. Epidemiol. Infect. 113: 435-444

Kochhar, S .L. (2006). Tropical Crops: A Textbook of Economic Botany. Macmillan Publisher Limited. London and Basingstoke.

Lewis, Joy E., Thompson, Rao, B., Kalavati, C., Rajanna, B. (2006). Human Bacteria in Street scale fruit juice processing. A Case Study of Visakhapatnam City, India: Int. J. Food Safety.

Lindror, A. and Prussia, S. E. (2003). Quality management an industrial approach to produce handling. In: Shwfelt, R. E. and Prussia S. E. (eds) Postharvest Handling, a systems Approach. Academic Press, New York.

Litz, R. E. (1997). The Mango. Botany, Production and Uses. CAB International, Willingford, Oxon Ox10 8DE. UK.

Lumpkin, T., K. Weinberger and S. Moore (2005). Increasing income through fruit and vegetable production opportunities and challenges. CGIAR Meeting 2005/12. Horticulture, Vegetables, AVRDC, Rural livelihoods.

Mausch, K., Dagmar, M.D., Asfaw, S. and Waibel, H. (2006). “Impact of EurepGap standards in Kenya: comparing smallholder to large-scale vegetable producers”, paper presented at the Conference on IARD, University of Bonn, Bonn.

Mawuli Agboka, Emmanuel Owusu, Harry Bleppony, Eli Gaveh, Daniel Nartey, Alina Djanie, Dorinda Agar, Kofi Boye Ninsau and Seth Asima (2013). “Export Marketing & Quality Awareness Project (EMQAP).

MaCoy Steven. 2007. Organic Mangoes Production Guide. Bull. 4712.

McGovern, T.W. and LaWarre, S. (2001). "Botanical briefs: the mango tree—Mangiferaindica L.". Cutis 67 (5): 365–6.

Mitra, S. K. (ed.) (2007). Postharvest Physiology and Storage of Tropical and sub-tropical Fruits. Biddles Ltd. Guild Ford and King,,s Lynn.

MOAP (2009), “Program progress report 2009 in collaboration with MoFA and GTZ”, Market Oriented Agriculture Program, Accra

MOFA, (2007). Food and agriculture sector development policy (FASDEP II). Accra: Ministry of Food and Agriculture.

Morton, J. (1997). Pineapple. p. 18–28. In: Fruits of warm climates. Julia F. Morton, Miami, FL.

Nakasone, H. Y. and Paul, R. E. (1998). TROPICAL FRUITS- Volume 7 of Crop production science in horticulture Cab International Publication.

Nartey Narh Anthony (2011). Assessment of postharvest handling practices on quality of organically produced banana (Musa spp) and okra (Abelmoschusesculentus L) in two districts in the eastern region of Ghana.

Natural Resource Institute (NRI) (2010). "Natural Resources Institute, Ghana Export Horticulture Cluster Strategic Profile Study", Study Prepared for the World Bank Sustainable Development Network Africa Region, Agriculture and Rural Development (AFTAR), The Republic of Ghana Ministry of Food and Agriculture, and European Union All ACP Agricultural Commodities Programme, Accra.

Neha, I. & Tumane, M. (2011). Studies on microbial flora of fruit juices and cold drinks Asiatic. J. Biotechnolo. Resources. 2(04):454-460.

Nkansah, Haruna, Chris, Mawuli, Emelia, Harry, Eric, Victor, Eli, Seth, Ines (2013). "Mango production in Ghana. Export marketing and Quality awareness project (EMQAP)".

Okimoto, M.C. (2008) Anatomy and histology of the pineapple inflorescence and fruit. Botanical Gazette110, 217–231.

Paulle, R. E., and Duarte, O. (2011). Pineapple. In J. Atherton (Series Ed.) Crop Production in science in horticulture series: Vol. 1. Tropical Fruits (2nd ed., pp. 327-365). Oxfordshire: CABI International.

Poksinska, B., Dahlgaardand, J.J. and Antoni, M. (2002). "The state of ISO 9000 certification: a study of Swedish organizations", The TQM Magazine, Vol. 14 No. 5.

Pongvinyoo, N., Jirapinyo, P., Thomonsiri, Wong, N., Pidatcha, D. & Suwannthol, L. (2014). Comparison of the Nutrient Content of fresh fruit juices and commercial fruit juices. J. the Medical Association of Thailand.

Pope W. T. 2009.Mango culture in Hawaii. Agricultural Experiment Station Bulletin 58. Honolulu.Popenoe, J. and. Long. W.G (1957). Evaluation of starch contents and specific gravity as measure of maturity of Florida mangoes. Proceedings of the Florida state Horticultural.

Purseglove, J.W. (2007) Tropical Crops. Monocotyledons. Longman, London, pp 75– 91.

Py. C. y M. Tisseau. (1969). La piña tropical. Ed. Blumé. Barcelona.

Quartey, L. (2008). Mango, Ghana's untapped "Gold Mine". Ghana News Agency, Ministry of Information and National Orientation.

