EFFECT OF POSTHARVEST HANDLING AND TREATMENTS ON THE SHELF LIFE AND QUALITY OF PASSION FRUIT (*Passiflora edulis sims var)* IN UASIN -GISHU COUNTY, KENYA

BY

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DECLARATION

Declaration by the student

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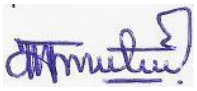
   Signature……  **……** **Date…29th October 2018…**

DEDICATION

To my parents Philip and Salina, wife Charity, son Junia, siblings (Jael, Debora, Tabitha and Rahab) and friends for their prayers, moral, and financial support which saw me through the turbulence of this work.

ABSTRACT

In Kenya, Passion fruits are part of solution in staving- off hunger and malnourishme among her citizens. Most of the underutilized fruits passion fruit included is often amo... those which have the greatest potential in terms of nutrition and income generation for small holders. Passion fruit is underutilized because of the significant amounts (10-60%) that go into waste during peak production. The objective of this study was to determine the effect of postharvest handling procedures and treatments on the shelf life and quality of passion fruit (*Passiflora edulis sims var)* in the Uasin -gishu county. The specific objectives were (i) To establish farmers harvesting methods, postharvest handling and storage of passion fruit, (ii) To determine effect of stage of fruit maturity, time of harvesting, postharvest handling practices and storage treatments on physical and chemical quality attributes of passion fruits and (iii) To evaluate the effect of postharvest treatments on organoleptic attributes of passion fruit. A base line survey was carried out in Soy and Kapseret sub-Counties in December 2015 to assess farmer's postharvest knowledge. A total of 100 farmers were surveyed and data collected using a structured questionnaire and analyzed using Statistical Package for Social Sciences (SPSS) soft ware. Secondly, 480 passion fruits were picked from the two (Soy and Kapsaret) sites which had been harvested at two maturity stages namely when the colour turned 25% (a0) and 75 % (a1), respectively. Secondly, detachment from mother plant was at fruit shoulder (b0) and leaving a stricture attached (b1) using a pocket knife. They were stored under either ambient storage conditions (c0) or under polythene film (c1). The time of harvesting was done either in the morning (d0) or in the afternoon (d1). Treated fruits were then taken to Chemelil Sugar Company Laboratory where they were stored and analyzed periodically for 28 days. The experiment was laid out in a completely randomized design (CRD) with three replicates. Passion fruits were analyzed for Weight change during storage, Total Titratable Acidity (TTA), Total Soluble Solids (TSS) and Pulp weight. The data collected was subjected to Analysis of Variance (ANOVA) using GenStat version 14th edition. Thirdly, an organoleptic taste analysis was carried out on the Passion fruits exposed to various Postharvest treatments. The data collected was analyzed for their physical appearance in color, absence and/or presence of bruises and flavor taste (using IBM SPSS Statistic version 21. The study indicated that almost half (44%) of the farmers harvested their produce in the early part of the morning when it is dry while about 20% stored their produce under modified atmosphere conditions. The color at which passion fruit was harvested significantly affected ($p< 0.05$) its titratable acidity, pulp weight and its brix. In addition the mode of storage significantly impacted ($p< 0.05$) the fruit total titratable acidity, pulp weight and whole fruit weight. The passion fruits harvested at 75% color maturity stage and stored under modified atmosphere packages were the most appealing to the organoleptic task panel. The farmers in Uasin Gishu County should harvest at 75% color maturity stage as well as employ the use polythene sheets during storage as this will greatly impact the fruits chemical and organoleptic quality attributes thus influencing its shelf life.

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May the good Almighty Lord, who knows the heart of all men, richly bless you.

CHAPTER ONE

INTRODUCTION

1.1 Background

The edible commercial species of Passion fruit originated on the edges of Amazon forest in South America. The purple passion fruit (*Passiflora edulis*) is adapted to the cool subtropics or high altitudes in the tropics while the yellow passion fruit (*P. edulis f. flavicarpa*) is more suited to tropical lowland conditions (Ministry of Fisheries, Crops and Livestock (MoFC&L, 2004).

In Kenya, Passion fruits are becoming a unique solution to a desperate effort to stave-off hunger and malnourishment in the Rift Valley region (Gantry, 2008).

Among the fruits that are classified as under-utilized in the Northwest region of Kenya, Passion fruit (*Passiflora edulis*) rates high. This is attributed to the fact that significant amounts go into waste during peak production. The other reasons for the underutilization of passion fruit is because of lack of knowledge on its importance, lack of market, lack of improved high yielding planting materials, lack of knowledge and information on value-addition because of its seasonal availability and that it cannot be stored for a long period (Koech et al., 2014).

Most of the underutilized and ‘under-researched fruits are often among those which have greatest potential in terms of nutrition and income generation for small-holders.

Thus if its utilization is enhanced, passion fruit is likely to be a major tool in achieving the world’s daily requirement of a minimum of 400g of fruits and vegetables per individual (Agudo, 2004).

Passion fruit like other tropical and subtropical fruits present special problems in storage and transportation because of its perishability and the long distance between the producing areas and major destination markets. Moreover it is estimated that 10-60% of the harvested fruits are lost due to poor post-harvest handling (Mitra, 2008).

Storage temperature, humidity and length of storage have a great influence on the visual quality attributes of passion fruit. Loss of water during storage is one of the main causes of deterioration, as it results in loss of fruit weight and unacceptable appearance due to shriveling, wilting, and loss of firmness (Bora and Narain 1997). Therefore the aim of this study was to determine the effect of postharvest handling procedures and treatments on the shelf life and quality of passion fruit (*Passiflora edulis sims* var) in the Uasin - gishu county.

1.2 Statement of the Problem

Passion fruit utilization faces several setbacks such as huge postharvest losses estimated at 10-60% of the harvested fruits (Mitra, 2008). Minimizing postharvest losses of already produced fruit is more sustainable than increasing production to compensate for these losses. Post harvest losses are caused by mechanical, physiological and pathological factors as well as weak post-harvest technologies that causes fruit deterioration (FAO, 2004).

1.3 Justification

Kenyan passion fruit is competitive, but has not yet reached its maximum potential because some farmers harvest premature fruits which are of poor quality thus fetching poor market price (Gaturuku and Isutsa, 2011). Passion fruit farming is also very capital

intensive and therefore a failure to minimize many losses may compromise returns (Sambu, 2012). Harvesting of premature fruits has negatively impacted global competitiveness of the passion fruit from Kenya. Factors like storage temperature, humidity and length of storage have a great influence on the visual quality attributes of passion (Good Neighbours Community Project, GNCP, 2010). Loss of water during storage is one of the main causes of deterioration as it results in loss of fruit weight and unacceptable appearance due to shriveling, wilting and loss of firmness (Becker & Fricke, 1996). Thus, proper management of the above mentioned factors is likely to increase the utilization of Passion fruit through prolonged shelf life. Uasin-gishu county is associated with maize, wheat and dairy farming but the trend is now shifting towards horticulture particularly passion fruits farming, which are known to have more returns compared to other enterprises (Horticultural News, 2012)**.**The region may be a major 'breadbasket' of Kenya, but it is increasingly emerging as an important passion fruit growing zone basically because farmers earn a good living even with small parcels of land (Sambu, 2012).

1.4 Objectives

1.4.1 Overall Objective

The objective of this study was to determine the effect of postharvest handli procedures and treatments on the shelf life and quality of passion fruit (*Passiflora edulis sims var)* in the Uasin -gishu County.

1.4.2 Specific objectives

1. To establish farmers harvesting methods, postharvest handling and storage of passion fruit.
2. To determine effect of stage of fruit maturity, time of harvesting, postharvest handling practices and storage treatments on the physical and chemical quality attributes of passion fruits.
3. To evaluate the effect of postharvest treatments on organoleptic attributes of passion fruit.

1.4.3 Research Questions

H_0- Do Uasin-gishu farmers carry out recommended harvesting; postharvest handling and storage of produce rightfully?