Rice, R. P.; Rice, L. W. and Tindall, H. D. (2000). Fruit and Vegetable Production in Warm Climates. Macmillian, London.

Rohrbach,K. G. and Johnson, M. W. (2003). Pests, Diseases and Weeds. In D.P. Bartholomew, R.E. Paulle and K.G. Rohrbach (Eds.), Pineapple: Botany, Production and uses. New York: NY: CABI publishing.

Salunkhe, D. K., Bolin, H. R. and Reddy, N. R. (2011). Storage, Processing, and Nutritional Quality of Fruits and Vegetables. Vol.1. Fresh Fruits and Vegetables. 2nd edn. CRC Press, Boca Raton. FL.

Samuel K. O. (2009). Determination of crop water requirement by mango in the transitional zone of Ghana.

Sarpong, D. (2006). "Policy options for smallholders and trade liberalization in Ghana", FAO Corporate Document Repository, Accra, available at: www.fao.org/docrep/007/y5784e04. htm (accessed June 12, 2012).

Schaffer B., Whiley A.W., and Crane J.H. (2004). Mango. In: Schaffer B. & Andersen P.C. (eds). Handbook of environmental physiology of fruit crops, Vol. II, Subtroprical and Tropical Crops. CRC Press, Boca Raton, Florida.

Sefa-Dedeh, S. (2005). "Ghana private-public partnership food industry development program", Final Report for USAID Associate Cooperative Agreement No. 641-A-00-03-0003, Accra.

Shakir, M., Ahmed, U., Nasreen, T., Feroza, B. & Parveen, S. (2003). Microbiological Quality of Local Market Vended Freshly Squeezed Fruit Juices in Dhaka City, Bangladesh. Bangladesh J. Sci. Ind. Res. 44: 421-424.

Sipes B. S., (2000). Crop Profile for Pineapples in Hawaii. USDA. Retrieved from: http://www.ipmcenters.org/CropProfiles/docs/hipineapples.html

Swiader, J. M., Ware, G.W. and McCollum, J. P. (2012). Producing Vegetable Crops 4th edition. Interstate publishers Inc. Danville, Illinois. pp 196.

TIPCEE (2008), "Trade and investment program for a competitive export economy", Economic Development Unit, Program Profile Brief, October.

Turcotte, M-F., S. Bellefeuille and F. Hond: (2007). 'GildanInc: Influencing Corporate Governance in the Textile Sector', Journal of Corporate Citizenship 27, 23-36.

Tyers, R. and Anderson, K. (2002), Disarray in World Food Markets: A Quantitative Assessment, Cambridge University Press, Cambridge and New York, NY.

WHO (World Health Organization). 2006b. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol. 94: Ingested nitrates and nitrites, and cyanobacterial peptide toxins. List of Participants. Accessed 6. 07- 2016. http://monographs.iarc.fr/ ENG/Meetings/vol94-participants.pdf.

Wills, R., McGlasson, B., Graham, D. and Joyce, D. (2008). Post-harvest.: An Introduction to the Physiology and Handling of Fruits, Vegetables and. Ornamentals. 4th edn. UNSW Press.

Zúñiga-Arias, G. &Ru ben, R. (2007). Variability in Quality and Management Practices in the Mango Supply Chain from Costa Rica. In, Mediterranean Conference of Agro-Food Social Scientists. 103rd EAAE Seminar Adding Value to the Agro-Food Supply Chain in the Future Euromediterranean Space". Barcelona, Spain, April 23rd - 25th, 2007.

APPENDICES

Appendix I

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY INSTITUTE OF DISTANCE LEARNING

Department of Food Science

QUESTIONNAIRE FOR GLOBALG.A.P. CERTIFIED MANGO FARMER

Introduction

This is a study being undertaken by a M.Sc. Food Quality Management student of the Kwame Nkrumah University of Science and Technology – Institute of Distance Learning with the aim of assessing the impact of GLOBALG.A.P. certification on the quality and safety of fresh mangoes and pineapples. This questionnaire is for academic purpose only and respondents are assured of confidentiality and privacy. Thank you.

Please tick the appropriate option given and fill in all blank spaces. Multiple answers can be ticked if applicable.

Section A: BACKGROUND CHARACTERISTICS OF RESPONDENTS

1) Sex

a) Male b) Female

2) Educational background

a) Basic education d) first degree

b) Secondary e) post - graduate

c) Diploma f) Others (specify)

3) Background education in Agriculture

a) Nil d) First degree

b) Basic e) post - graduate

c) Secondary f) Others (specify) …….

4) How long have you been farming?

a) 1 – 5 years ago d) 16 – 20 years

b) 6 – 10 years ago e) more than 20 years

c) 11 – 15 years ago

SECTION B: SELECTION OF VARIETIES FOR CULTIVATION

5) Which variety/varieties have you planted on your farm?

a) Keitt d) Kent

b) Haden e) Others (specify) …….

c) Palmer

6) If you have more than one variety, which is the most planted?

…….