H_0- Do stage of fruit maturity and time of harvesting, postharvest handling practices and storage affect the quality attributes of passion fruits?

H_0- Do postharvest treatments affect organoleptic attributes of passion fruits?

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and distribution

2.1.1 Origin

Passion fruit (*Passiflora edulis*) a native of tropical America, belongs to Passifloraceae family which comprises about 530 species. Among the species, yellow passion fruit (*Passiflora edulis flavicarpa*), purple passion fruit (*Passiflora edulis)* and the giant varieties (*Passiflora quadrangularis*) are the most widely cultivated (Joy, 2010).

2.1.2 Distribution

The purple passion fruit is considered to have originated from southern Brazil through Paraguay to northern Argentina (Acland, 1971; Morton, 1987). In Kenya, purple passion fruit farming was introduced in the 1920's and expanded in the mid 20th century. The fruit is mainly grown in the Rift valley (Elgeyo- Marakwet and Uasin-gishu counties), Eastern (Meru and Embu counties), Central (Murang' and Kiambu counties), Western (Bungoma county) and Nyanza (Kisii county) regions (Amata et al., 2009; Horticultural Crop Development Authority, 2012).

2.1.3 Production

Purple passion fruit cultivation is well suited for the tropics with a frost free climate.

Passiflora edulis variety is purple and grows and produces well at an altitude of 1200 m above sea level and temperature range from 8-20^{0}C. The plant remains productive all year round in more tropical areas (Gorvernment of Kenya, 2010). In Kenya, the regions where passion fruit is grown is characterized by an altitude of 1200-2200 m ASL, rainfall of 1800-2800 mm per annum and temperatures averaging 18^{0}C (Otipa et al., 2008).

The purple passion fruit plant is highly susceptible to strong winds and high amounts of rainfall. Therefore, it requires wind protection and well distributed rainfall. The plant requires annual rainfall of between 1000 and 2500mm but can also do well with 900 mm (GoK, 2010). High rainfall during the flowering stage is destructive to the flowers and limits activities of insects thus hindering pollination. Its vine is shallow rooted thus prone to drought stress. These effects may culminate to poor quality fruits, low yields as well as economic losses to farmers (Gaturuku and Isutsa, 2011).

2.2 Description

2.2.1 Growth habit

It is a strong climbing vine that grips by tendrils nearby support. It can grow 15-20 ft high per year once established and needs strong support. Its lifespan is 5-7 years (Acland, 1971; Morton, 1987).

2.2.2 Cultivars

Purple passion fruit (*Passiflora edulis* sims)

It is a robust bearer with stems, tendrils and leaves that are clear green with round or oval fruits, 3-5 cm in diameter with a deep purple colour when ripe (Tingbani, 2012).

Yellow passion fruit (*Passiflora flavicarpa*)

This is a more vigorous grower variety than the purple and is distinguished by the reddish pinkish or purple colour in the stem, leaves and tendrils with slightly larger fruit than the purple (Makomere, 2016).

Kaveri

It is a hybrid marketed while grafted on rootstock of the yellow variety with fruits that are a blend of purple and yellow varieties but having the size of the yellow variety (Morton, 1987)

Noel Special

It is a variety found to be tolerant to Alternaria disease that comes to yield in one year after planting but is a self-incompatible and needs a pollinator for satisfactory fruiting (Martin and Nakasone, 1970)

2.2.3 Uses of purple passion fruit

It is mainly used in jams, jellies and fruit juices and also used for medicinal purposes as a seductive, headache reliever as well as a food source apart from the delicious juice made from it (Silva *et al*., 2015).

2.3 Cultural Practices

Passion fruit have deep root system; therefore cultivation practices should be as deep as possible, not less as 500 mm to ensure proper root development and good soil drainage (California Rare Fruit Growers, 1996).

2.3.1 Spacing

Generally, plant spacing of 3 m x 2 m or 3 m x 3 m are used. The average lifespan of healthy passion fruit is three years so the spacing is selected based on the expected lifespan, a smaller spacing to maximize yield for a shorter lifespan (Utsunomiya, 1992).

2.3.2 Irrigation

A well distributed rainfall of about 1000 to 1200 mm/year is essential for commercial production. The maximum water requirements are approximately 50 m^3/ha/day during

summer or dry period or 25 m^3/ha/day in cool season. It is important to obtain an optimum soil water status throughout the season. It is also proper to avoid over irrigation because it could enhance the multiplication and distribution of fungi (Soares et al., 2002)

2.3.3 Fertilizer application

It has been said that application of manure is very much necessary to have vigorous plants giving a regular and an optimum yield (Gomes et al., 2006).

2.3.4 Pruning

Passion fruit bears on current season's growth and hence pruning of vine encourages new growth resulting in regular and higher yield of fruits. It is normally accomplished by cutting back the laterals to 4-5 buds (Makomere, 2016)

2.3.5 Harvest maturity

There are several harvest maturity indices of passion fruit; they include the time after transplanting and external skin colour. Chen and Paull (2008) postulated that fruits that are harvested when they are ≥ 75% turning yellow or purple, they continue to stay that Purple. Passion fruits harvested at the light-purple stage are more suitable for long distance transport and those fruits harvested earlier have an unripe flavor. In some cases, fruits are allowed to ripen on the mother plant, abscise and fall, and are then picked up from the ground.

Important quality considerations in passion fruits include a consistent and fresh appearance, acceptable texture, characteristic flavor, and sufficient shelf-life to survive the distribution system (Watada, 1996). This therefore means that harvesting has to be done at a stage that gives a ripened flavour or rather an appealing organoleptic taste with a compromise stage that allows for long distance transport.

2.4 Harvesting and Storage

2.4.1 Harvesting

Passion fruit are harvested manually by cutting or clipping the fruit off the vine. The recommended harvest tools to be used are sharp knife or clippers with a sharp edge. A short piece of stem, approximately 4 cm (1.5 inches) in length is left attached to the fruit to help prevent water loss and fungal development. The fruit should not be pulled from the plant (Chan, 1980).

The earliest physiological responses to wounding include a transient increase in ethylene production and an enhanced rate of respiration, which may be interlinked with the wound healing response of the tissue (Wu, 2010).

Passion fruit should be harvested in the morning hours when it is cool but then the fruit surface should be dry as this will prevent built up of field heat that enhances deterioration (Abeles and Salveit, 1992).

2.4.2 Storage

Modified atmosphere packaging (MAP) storage for passion fruit is desirable. Film-bagging and various coatings also reduce water loss in yellow and purple passion fruit. It is said that response to coatings and film bagging may be associated with control of water loss, rather than modified atmosphere effects (Chen and Paull, 2008). Elsewhere it is said that plastic films and waxes increase post-harvest life because fruit respiration occurs inside the coating and consequently there is a reduction in the concentration of O_2 and an increase in CO_2, and an atmosphere with high relative humidity is formed, thus reducing water loss by transpiration (Fonseca *et al*., 2000).

Carnauba wax is regularly used in emulsions, but it is not particularly effective in preventing water loss, and it is also more permeable to O_2, CO_2 and ethylene. For these reasons, many formulations include paraffin, which is more impermeable (Ministry of Fisheries Crops Livestock; New Guyana Marketing Corporation; National Agricultural Research Institute, 2004).

Little information is available concerning the retention of vitamins and minerals, and other nutritive components in fresh-cut produce during handling, storage, and senescence. Wounding induces signals that elicit physiological and biochemical responses in both adjacent and distant tissues. It not only directly affects appearance attributes (skin and flesh skin lesions and browning) but also creates sites for pathogen infection and water loss (Wu, 2010).

Apparently there is a clear relation between the use of film bagging (packaging) and control of water loss. However, there is need to establish distinctively how use of film bagging influences other quality attributes of passion fruit such as soluble solid content, titratable acidity, flavor taste, weight and appearance

2.4.3 Postharvest losses

Post-harvest losses in tropical fruits vary widely from 10 percent to 80 percent in both developed and developing countries (Paull, 2001).