7) Why did you choose that/those variety/varieties?

a) Bigger fruits e) Well – patronized by consumers

b) Resistant to diseases and pests f) Higher yield

c) Fast growing rate g) Longer shelf-life

d) Meet export demands h) others (specify) …….

SECTION C: CULTURAL PACTICES ON THE FARM

8) Which method(s) do you mostly use to control weeds on your farm?

a) Use of agro-chemicals d) Growing of cover crops

b) Use of slashers/cutlass e) Intercropping

c) Others (specify)…….

9) Which common pest do you encounter on your farm?

a) Fruit flies d) Scale insects

b) Mealy bags e) Mango thrips

c) Mango stone weevil

10) Which of (No 9) causes the greatest damage?

……..

11) What method do you use to control pest on you farm? a) Use of pesticides

b) Biological methods

c) Cultural methods – such as pruning, monitoring, scouting, etc)

d) Physical methods – steam of water, hand picking, etc) 12) Which common disease(s) is (are) found on your mango farm?

a) Anthracnose c) Stem-end rot

b) Powdery mildew d) others (specify) ……

c) Bacteria spot

13) Which of the above causes the greatest harm on you farm?

……

14) What are the sources of infection

a) Local mangoes c) The weather

b) Related crops d) Transport, harvest, packing material

c) Others(s)

SECTION D: GENERAL HYGIENE O THE FARM 15)

Do you keep records on your farm?

a) Yes b) No

16) If yes, which records do you keep?

a) Cultural practices d) Chemical application

b) Fertilizer application e) Others (specify) ……

c) Sales records

17) How many workers are on the farm?

a) 0 – 5 d) 11 – 15

b) 6 – 10 e) More than 20

c) 16 – 20

18) What type of workers do you have?

a) Permanent c) Both permanent and casual

b) Casual d) Seasonal

19) Which other people come to you farm apart from your workers?

a) Family d) Visitors

b) Subcontractors e) Others (specify)

c) Service providers

20) How are the people in (No 19) informed about hygiene measures on the farm?

a) Hygiene posters

b) Hygiene training

c) Clean water and soap are provided for all

d) Personal protective equipment are made available for all

e) Nothing is done f) Others (specify) …….

21) How are workers made aware of hygiene measures on the farm a)

They are informed verbally c) Posters

b) They are trained d) Others (specify)

…….

SECTION E: THE HARVESTING PROCESS

22) Who carries out the harvesting of mangoes on the farm a) The buyers c) The farm workers

b) Hired labourers d) Others (specify) ……

23) Have your workers received any training on hygiene

a) Yes

b) No

24) What method(s) do you use during harvesting?

a) Handpicking d) Shaking of the tree

b) Use of secateurs/scissors e) Use of knife/chippers

c) Use of picking poles

25) What does the harvester do before harvesting? a) Washing of hands with water

b) Washing of hands with soap and water

c) Wears gloves

d) Others(s) …….

e) Nothing is done

26) Which containers do you use for packing your mango fruits?

a) Baskets d) Plastics crates

b) Wooden crates e) Paper cartons

c) Polythene sacks f) Others (specify) ……

SECTION F: GLOBALG.A.P. CERTIFICATION

27) Why are you into GLOBALG.A.P. certification?

a) For export market access c) for health and safety reasons

b) For good agricultural practices d) others (specify)

28) How long have you been certified?

a) 1 – 3 years d) 10 – 12 years

b) 4 – 6 years e) more than 10 years

c) 7 – 9 years

29) How are you able to comply with the GLOBALG.A.P. standard?

a) Support from farm association
b) Support from government
c) Support from NGO's
d) support from buyers/suppliers
e) by my singular effort
f) others (specify) ……

30) If you receive support, what kind of support do you receive?

a) Education/training
b) Provision of farm inputs
c) Facilitation of loans from banks
d) information/updates
e) others (specify) ……..

31) How many time are you audited against the GLOBALG.A.P. standard in a year?

a) Once
b) Twice
c) thrice
d) more than 3 times

32) When was the last time you were audited?

a) 12 months ago
b) 11 - 7 months ago
c) 6 – 3 months ago
d) others (specify) …….

33) Were there any non – conformity(ies) identified during the audit?

a) Yes
b) No

34) Which areas were the non-conformity identified?

a) Farm practices
b) Harvesting
c) Hygiene
d) Post-harvest handling
e) records
f) agro – chemicals issues
g) others (specify) …….

35) What is the state of the non-conformiy (ies) identified in the previous audit? a) Corrective actions have been sent to the Certification body

b) Corrective actions are yet to be sent to the certification body
c) Non-compliances have been closed
d) Certification audit is scheduled

e) Others (specify) ……..

36) What are some of the challenges you encounter with audits

a) The checklist is voluminous c) time consuming

b) Diverse interpretation by auditors d) others (specify) ……

37) Would you want to opt out of GLOBALG.A.P. certification?

a) Yes

b) No

38) If your answer above is yes, why? a)

The requirements are so many

b) There are a lot of records keeping

c) There is no support

d) Local market is lucrative

e) Others (specify) ……..

39) In your opinion, do you think there is any difference between fruits produced from certified farms and those from non-certified farms

a) Yes

b) No

40) From your answer above, what could be some of the reasons

……

……

……

Appendix II

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

INSTITUTE OF DISTANCE LEARNING

Department of Food Science

QUESTIONNAIRE FOR NON-GLOBALG.A.P. CERTIFIED MANGO FARMER

Introduction

This is a study being undertaken by a M.Sc. Food Quality Management student of the Kwame Nkrumah University of Science and Technology – Institute of Distance Learning with the aim of assessing the impact of GLOBALG.A.P. certification on the quality and safety of fresh mangoes and pineapples. This questionnaire is for academic purpose only and respondents are assured of confidentiality and privacy. Thank you.

Please tick the appropriate option given and fill in all blank spaces. Multiple answers can be ticked if applicable.

Section A: BACKGROUND CHARACTERISTICS OF RESPONDENTS

1) Sex

a. Male b) Female

2) Educational background

a. Basic education d) first degree

b. Secondary e) post - graduate

c. Diploma f) Others (specify)

3) Background education in Agriculture

a. Nil d) First degree

b. Basic e) post - graduate

c. Secondary f) Others (specify) …….

4) How long have you been farming?

a. 1 – 5 years ago d) 16 – 20 years

b. 6 – 10 years ago e) more than 20 years

c. 11 – 15 years ago

SECTION B: SELECTION OF VARIETIES FOR CULTIVATION

5) Which variety/varieties have you planted on your farm

a. Keitt d) Kent

b. Haden e) Others (specify) …….

c. Palmer

6) If you have more than one variety, which is the most planted

…….

7) Why did you choose that/those variety/varieties

a. Bigger fruits
b. Resistant to diseases and pests
c. Fast growing rate
d. Meet export demands
e) Well – patronized by consumers
f) Higher yield
g) Longer shelf-life
h) others (specify)
…….

SECTION C: CULTURAL PACTICES ON THE FARM

8) What method(s) do you mostly use to control weeds on your farm

a. Use of agro-chemicals
b. Use of slashers/cutlass
c. Others (specify)…….
d) Growing of cover crops
e) Intercropping

9) Which common pest do you encounter on your farm

a. Fruit flies
b. Mealy bags
c. Mango stone weevil
d) Scale insects
e) Mango thrips

10) Which of (No 9) causes the greatest damage

……..

11) What method do you use to control pest on you farm a. Use of pesticides
b. Biological methods
c. Cultural methods – such as pruning, monitoring, scouting, etc)
d. Physical methods – steam of water, hand picking, etc) 12) Which common disease(s) is(are) found on your mango farm

a. Anthracnose
b. Powdery mildew
c) Stem-end rot
d) Bacteria spot

13) Which of the above causes the greatest harm on you farm

……

14) What are the sources of infection

a. Local mangoes
b. Related crops
c. Others(s)
c) The weather
d) Transport, harvest, packing material

SECTION D: GENERAL HYGIENE OF THE FARM

15) Do you keep records on your farm

a. Yes b) No

16) If yes, which records do you keep

a. Cultural practices d) Chemical application

b. Fertilizer application e) Others (specify) ……

c. Sales records

17) How many workers are on the farm

a. 0 – 5 d) 11 – 15

b. 6 – 10 e) More than 20

c. 16 – 20

18) What type of workers do you have

a. Permanent c) Both permanent and casual

b. Casual d) Seasonal

19) Which other come to your farm apart from your workers

a. Family d) Visitors

b. Subcontractors e) Others (specify)

c. Service providers

20) How are the people in (No 19) informed about hygiene measures on the farm

a. Hygiene posters

b. Hygiene training

c. Clean water and soap are provided for all

d. Personal protective equipment are made available for all

e. Nothing is done f) others (specify) ……..

21) How are workers made aware of hygiene measures on the farm a.

They are informed verbally c) Posters

b. They are trained d) Others (specify) …….

SECTION E: THE HARVESTING PROCESS

22) Who carries out the harvesting of mangoes on the farm a.

The buyers c) The farm workers

b. Hired labourers d) Others (specify) ……

23) Have your workers received any training on hygiene

a. Yes

b. No

24) What method(s) do you use during harvesting

a. Handpicking d) Shaking of the tree

b. Use of secateurs/scissors e) Use of knife/chippers

c. Use of picking poles

25) What does the harvester do before harvesting a.

Washing of hands with water

b. Washing of hands with soap and water

c. Wears gloves

d. Others(s) …….

e. Nothing is done

26) Which containers do you use for packing your mango fruits

a. Baskets d) Plastics crates

b. Wooden crates e) Paper cartons

c. Polythene sacks f) Others (specify) ……

SECTION F: GLOBALG.A.P. CERTIFICATION

27) Have you heard of GLOBALG.A.P certification

a. Yes b) No

28) If yes, how long have you heard of it? a. Less

than a year ago

b. A year ago

c. More than a year ago

29) From where/whom did you hear GLOBALG.A.P. certification a.

From other farmers

b. Government agency

c. From the media

d. Others (specify) ……..