The purpose of applying post-harvest technology to harvested tropical fruits is to maintain quality in terms of appearance, texture, flavor and nutritive value, to maintain food safety and to reduce losses along the supply chain between harvest and consumption (Silva *et al*., 2015).

When the water vapor pressure in the fruit is higher than that which is in the surrounding environment, the fruit loses water. One of the mechanisms utilized to reduce water loss and increase the storage period of passion fruits is modified atmosphere packaging by use of appropriate plastic linings / packaging or hydrophobic additives on the fruit surface, such as waxes, thus reducing transpiration and respiration rates (Fonseca et al., 2000).

2.5 Pest and diseases

2.5.1 Brown spot

It is caused by the fungus *Alternaria passiflorae* with symptoms that appear as tiny spots which enlarge into sunken circular lesions with brownish centers as the rind around the diseased area becomes wrinkled (MFCL, 2004).

2.5.2 Fruit rot

It is caused by the soil-borne fungi *Phytophora nicotianae var*. *parasitica* and affects the passion fruit produced on poorly drained soils. Symptoms appear as water soaked dark green patches that dry out (Robert & Chen, 2014).

2.5.3 Septoria spot

This disease is also caused by fungus *Septoria passiflorae* which typically infects fruits while on the plant. Initial symptoms of infection appear as tiny irregular light brown spots on the fruit surface. The spots eventually develop into blotches filled with minute black fruiting bodies of the fungus. These blotches often coalesce to cover large areas of the fruit. Infection results in uneven ripening and mottled fruit colouration (Wangungu et al., 2010)

2.6 Some chemical and physical changes that takes place during fruit ripening

2.6.1 Weight loss

This is caused basically by two major processes; respiration and transpiration. Respiration is the process through which plants metabolize the products of photosynthesis in the presence of oxygen (aerobic) or absence (anaerobic). After the plant is detached from the mother plant, there is no fresh supply of substrates by the process of photosynthesis to replace those being metabolized. Therefore, the produce loses weight (Fonseca *et al*., 2000). On the other hand much loss of water through transpiration is major cause of weight in harvested produce (Fonseca *et al.*, 2000)

2.6.2 Pulp weight

The pulp represents the edible portion of the fruit and could either increase or decrease during postharvest life of the produce (Aked, 2002).

2.6.3 Change in Total soluble solids

Passion fruit contains about 14.45g of sugar/100g of edible portion which add to the unique taste and serve as natural preservative for tropical fruit (Amira *et al.*, 2013)

2.6.4 Change in Total Titratable Acidity

Passion fruit is a high acid food (pH 3.2) due to the predominance of two acids, citric (93-96% of total) and malic (3-6% of total) (Cindy, 2003)

2.7 Sensory attributes

2.7.1 Appearance

This includes the size, shape, color, structure, transparency, and degree of wholeness and so on while judging the quality of a food. The consumer takes all these factors into account (Ahmad and Siddiqui, 2015).

2.7.2 Flavor

This is a combination of taste and smell. Taste is detected by the taste buds at the lips, side and back of the tongue. Any food will smell bad before it looks bad (Jain *et al*., 2013).

2.7.3 Texture

This refers to those qualities that can be felt with the fingers, tongue, palate and/ or teeth. Texture can change during storage hence affecting the quality. Evaluation of texture involves measuring the response of a food when it is subjected to forces such as cutting, shearing, chewing, compressing and stretching (Holcroft, 2015).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Survey

3.1.1 Survey area

The study was conducted in Kapsaret and Soi sub counties, which are among the major passion fruit producing areas in Uasin-gishu County (HCDA, 2012). The areas are suitable for passion growing due to favorable climatic conditions. Farmers in the selected sub counties differ in the postharvest management of produce which made them suitable for assessing the postharvest handling techniques employed by the farmers along with other management practices. The various parameters of the 2 sub counties are described in Table 1.

3.1.2 Sampling design

Since the population of the farmers undertaking purple passion fruit farming in respective sub counties was unknown, the study determined the desired sample size for the sub counties together will reflect a normal distribution, and then a proportionate sample for each sub county based on its population was determined from the total sample size. The sampling frame comprised of purple passion fruit farmers. A total sample of hundred farmers was selected by snow ball sampling technique.

Table 1: Description of the study area

Population	Kapsaret	Soy
Area(km^2)	451.00	702.9
Population	121178	171941
Population Density/km^2	268.7	244.6
Altitude (ma.s.l.)	2043	2116
Rainfall(mm)	900-1200mm	600-1200
Temperature ranges(^{0}c)	7^0c-29^0c	7^0c-29^0c
Soils	Red clay soils	Red clay soils

Source: Uasin Gishu County, 2015.

3.1.3 Research instruments

The study made use of primary data. The data was collected through personal interviews with an aid of semi structured questionnaire (Appendix 9) administered to the farmers.

3.1.4 Statistical analysis

Data collected was analyzed by use of descriptive statistical IBM SPSS statistic version 21. Postharvest handling techniques, management practices scores, socioeconomic and institutional characteristics of the purple passion fruit farmers was examined.

3.2 Laboratory analysis

3.2.1 Experimental procedure

Fruits from the two sites Soi (Site A) and Kapsaret (Site B) were picked. In all cases the fruits selected were healthy and uniform sized. The fruits were then transported to Chemelil Sugar Company. On arrival at the company's Agronomy Laboratory, the fruits were pre-cooled and later stored in a ripening chamber $(27 \pm 1)^0$C and 50% RH. The time gap between harvest and final storage did not exceed 24 hours.

3.2.2 Treatments and experimental design

Passion fruit (*Passiflora edulis sims var*.) were picked from the two (Soy and Kapsaret) sites which had been harvested at two maturity stages namely when the colour turned 25% (a_0) and 75 % (a_1), respectively. The skin color was determined by visual expression. Secondly, detachment from mother plant was at two points that is fruit shoulder (b_0) and leaving a stricture attached (b_1) using a pocket knife. They were stored under two conditions that is ambient storage conditions (c_0) and under polythene film (c_1). The time of harvesting was done in the early part of the morning (d_0) and in the afternoon (d_1). The treatments combinations were as follows;

Treatment	Treatment combination
T1	a0b0c0d0
T2	a0b0c1d0
T3	a0b0c0d1
T4	a0b0c1d1
T5	a1b0c0d0
T6	a1b0c1do
T7	a1b0c0d1
T8	a1b0c1d1
T9	a0b1c0d0
T10	a0b1c1d0
T11	a0b1c0d1
T12	a0b1c1d1
T13	a1b1c0d0
T14	a1b1c1d0
T15	a1b1c0d1
T16	a1b1c1d1

The fruits were exposed to postharvest storage treatments and analyzed at periodic intervals of 7 days with initial storage interval as the starting point. The treatments were combined in CRD factorial experiment, resulting in total of 160 treatments combination (2x16x5) with three replication resulting in a total of 480 observations (2x16x5x3). There was another 96 observations (2x16x3) for the weight maintained throughout the experiment period.

3.2.3 Parameters measured

3.2.3.1 Weight

An electronic weighing balance, with an accuracy of 0.01g was used to measure the weight of fruits. The weight of the fruits was taken periodically after every 7 days interval for a period of 28 days. It is important to note that the fruits subjected to weight measurements were selected and maintained for the whole period of 28 days.

3.2.3.2 Pulp yield

The pulp of the fruits was manually scooped using a spatula and weighed. Thereafter, the pulp was sieved through a nylon cheese cloth and recovered juice was used for measurement of fruit quality parameters.

3.2.3.3 Fruit quality analysis

For determination of total soluble solids (TSS), one drop of the juice was used with a calibrated bench top refractometer and readings made corrected against the prevailing room temperature (Dadzie and Orchard, 1997). Total titratable acidity (TTA) was determined by titrating 0.1 M NaOH against 1ml of fruit juice solution in a ratio of 1: 9 water as the amount needed to obtain neutral pH of 7 (Fernandes *et al*., 2011). Fruit quality parameters was taken and recorded at 7-day intervals for 28 days.

3.2.4 Statistical analysis

The data obtained for different parameters during the storage period were subjected to analysis of variance (ANOVA) using GenStat with maturity stage, point of detachment, mode of storage, harvest time and storage time as sources of variation. The comparison among means was performed using the HSD Tukeys test at a significance level of $P<0.05$.

3.3 Organoleptic test

3.3.1 Plant material

Passion fruits were collected from 2 orchards located at Soy and Kapseret sub counties in Uasin Gishu County. The samples were collected in the April season. Each sample was cleaned and stored and brought in for analysis after every 7 day interval until day 28. There were 16 treatments and a total of 460 (2 sites x16 treatments x 5 storage intervals x 3 replicates) fruit samples.

3.3.2 Sensory panel

The sensory panel included 8 individuals (4 men and 4 women) aged 23 and 35 years who were randomly selected from among Tropical college of management students doing food science and nutrition course. Fruit quality was assessed by comparing flavor. During flavor evaluation panelists rinsed their mouths with water at room temperature after intake of each served sample. The fruit sample was cut into 8 pieces and serving made to the judges. The sensory panel was convened at a 7 day interval for a period of 28 eight days.

3.3.3 Data collection

The samples were randomized and the sensory panel evaluated each sample according to the organoleptic taste questionnaire presented in Appendix 10.

3.3.4 Statistical analysis

The results obtained from the sensory panel evaluation of the samples were computed using one-way analysis of variance by use of SPSS programme version 21.

CHAPTER FOUR

RESULTS

4.1 Farmers knowledge of harvesting and postharvest handling practices

4.1.1 Color maturity index at which farmers harvest their passion fruit

The survey showed that 15.6% of the farmers harvested their produce at mature green stage or at 25% purpling, while 59.7% of the farmers harvested their produce when it is fully ripe or at 75% purpling and another 24.7% of the farmers harvested their produce at any of the above colour maturity stages (Table 9).

Table 2: Percentage analysis of colour maturity index employed by farmers in Soy and Kapseret Sub counties in Uasin Gishu County

			Color maturity Index			
			25% Purpling	75% Purpling	Other	Total
Sub county	Soy	Count	7	23	8	38
		% within Sub county	18.4%	60.5%	21.1%	100.0%
		% within Color maturity Index	58.3%	50.0%	42.1%	49.4%
		% of Total	9.1%	29.9%	10.4%	49.4%
	Kapseret	Count	5	23	11	39
		% within Sub county	12.8%	59.0%	28.2%	100.0%
		% within Color maturity Index	41.7%	50.0%	57.9%	50.6%
		% of Total	6.5%	29.9%	14.3%	50.6%
Total		Count	12	46	19	77
		% within Sub county	15.6%	59.7%	24.7%	100.0%
		% of Total	15.6%	59.7%	24.7%	100.0%

4.1.2 Point of detachment from the mother plant

The farmers interviewed showed parity in their understanding of where to detach their produce with 27.3% of the respondents detaching their produce at the fruit shoulder, 50.6% at a 5cm stricture from the fruit shoulder and the rest at 22.1% when the fruit has dropped to the ground (Table 10).

Table 3: Farmers detachment of produce from the mother plant during harvesting in Soy and Kapseret sub counties in Uasin- Gishu counties

			Fruit Shoulder	5 cm Stricture Attached	When the Fruit has dropped	
Sub county	Soy	Count	7	20	11	38
		% within Sub county	18.4%	52.6%	28.9%	100.0%
		% within Detachment Point	33.3%	51.3%	64.7%	49.4%
		% of Total	9.1%	26.0%	14.3%	49.4%
	Kapsaret	Count	14	19	6	39
		% within Sub county	35.9%	48.7%	15.4%	100.0%
		% within Detachment Point	66.7%	48.7%	35.3%	50.6%
		% of Total	18.2%	24.7%	7.8%	50.6%
Total		Count	21	39	17	77
		% within Sub county	27.3%	50.6%	22.1%	100.0%
		% of Total	27.3%	50.6%	22.1%	100.0%

4.1.3 Mode of storage used by farmers

The survey found that 74 % of the respondents store their produce under the prevailing room conditions while only 20.8 % stored them on polythene films and another 5.2% did not use a specific mechanism for storage of their produce (Table 11).

Table 4: Mode of storage of passion fruit used by farmers in the Soy and Kapseret Sub counties in Uasin Gishu County

			Ambient condition	Modified atmosphere	Others	
Sub county	Soy	Count	25	11	2	38
		% within Sub county	65.8%	28.9%	5.3%	100.0%
		% within Mode of storage	43.9%	68.8%	50.0%	49.4%
		% of Total	32.5%	14.3%	2.6%	49.4%
	Kapsaret	Count	32	5	2	39
		% within Sub county	82.1%	12.8%	5.1%	100.0%
		% within Mode of storage	56.1%	31.3%	50.0%	50.6%
		% of Total	41.6%	6.5%	2.6%	50.6%
Total		Count	57	16	4	77
		% within Sub county	74.0%	20.8%	5.2%	100.0%
		% of Total	74.0%	20.8%	5.2%	100.0%

4.1.4 Time of the day in which harvesting is done

Only 44.2% of the respondents harvest their produce in the morning when the fruit is dry, 29.9 % do it in the morning when the fruit is wet, 23.4 % harvest their produce in the

afternoon when the fruit is dry and another 2.6% do it in the afternoon when the fruit is wet (Table 12).

Table 5: The time of the day in which passion fruit harvesting is done by the farmers in Soy and Kapseret Sub counties in Uasin Gishu County

			Morning when fruit is dry	Morn when fruit is wet	Afternoon when fruit is dry	Afternoon when the fruit is wet	Total
Sub county	Soy	Count	21	7	9	1	38
		% within Sub county	55.3%	18.4%	23.7%	2.6%	100.0%
		% of Total	27.3%	9.1%	11.7%	1.3%	49.4%
	Kapsaret	Count	13	16	9	1	39
		% within Sub county	33.3%	41.0%	23.1%	2.6%	100.0%
		% of Total	16.9%	20.8%	11.7%	1.3%	50.6%
Total		Count	34	23	18	2	77
		% within Sub county	44.2%	29.9%	23.4%	2.6%	100.0%

4.2 Effect of Harvesting, Post- harvest handling and Storage on Quality Attributes of Passion Fruit.

4.2.1 Effect of color stage on weight of fruit during storage

Passion fruit harvested at 25% and 75% color maturity index did not show significant (*p>0.05*) difference on its weight (Table 13).

Table 6: The variance components and approximate sampling errors of passion fruit given various postharvest handling treatments

Color				
Treatment	Titratable acidity	Pulp weight	Brix	Weight
Color 0	34.92a	21.08b	14.63c	38.48a
Color 1	30.84b	22.01a	15.08a	39.31a
F-Probability	<0.001	<.05	<.05	>0.05
Cv (%)	22	20.4	8.4	13.7
SED	0.66	0.4	0.11	0.487
Point of detachment				
Treatment	Titre volume	Pulp yield	Brix	Weight
Detachment 0	33.37a	21.58a	14.9a	38.61a
Detachment 1	32.39b	21.51a	14.81a	39.17a
F-Probability	<0.001	>0.05	>0.05	>0.05
Cv (%)	22	20.4	8.4	13.7
SED	0.66	0.4	0.11	0.487
Mode of storage				
Treatment	Titre volume	Pulp yield	Brix	Weight
Mode of Storage 0	31.96b	20.46b	14.85a	36.1a
Mode of storage 1	33.81a	22.64a	14.86a	41.69a
F-Probability	<0.001	<.05	>0.05	<0.005
Cv (%)	22	20.4	8.4	13.7
SED	0.66	0.4	0.11	0.487
Harvest time				
Treatment	Titre volume	Pulp yield	Brix	Weight
Harvest time 0	32.45b	21.59a	14.84b	38.7a
Harvest time 1	33.32a	21.5a	14.87c	39.08b
F-Probability	<0.001	>0.05		>0.05