30) Why are you not into GLOBALG.A.P. certification

a. Do not want to export my fruits

b. There is no difference in the fruits

c. Cost of compliance

d) local market is good

e) others (specify)

31) Are you inspected by any regulatory body or institution?

a. Yes

b. No

32) If yes, which regulatory body or institution

a. Environmental protection agency

b. Ghana Standards Authority

c. Plant protection Agency

d) Ministry of Food and Agriculture

e) the buyer

f) others (specify) …….

33) How many time are you audited in a year?

a. Once

b. Twice

c) thrice

d) more than 3 times

34) When was the last time you were audited?

a. 12 months ago

b. 11 - 7 months ago

c) 6 – 3 months ago

d) others (specify) …….

35) Were there any non – conformity (ies) identified during the audit?

a. Yes

b. No

36) Which areas were the non-conformity identified?

a. Farm practices e) records

b. Harvesting f) agro – chemicals issues

c. Hygiene g) others (specify) …….

d. Post-harvest handling

37) What is the state of the non-conformiy (ies) identified in the previous audit? a. Corrective actions have been sent to the Certification body

b. Corrective actions are yet to be sent to the certification body

c. Non-compliances have been closed

d. Certification audit is scheduled

e. Others (specify) ……..

38) What are some of the challenges you encounter with audits

a. The checklist is voluminous c) time consuming

b. Diverse interpretation by auditors d) others (specify) ……

39) Do you receive any support in your farming?

a. Yes

b. No

40) If yes, where do you get the support?

a. Support from farm association d) support from buyers/suppliers

b. Support from government e) by my singular effort

c. Support from NGO's f) others (specify) …… 41)If you receive support, what kind of support do you receive?

a. Education/training d) information/updates

b. Provision of farm inputs e) others (specify) ……..

c. Facilitation of loans from banks

42) Would you want to part of GLOBALG.A.P. certification in the near future? Why?

a. Yes

b. No

43) If your answer is yes, why?

a. For export market access

b. For good agricultural practices

c) for health and safety reasons

d) others (specify)

44) In your opinion, do you think there is any difference between fruits produced from certified farms and those from non-certified farms

a. Yes

b. No

45) From your answer above, what could be some of the reasons

……

……

…….

Appendix III

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

INSTITUTE OF DISTANCE LEARNING

Department of Food Science

QUESTIONNAIRE FOR GLOBALG.A.P. CERTIFIED PINEAPPLE FARMER

Introduction

This is a study being undertaken by a M.Sc. Food Quality Management student of the Kwame Nkrumah University of Science and Technology – Institute of Distance Learning with the aim of assessing the impact of GLOBALG.A.P. certification on the quality and safety of fresh mangoes and pineapples. This questionnaire is for academic purpose only and respondents are assured of confidentiality and privacy. Thank you.

Please tick the appropriate option given and fill in all blank spaces. Multiple answers can be ticked if applicable.

Section A: BACKGROUND CHARACTERISTICS OF RESPONDENTS

1) Sex

a. Male b) Female

2) Educational background

a. Basic education d) first degree

b. Secondary e) post - graduate

c. Diploma f) Others (specify)

3) Background education in Agriculture

a. Nil d) First degree

b. Basic e) post - graduate

c. Secondary f) Others (specify) …….

4) How long have you been farming?

a. 1 – 5 years ago d) 16 – 20 years

b. 6 – 10 years ago e) more than 20 years

c. 11 – 15 years ago

SECTION B: SELECTION OF VARIETIES FOR CULTIVATION

5) Which variety/varieties have you planted on your farm

a. MD2 d) local

b. Smooth Cayenne e) Others (specify) …….

c. Sugar loaf

6) If you have more than one variety, which is the most planted

…….

7) Why did you choose that/those variety/varieties

a. Bigger fruits e) Well – patronized by consumers

b. Resistant to diseases and pests f) Higher yield

c. Fast growing rate g) Longer shelf-life

d. Meet export demands h) others (specify) …….

SECTION C: CULTURAL PACTICES ON THE FARM

8) What method(s) do you mostly use to control weeds on your farm

a. Use of agro-chemicals d) Growing of cover crops

b. Use of slashers/cutlass e) Intercropping

c. Others (specify)…….

9) Which common pest do you encounter on your farm?

a. Nematodes d) Scale insects and ants

b. Mealy bags e) others (specify)……..

c. Symphylids

10) Which of (No 9) causes the greatest damage

……..

11) What method do you use to control pest on you farm a. Use of pesticides

b. Biological methods

c. Cultural methods – such as pruning, monitoring, scouting, etc)

d. Physical methods – steam of water, hand picking, etc) 12) Which common disease(s) is(are) found on your pineapple farm

a. Phythopthora rot c) black spot

b. Fussarium stem rot d) others (specify) ……..