			>0.05	
Cv (%)	22	20.4	8.4	13.7
SED	0.66	0.4	0.11	0.487

Site

Treatment	Titre volume	Pulp yield	Brix	Weight
Site0	38.11a	25.65a	14.09b	47.54a
Site1	27.66b	17.44b	15.62a	30.25b
F-Probability	<0.005	<.05	<.05	<0.005
Cv (%)	22	20.4	8.4	13.7
SED	0.66	0.4	0.11	0.487

Storage interval

Treatment	Titre volume	Pulp yield	Brix	Weight
1(day 1)	47.01a	23.35a	16.079b	43.24a
2(day 7)	33.85c	21.63c	16.129a	40.27b
3(day14)	29.74d	21.95b	14.975c	37.15d
4(day 21)	35.63b	20.84d	14.001d	34.61e
5(day 28)	18.18e	19.96e	13.085e	39.2c
F-Probability	<0.005	<.005	<.005	<.005
Cv (%)	8.5	20.5	6.3	11.3
SED	0.255	0.402	0.0849	0.402

Means followed by the same letter in the column are not statistically significant

4.2.1.2Effect of point of detachment of passion fruit on weight of fruit during storage

The effect of the two points of detachment on weight of passion fruit was insignificant ($p>0.05$) (Table 13). When the effect of the two points of detachment was compared, the fruits harvested by detaching at fruit shoulder had a slightly lower weight than those with a 5cm stricture length left attached to it (Table 13). When the effect of the point of detachment of the fruit from the mother plant was evaluated against length of storage, fruits detached at points (fruit shoulder and 5cm stricture) exhibited a decreasing trend in

their weights. However that which was detached at fruit shoulder had a lower mean weight in all the measurements along the storage period (Table 13).

4.2.1.3 Effect of mode of storage on weight

That the mode of storage of passion fruit is highly significant ($p<0.05$) is evidenced by huge difference in weight of fruits stored both under ambient and modified atmosphere (MAP) conditions. Storage of produce under ambient conditions realized the lowest fruit weight compared to that which was stored under modified atmosphere that is a polyethene sheath (Table 13). There was a decline of the fruit weight over the period of storage for fruits stored under ambient and modified atmospheric conditions as it is shown in (Table 13).

4.2.1.4 Effect of harvest time on weight

The fruits harvested both in the morning and those harvested in the afternoon did not show any significant effect ($p>0.05$) in their weight (Table 13). There was also general drop of weight of fruits harvested at the two harvests time over the storage. On average the fruit that was harvested in the morning had a higher weight compared to that that was harvested in the afternoon**.**

4.2.1.5 Effect of site on weight

There was significant ($p<0.05$) effect of site selected on the weight of the fruits with site A having the highest mean (47.54g) while site B was lowest (30.25 g) (Table 13).The variation in the means for the two sites was prominent due to varying geographical variation.

4.2.1.6 Effect of postharvest storage on weight

There was significant (P<0.05) effect of postharvest storage on weight of the produce. There was gradual reduction in the weight of the samples during the storage period (Table 13). The weight of the treatments on the first day when measurements were taken had the highest mean weight (43.24 g), decreasing gradually over the storage period to day 21 being with the least mean weight (34.61 g). As expected, there was a rise in mean weight (39.2 g) on day 28, contrary to the set trend on mean weights of the preceding days (Table 13).

4.2.2 Effect of color maturity stage, point of detachment, mode of storage and harvest time on brix analysis of fruit during storage

4.2.2.1 Effect of color maturity stage on brix

Color in which passion fruit is harvested was highly significant (p< 0.001) (Table 13). The brix measurements indicated that fruits harvested at 25% coloring stage had the lowest brix level (14.63) compared to passion that was harvested at 75% colour maturity stage with brix level (15.08). Passion fruit harvested at 25% colour maturity stage recorded the highest brix (16.188) at day 7 storage interval. On the other hand passion fruit harvested at 75% colour maturity stage exhibited uniform declining trend in the brix levels during the storage intervals.

4.2.2.2 Effect of point of detachment on brix

Point at which passion fruit was detached from the mother plant did not have any significant effect on brix (*p> 0.005*) (Table 13). However passion fruit detached at the fruit shoulder had the highest brix on average (14.9) compared to that which was harvested leaving behind a 5cm stricture that had a brix reading of 14.81. During the

period of storage, passion fruit detached at the fruit shoulder had declining levels of brix with day 28 having the lowest brix of 12.71. Passion fruit detached at 5cm fruit stricture had the highest brix at day 7 then followed by a declining level to day 28 being lowest.

4.2.2.3 Effect of mode of storage on brix during storage

Mode of storage did not have significant effect on brix ($p>0.005$) (Table 13). Passion fruit that was stored in polythene film (MAP) had highest brix (14.86) compared to that which was stored under ambient conditions with brix content (14.85).

4.2.2.4 Effect of harvest time on brix during storage

The time in which passion fruit is detached from the mother plant did not have any significant effect on brix content ($p> 0.005$) (Table 13). On average, fruits that were harvested in the morning had the highest brix of (14.87) while that which was harvested in the afternoon had a brix reading of (14.84).

4.2.2.5 Effect of site on brix

Table 13 gives the brix means of the two sites with their probabilities. Site B had the highest brix (15.62) compared to site A (14.09). The p value showed that there was significant effect of site on brix content in all the sites ($p<0.05$) (Table 13).

4.2.2.6 Effect of storage on brix

There was a declining trend of the brix over the postharvest storage period (Table 13). It was evident that there was a significant effect of postharvest storage on brix content ($p< 0.05$). On comparison of the treatments within each site there was a general decline in the brix content for all the treatments in the two sites (Table 13).

4.2.3 Effect of color stage, point of detachment, mode of storage and harvest time on titratable acidity of fruit during storage

4.2.3.1 Effect of color maturity stage on titratable acidity

Color stage at which passion fruit was harvested had a significant effect on titratable acidity of passion fruit. This is evidenced by the $p<0.05$ value (Table 13) The fruits harvested at 25% Color maturity index had the highest mean of 34.92 titre volume, while that which was harvested at 75% Color maturity index had a mean of 30.84 titre volume.

4.2.3.2 Effect of point of detachment on titratable acidity

The point at which passion fruit was detached from the mother plant in this study did not have any significance $(p>0.05)$ on titratable acidity (Table 13) (Appendix 4). However when comparison were made within the treatments itself, passion fruit detached on the fruit shoulder had the highest mean (33.37) of titratable acidity compared to passion fruit that was detached leaving behind a 5 cm stricture which had the lowest mean (32.39) of titratable acidity.

4.2.3.3 Effect of mode of storage on titratable acidity

Storage in both ambient and modified atmosphere (polythene films) conditions did not have any significant effect on passion fruit titratable acidity $(p> 0.05)$ Table 13. However mean comparisons indicated that storage under polythene films maintained passion fruits acidity levels (33.81) of titratable acidity higher than storage under ambient condition which had a mean of 31.96 titre volume (Table 13).

4.2.3.4 Effect of harvest time of passion fruit on titratable acidity of the fruit during storage

The passion fruits that were harvested in the afternoon and those that were harvested in the morning had a highly significant difference (<0.001) (Table 13). On comparing the two harvest time means, passion fruits harvested in morning retained much their acidity (33.32 cm^3) levels than those that were harvested in afternoon which had a mean of 32.45 cm^3.

4.2.3.5 Effect of site on titratable acidity

The effect of site on titratable acidity in this study was significant (*p<0.05*) (Table 13)**.** Titre volume was highest in site A (38.11cm^3) and lowest in site B (27.66 cm^3).

4.2.3.6 Effect of storage interval (S.I) on titratable acidity

Titratable acidity declined during the postharvest storage and there was a significant effect (p<0.005) of the various treatments on titratable acidity of passion fruit (Table 13). Titratable was highest in day 1 (47.0cm^3) dropping in storage interval 2 to a (33.9cm^3) then 29.74cm^3 in storage interval 3 before rising to a 35cm^3 in storage interval 4 and then dropping back once again to a low of 18.2cm^3 in storage interval 5.