13) Which of the above causes the greatest harm on you farm ……

14) What are the sources of infection

a. Local pineapples c) The weather

b. Related crops d) Transport, harvest, packing material

c. Others(s)

SECTION D: GENERAL HYGIENE O THE FARM

15) Do you keep records on your farm

a. Yes b) No

16) If yes, which records do you keep

a. Cultural practices d) Chemical application

b. Fertilizer application e) Others (specify) ……

c. Sales records

17) How many workers are on the farm

a. 0 – 5 d) 11 – 15

b. 6 – 10 e) More than 20

c. 16 – 20

18) What type of workers do you have

a. Permanent c) Both permanent and casual

b. Casual d) Seasonal

19) Which other come to your farm apart from your workers

a. Family d) Visitors

b. Subcontractors e) Others (specify)

c. Service providers

20) How are the people in (No 19) informed about hygiene measures on the farm?

a. Hygiene posters

b. Hygiene training

c. Clean water and soap are provided for all

d. Personal protective equipment are made available for all

e. Nothing is done f) Others (specify) …….

21) How are workers made aware of hygiene measures on the farm

a. They are informed verbally c) Posters

b. They are trained d) Others (specify) …….

SECTION E: THE HARVESTING PROCESS

22) Who carries out the harvesting of pineapples on the farm

a. The buyers c) The farm workers

b. Hired labourers d) Others (specify) ……

23) Have your workers received any training on hygiene

a. Yes

b. No

24) What method(s) do you use during harvesting

a. Handpicking d) Shaking of the tree

b. Use of secateurs/scissors e) Use of knife/chippers

c. Use of picking poles

25) What does the harvester do before harvesting a.

Washing of hands with water

b. Washing of hands with soap and water

c. Wears gloves

d. Others(s) …….

e. Nothing is done

26) Which containers do you use for packing your pineapples fruits

a. Baskets d) Plastics crates

b. Wooden crates e) Paper cartons

c. Polythene sacks f) Others (specify) ……

SECTION F: GLOBALG.A.P. CERTIFICATION

27) Why are you into GLOBALG.A.P. certification

a. For export market access c) for health and safety reasons

b. For good agricultural practices d) others (specify) 28) How long have you been certified?

a. 1 – 3 years d) 10 – 12 years

b. 4 – 6 years e) more than 10 years

c. 7 – 9 years

29) How are you able to comply with the GLOBALG.A.P. standard?

a. Support from farm association d) support from buyers/suppliers

b. Support from government e) by my singular effort

c. Support from NGO's f) others (specify) ……

30) If you receive support, what kind of support do you receive?

a. Education/training d) information/updates

b. Provision of farm inputs e) others (specify) ……..

c. Facilitation of loans from banks

31) How many time are you audited against the GLOBALG.A.P. standard in a year?

a. Once c) thrice

b. Twice d) more than 3 times

32) When was the last time you were audited?

a. 12 months ago c) 6 – 3 months ago

b. 11 - 7 months ago d) others (specify) …….

33) Were there any non – conformity (ies) identified during the audit?

a. Yes

b. No

Which areas were the non-conformity identified?

c. Farm practices e) records

d. Harvesting f) agro – chemicals issues

e. Hygiene g) others (specify) ……

f. Post-harvest handling

34) What is the state of the non-conformity (ies) identified in the previous audit? a. Corrective actions have been sent to the Certification body

b. Corrective actions are yet to be sent to the certification body

c. Non-compliances have been closed

d. Certification audit is scheduled

e. Others (specify) ……..

35) What are some of the challenges you encounter with audits

a. The checklist is voluminous c) time consuming

b. Diverse interpretation by auditors d) others (specify) ……

36) Would you want to opt out of GLOBALG.A.P. certification?

a. Yes

b. No

37) If your answer above is yes, why? a.

The requirements are so many

b. There are a lot of records keeping

c. There is no support

d. Local market is lucrative

e. Others (specify) ……..

38) In your opinion, do you think there is any difference between fruits produced from certified farms and those from non-certified farms

a. Yes

b. No

39) From your answer above, what could be some of the reasons

……

……

……

Appendix IV

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

INSTITUTE OF DISTANCE LEARNING

Department of Food Science

QUESTIONNAIRE FOR NON-GLOBALG.A.P. CERTIFIED PINEAPPLE FARMER

Introduction

This is a study being undertaken by a M.Sc. Food Quality Management student of the Kwame Nkrumah University of Science and Technology – Institute of Distance Learning with the aim of assessing the impact of GLOBALG.A.P. certification on the quality and safety of fresh mangoes and pineapples. This questionnaire is for academic purpose only and respondents are assured of confidentiality and privacy. Thank you.

Please tick the appropriate option given and fill in all blank spaces. Multiple answers can be ticked if applicable.

Section A: BACKGROUND CHARACTERISTICS OF RESPONDENTS

1) Sex

a. Male b) Female

2) Educational background

a. Basic education d) first degree

b. Secondary e) post - graduate

c. Diploma f) Others (specify)

3) Background education in Agriculture

a. Nil d) First degree

b. Basic e) post - graduate

c. Secondary f) Others (specify) …….

4) How long have you been farming?

a. 1 – 5 years ago d) 16 – 20 years

b. 6 – 10 years ago e) more than 20 years

c. 11 – 15 years ago

SECTION B: SELECTION OF VARIETIES FOR CULTIVATION

5) Which variety/varieties have you planted on your farm

a. MD2 d) local

b. Smooth Cayenne e) Others (specify) …….

c. Sugar loaf

6) If you have more than one variety, which is the most planted

…….

7) Why did you choose that/those variety/varieties

a. Bigger fruits
b. Resistant to diseases and pests
c. Fast growing rate
d. Meet export demands
e) Well – patronized by consumers
f) Higher yield
g) Longer shelf-life
h) others (specify) …….

SECTION C: CULTURAL PACTICES ON THE FARM

8) What method(s) do you mostly use to control weeds on your farm

a. Use of agro-chemicals
b. Use of slashers/cutlass
c. Others (specify)…….
d) Growing of cover crops
e) Intercropping

9) Which common pest do you encounter on your farm?

a. Nematodes
b. Mealy bags
c. Symphylids
d) Scale insects and ants
e) others (specify)……..

10) Which of (No 9) causes the greatest damage

……..

11) What method do you use to control pest on you farm a. Use of pesticides
b. Biological methods
c. Cultural methods – such as pruning, monitoring, scouting, etc)
d. Physical methods – steam of water, hand picking, etc) 12) Which common disease(s) is(are) found on your pineapple farm

a. Phythopthora rot
c) black spot
Fussarium stem rot
d) others (specify) ……..

13) Which of the above causes the greatest harm on you farm ……

14) What are the sources of infection

a. Local pineapples
c) The weather

b. Related crops d) Transport, harvest, packing material

c. Others(s)

SECTION D: GENERAL HYGIENE O THE FARM

15) Do you keep records on your farm

a. Yes b) No

16) If yes, which records do you keep

a. Cultural practices d) Chemical application

b. Fertilizer application e) Others (specify) ……

c. Sales records

17) How many workers are on the farm

a. 0 – 5 d) 11 – 15

b. 6 – 10 e) More than 20

c. 16 – 20

18) What type of workers do you have

a. Permanent c) Both permanent and casual

b. Casual d) Seasonal

19) Which other come to your farm apart from your workers

a. Family d) Visitors

b. Subcontractors e) Others (specify)

c. Service providers

20) How are the people in (No 19) informed about hygiene measures on the farm?

a. Hygiene posters

b. Hygiene training

c. Clean water and soap are provided for all

d. Personal protective equipment are made available for all

e. Nothing is done f) Others (specify) …….

21) How are workers made aware of hygiene measures on the farm a.

They are informed verbally c) Posters

b. They are trained d) Others (specify) …….

SECTION E: THE HARVESTING PROCESS

22) Who carries out the harvesting of pineapples on the farm

a. The buyers c) The farm workers

b. Hired labourers d) Others (specify) ……

23) Have your workers received any training on hygiene

a. Yes

b. No

24) What method(s) do you use during harvesting

a. Handpicking d) Shaking of the tree

b. Use of secateurs/scissors e) Use of knife/chippers

c. Use of picking poles

25) What does the harvester do before harvesting a.

Washing of hands with water

b. Washing of hands with soap and water

c. Wears gloves

d. Others(s) …….

e. Nothing is done

26) Which containers do you use for packing your pineapples fruits

a. Baskets d) Plastics crates

b. Wooden crates e) Paper cartons

c. Polythene sacks f) Others (specify) ……

SECTION F: GLOBALG.A.P. CERTIFICATION

27) Have you heard of GLOBALG.A.P certification

a. Yes b) No

28) If yes, how long have you heard of it? a. Less

than a year ago

b. A year ago

c. More than a year ago

29) From where/whom did you hear GLOBALG.A.P. certification a. From other farmers

b. Government agency

c. From the media

d. Others (specify) ……..

30) Why are you not into GLOBALG.A.P. certification

a. Do not want to export my fruits

b. There is no difference in the fruits

c. Cost of compliance

d) local market is good

e) others (specify)

31) Are you inspected by any regulatory body or institution?

a. Yes

b. No

32) If yes, which regulatory body or institution

a. Environmental protection agency

b. Ghana Standards Authority

c. Plant protection Agency

d) Ministry of Food and Agriculture

e) the buyer

f) others (specify) …….

33) How many time are you audited in a year?

a. Once

b. Twice

c) thrice

d) more than 3 times

34) When was the last time you were audited?

a. 12 months ago

b. 11 - 7 months ago

c) 6 – 3 months ago

d) others (specify) …….

35) Were there any non – conformity (ies) identified during the audit?

a. Yes

b. No

36) Which areas were the non-conformity identified?

a. Farm practices
b. Harvesting
c. Hygiene
d. Post-harvest handling
e) records
f) agro – chemicals issues
g) others (specify) …….

37) What is the state of the non-conformiy (ies) identified in the previous audit? a. Corrective actions have been sent to the Certification body

b. Corrective actions are yet to be sent to the certification body

c. Non-compliances have been closed

d. Certification audit is scheduled

e. Others (specify) ……..