4.2.4 Effect of color stage, point of detachment, mode of storage, harvest time, storage interval and their interactions on pulp weight

4.2.4.1 Effect of color stage on pulp weight

There was significant effect on the color maturity stage (CMS) at which passion fruit is harvested (*p< 0.05*) (Table 13). Passion fruits harvested at 75% colour maturity stage had the highest mean yield of 22.01 g with that which was harvested at 25% colour maturity stage having a mean of 21.08 g pulp weight (Table 13).

4.2.4.2 Effect of point of detachment of passion fruit on pulp weight of fruit during storage

Point at which passion fruit was detached from the mother plant did not have significant effect with a ($p< 0.05$) (Table 13). On the other hand when the means of the two points of detachment are considered it is the facts suggest that there is preservation of pulp weight when detachment is done at the fruit shoulder (21.58 g) compared to detachment at 5cm stricture (21.51 g).

4.2.4.3 Effect of mode of storage on pulp weight of passion fruit during storage

Mode of storage significantly affected the passion fruit pulp weight during storage ($p< 0.001$) (Table 13). There was conspicuous difference in the means of the two modes of storage with storage under modified atmosphere having the highest pulp yield of mean (22.64 g) with that stored under ambient condition having lowest mean (20.46 g) (Table 13).

4.2.4.4 Effect of harvest time of passion fruit on pulp weight of the fruit during storage

The time in which passion fruit was harvested did not have any significant effect on pulp weight ($p>0.05$) (Table 13) There was slight variation in the means of fruits harvested in the morning from those harvested in the afternoon that is 21.59 and 21.5 g respectively (Table 13).

4.2.4.5 Effect of site on pulp yield of passion fruit

Site had a significant effect on pulp yield of passion fruit ($p<0.05$) (Table 13). There was a wide divergence of means from the two sites where passion fruits were collected from,

for instance passion fruits from site A had a mean pulp weight of 25.65g while site B had 17.44g pulp weight.

4.2.4.6 Effect of storage interval on pulp weight

Storage interval had significant effect on pulp yield ($p<0.05$) (Table 13) (Appendix 2). There was considerable variation in pulp yield among the treatments at various storage intervals. Pulp yield was highest in storage interval 1 (23.35g) dropping to mere 21.63g in storage interval 2 then rising slightly to a 21.95 g in storage interval 3 beating the obvious thinking before gradually dropping to a low of 20.84g and 19.96g in storage interval 4 and storage interval 5, respectively (Table 13).

4.3 Effect of treatments on organoleptic attributes of passion fruit

4.3.1 Effect of colour maturity stage, point of detachment, mode of storage and harvest time on perceived colour.

In the organoleptic color attribute analysis 62.5% of the judges disliked very much the color for passion fruit sample a0b1c0d0 (Figure 1; Appendix 5). It was also noted that fruit color of passion fruit sample a0b0c0d0 was disliked by 57.5% of the panelists. Another 42.5 % of panelists were neutral on their perception of skin color of passion fruit sample a1b1c1d1. A total 80% of the judges liked the color of passion fruit sample (a1b0c1d1).

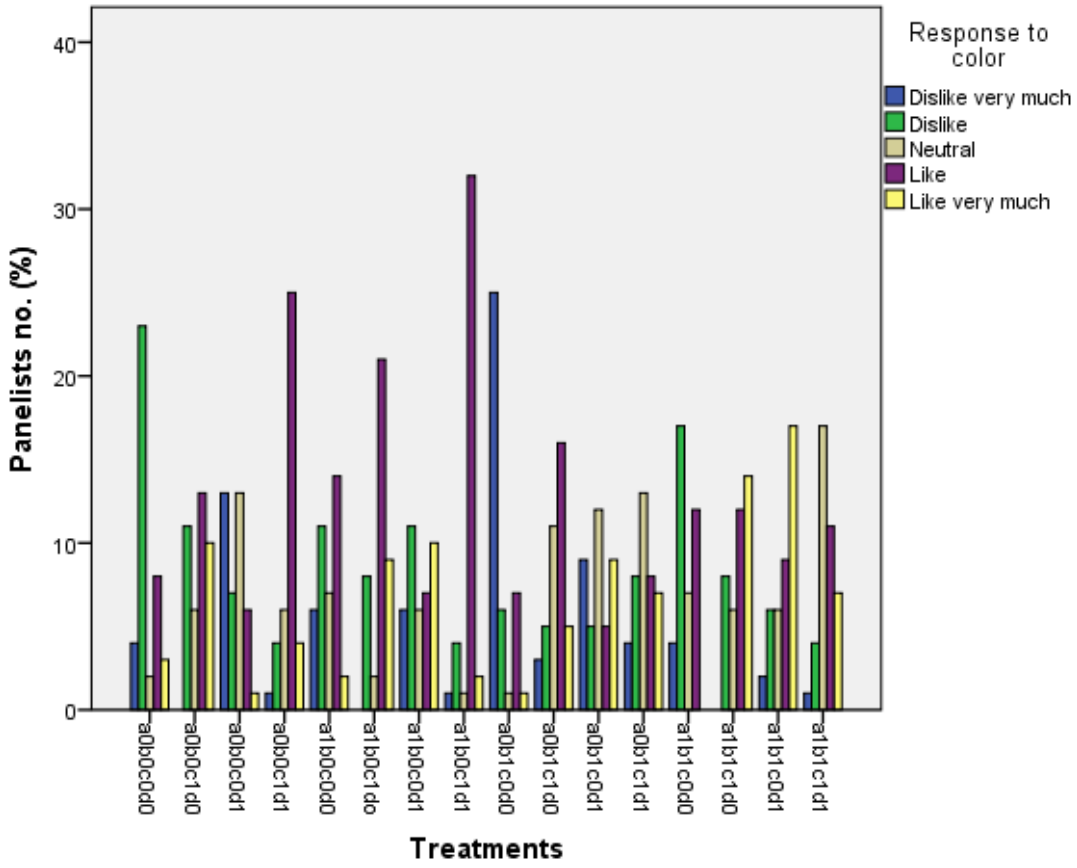

Figure 1: Effects of treatments on organoleptic taste panel perception of colour

4.3.2 Effect of colour maturity stage, point of detachment, mode of storage and harvest time on appearance of the fruit

The appearance of fruit a0b1c0d0 was disliked very much by 47.5% of the panelists (Figure 2; Appendix 6). Another 47.5 % of the panelists just disliked the appearance of fruit samples a0b0c0d0 and a0b0c0d1. Also to note was that 32.5% of the panelists took a neutral stand in their perception of the appearance of fruit sample a1b0c0d0. On the other hand a good number (67.5%) of the judges liked the appearance of fruit sample

a1b0c1d1. It was as well noted that the appearance of fruit sample a0b0c1d0 was very much liked by 35% of the judges.