38) What are some of the challenges you encounter with audits

a. The checklist is voluminous
b. Diverse interpretation by auditors
c) time consuming
d) others (specify) ……

39) Do you receive any support in your farming?

a. Yes

b. No

40) If yes, where do you get the support?

a. Support from farm association
b. Support from government
c. Support from NGO's
d) support from buyers/suppliers
e) by my singular effort
f) others (specify) ……

41) If you receive support, what kind of support do you receive?

a. Education/training
b. Provision of farm inputs ……..
c. Facilitation of loans from banks
d) information/updates
e) others (specify)

42) Would you want to part of GLOBALG.A.P. certification in the near future? Why?

a. Yes

b. No

43) If your answer is yes, why?

a. For export market access

b. For good agricultural practices

c) for health and safety reasons

d) others (specify)……

44) In your opinion, do you think there is any difference between fruits produced from certified farms and those from non-certified farms

a. Yes

b. No

45) From your answer above, what could be some of the reasons

……

……

……

Appendix V

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

INSTITUTE OF DISTANCE LEARNING

Department of Food Science

OBSERVATION GUIDE

AREA THINGS TO LOOK OUT FOR

Field Pruning

Weeding

Mulching

protection from entry of poultry, cattle, ruminants, etc

Chemical store Ventilation

well lit

located away from food, harvesting materials and cleaning agents

accident procedure

harvesting materials storage area cleanliness of storage area

cleanliness of the harvesting materials harvesting

materials exclusively used for harvesting cleanliness of

truck which may be used for harvesting

harvesting and post-harvest activities hygiene procedure and

instructions hand washing facilities toilet facility

Packing and storage area cleanliness of the area

protection from contamination

Physical separation of cleaning agent from fruits

Whether cleaning agents are food grade

pest control equipment

Records Agronomic

records Scouting records

chemical records cleaning

schedules

Score Points

Excellently done 10

Moderately done 7

Yet to be done 3

Does not know it has to be done 0

Do not have that facility NA (Not applicable)

Appendix VI

Preparation of samples for the laboratory analyses.

Titratable Acidity

The sampled fruits were peeled and macerated with a commercial juice extractor, filtered and then centrifuged. Five milliliters (5ml) of the supernatant juice was mixed with 25ml CO_2 free water. The mixture in triplicate was then titrated against 0.1M NaOH using 0.04% cresol red as indicator. Acidity was calculated as citric acid (%) by the AOAC (1990) method.

pH

pH was determined using the same filtrate prepared during the determination of the titratable acidity. The pH of ten milliliters (10ml) of juice was determined using a pH meter (Model pHep3, μicropHep). **Microbiological analyses**

The skin of the fruit and juice was tested for their microbiological safety by determining the total plate count (TPC), yeasts /moulds, and total coliforms using international procedures.

Media preparation

A volume of 39.5g of Violet Red Bile Glucose agar, 17.5g of Plate Count Agar and 39g of Potato Dextrose Agar were respectively weighed using the analytical balance into a one litre conical flask and heated to boil. These were then capped and all except, the Violet red bile glucose agar were autoclaved at 121°C for 15min.

Sample preparation

The mango and pineapple sample were aseptically transferred into sterilized stomacher bags and swabbed using moisten sterilized cotton swabs into sterilized buffered peptone water in test tubes, and homogenized. One milliliter of the solution was pipetted into 9ml of peptone water to obtain 1:10 dilutions of the swabbed solution. Subsequently the mango and pineapple samples were peeled using sterilized knife and 10g weighed into stomacher bags.

Analytical method

The pour plate techniques was used, the samples were homogenized using the stomacher blender for 30s, one milliliter aliquots was pipetted into sterilized petri dishes in duplicates and the appropriate agars added, it was then swirled and allow to solidify, and incubated at the respective temperatures, 35°C for 18-24h for total plate count and total coliform count, and 250C for Yeasts and moulds count. After the incubation period the colonies were counted using the colony counter and the results expressed as colony forming unit per ml or grams.

Total Plate Count

The total population counts of the mesophilic bacteria were determined using the Total Plate Count Method, on a plate Count Agar (pH 7.0 from Oxoid Ltd., Basingstoke, Hampshire – England). The plate was incubated at 35oC for 48 ± 2h. The number of colonies developed were counted and recorded as colony forming units per gram of sample (cfu/g).

Yeasts and Moulds

Potato Dextrose Agar (pH 6.6 from Oxoid Ltd., Basingstoke, Hampshire – England) was used to determine the yeasts and moulds population in the sample. The plates were incubated at 25oC for 5 days. The number of colonies developed were counted and recorded as colony forming units per gram of sample (cfu/g).

Total Coliforms (Presumptive Test)

Violet red bile glucose agar (pH 6.8 from Oxoid Ltd., Basingstoke, and Hampshire -England) was used to determine the presence of Coliforms.. The plate was incubated at 35oC for 48 ± 2h. The number of colonies developed were counted and recorded as colony forming units per gram of sample (cfu/g).