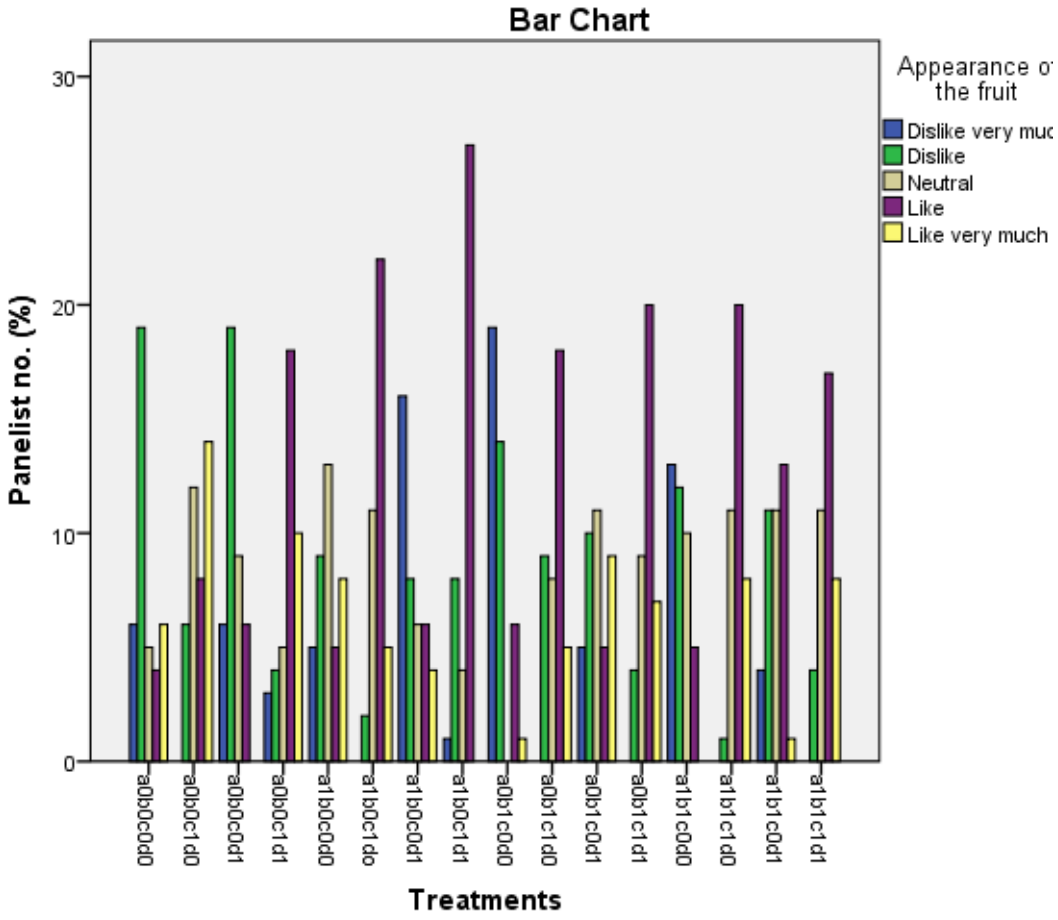

Figure 2: Organoleptic taste panel response on appearance of passion fruit samples

4.3.3 Effects of colour maturity stage, point of detachment, mode of storage and harvest time on flavor attribute of passion fruit

On evaluation of flavor, fruit sample a1b0c0d0 was disliked very much by 20% of the judges when compared to other fruit samples (Figure 8; Appendix 7). 32.5% of the judges disliked the flavor of fruit sample a0b1c0d0. Another 37.5% of panelist score was neutral on their take on flavor taste for fruit sample a0b1c0d1. A great number of panelists (90%)

liked the flavor taste of fruit sample a1b0c0d1. Fruit samples a0b1c0d) and a1b1c1d0 was very much liked by the judges.

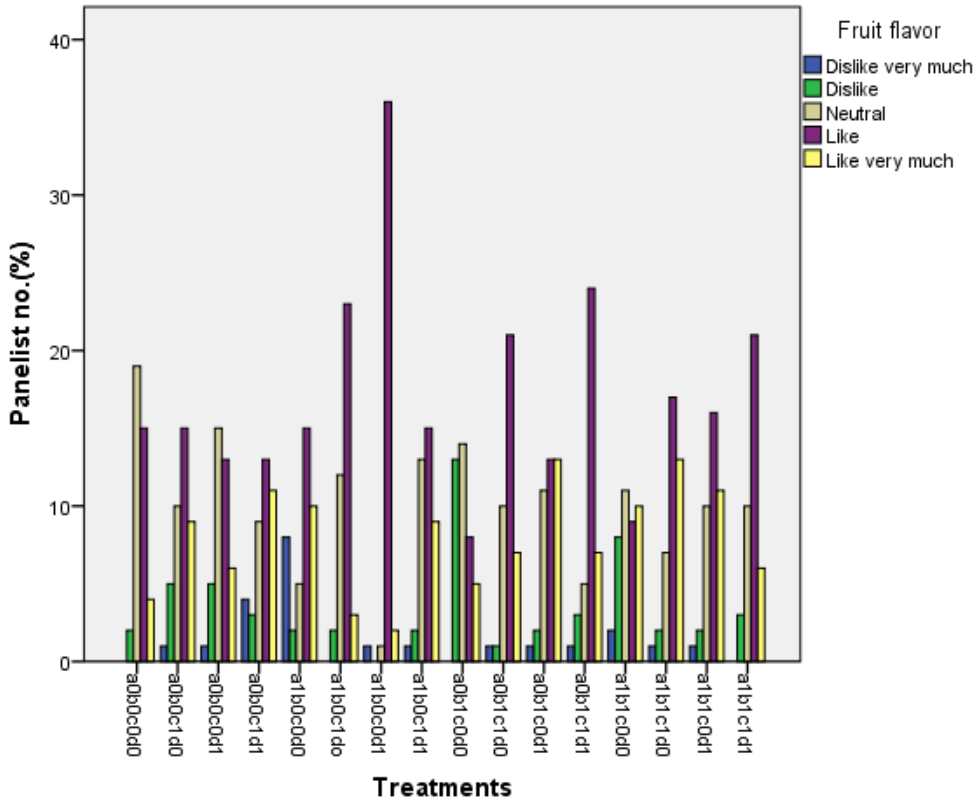

Figure 3: Bar chart showing the organoleptic taste panel response on Flavor of passion fruit samples

Day 1: Ambient

Day 1: MAP

Day 7: Ambient

Day: MAP

Day 14: Ambient

Day 14: MAP

Day 21: Ambient

Day 21: MAP

Day 28: Ambient

Day 28: MAP

Plate 1: Showing passion fruit appearance exposed to Ambient and modified storage conditions for a period of 28 days.

4.3.4 Effect of colour maturity stage, point of detachment, mode of storage and harvest time on texture of the fruit

The texture of fruit sample a0b1c0d0 was very much disliked by the jury. On the other hand the texture of fruit sample a1b1c0d0 was disliked by 32.5% of the panelists. 40% of the jury was neutral on their perception of texture of fruit a0b1c0d1 while 67.5% of the judges did like the texture of fruit samples a0b0c1d1 and a1b1c1d0 respectively. Another 35% of the jury liked very much the texture of fruit sample a0b1c1d1 (Appendix 8).

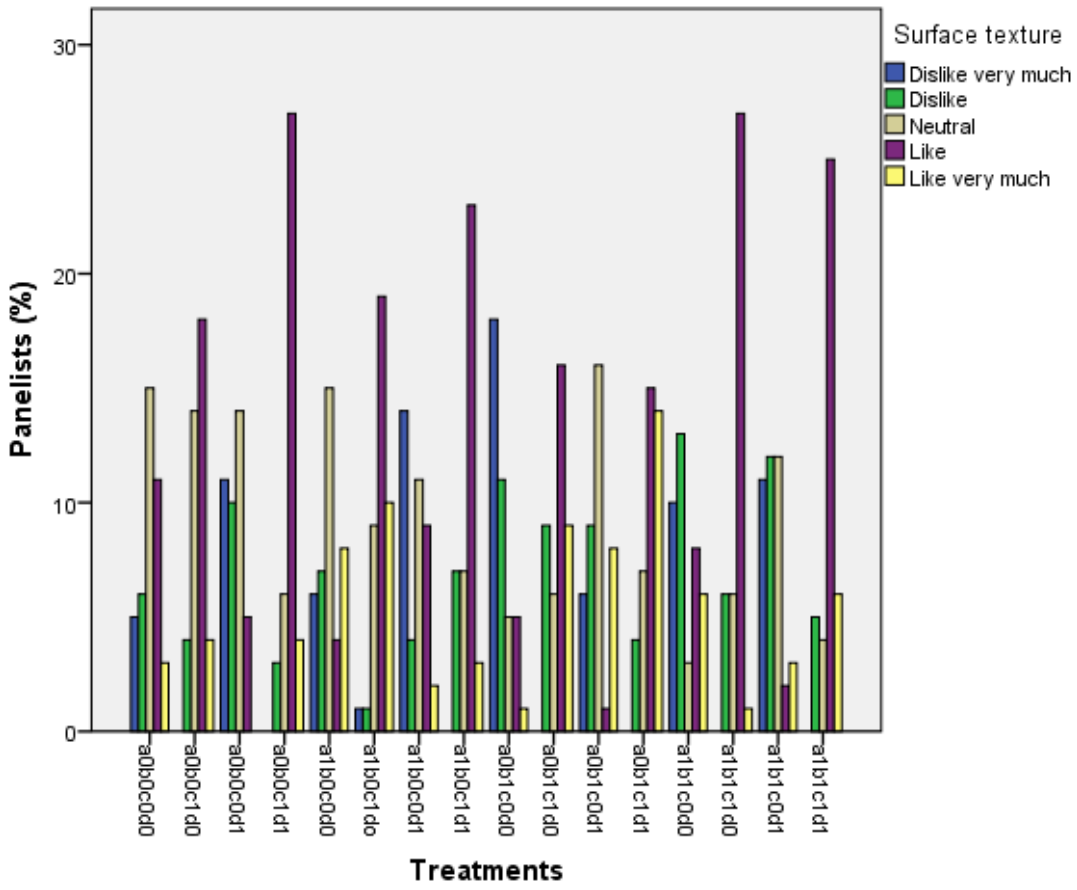

Figure 4: Showing the organoleptic taste panel response on texture of passion fruit samples.

4.3.5 Effects of colour maturity stage, point of detachment, mode of storage and harvest time on overall organoleptic attributes of passion fruit

The panelist's response for the overall liking of the fruit along the postharvest period was as follows; in the first day of analysis those who liked it were ranked number one (40.6%), neutral ranked second (35.9%), liked very much ranked third (12.5%), those that disliked ranked fourth (10.2%) and finally those that disliked it very much ranked last (0.8%) (Appendix 9).

On the seventh day of storage period those that ranked number one were neutral (45.3%), those that liked it ranked second (41.4%), Disliked ranked third (10.2%), while those that liked it very much ranked fourth (2.3%) and finally those that disliked the fruit very much ranked last (0.8%).

On the fourteenth day, the ranking was similar to that in day seven except that those that disliked the fruit very much ranked fourth (6.3%) and those who liked the fruit very much being last in the ranks (4.7%).

The trend seemed to change on day twenty one of storage with those liking the fruit ranking number one (38.3%), those that scored neutral ranking second (28.9%), while those that disliked it ranking third (21.1%), those that liked it very much coming up fourth (7.8%) and finally those that disliked it very much closing the ranking at 3.9%.

The outcome on day twenty eight was interesting with those that liked the fruit ranking number one (32.8%), those disliking second(27.3%), those that liked it very much ranked third (23.4%), fourth were those that scored neutral (8.6%) and lastly those that disliked the fruit very much ranked fifth (7.8%).

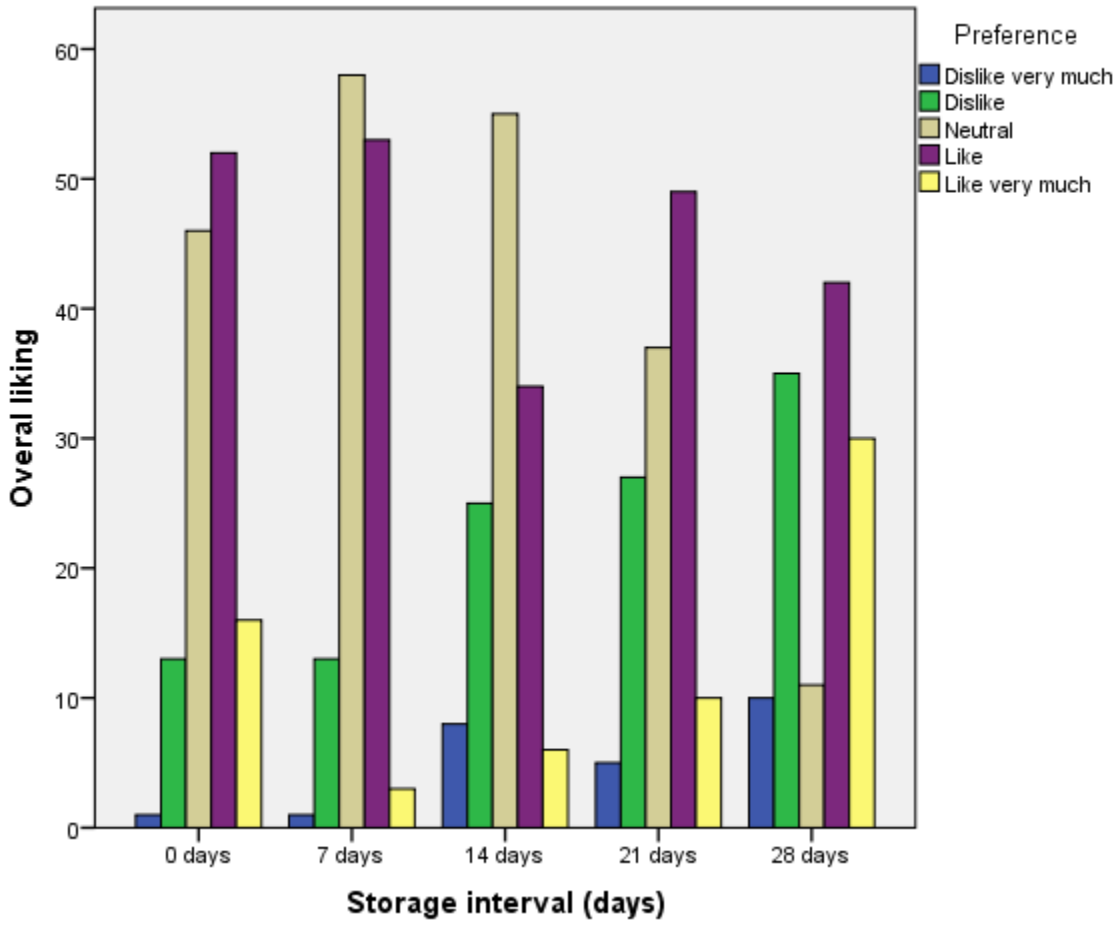

Figure 5: Showing the organoleptic taste panel scoring on overall liking of the fruit given the various treatments

CHAPTER FIVE

DISCUSSION

5.1 Evaluation of farmers knowledge on Passion fruit harvesting, postharvest handling and storage principles

The survey on the 2 sub-counties indicated that farmers harvested their fruits on a diverse range of color maturity indices which could compromise the quality and shelf life of harvested produce. Some fruits and vegetables are best harvested when fully matured and still in the green stage, matured fruits stay longer as they ripen gradually while those that are already ripe will have a short storage life (Harvey, 1978). Very often it has been stated that fruits that are harvested earlier will have an unripe flavor (Campbell and Knight, 1983).

Studies have shown that harvesting of fruits should be done as carefully as possible to minimize mechanical damage such as bruises, scratches and punctures to the produce (Muhammad *et al*., 2012). That half of interviewed farmers during harvest detach their produce leaving attached a stalk of about 5cm long is good. However, the fact that another half of farmers does it otherwise with detachment at the fruit shoulder and when the fruit has fallen to the ground suggests that a good amount of the produce loss is due to fruit bruises when they fall to the ground. When fruits are also detached close to the fruit shoulder, it may result to wounding and bruises on the skin which may accelerate transpiration loss of water and could also create openings for entry of disease causing pathogens (Tingbani, 2012).

The survey exhibited a mixed reaction on mode of storage; most farmers stored their produce under prevailing weather conditions while a few of them stored them under some

kind of modified environment and / or both. It has been said that modified atmosphere packaging (MAP) and coatings such as use of wax is desirable for yellow and purple passion fruit. The observed response is a good indicator that most farmers are not aware of modern storage technologies that are there to enhance shelf life of produce. This goes without saying that farmers have limited access to such valuable information as shown in findings in this study where up to 70% of the farmers had not received any extension service (Table 7).

There was varied responses as to the time of the day when harvesting should be done. It is recommended that fruit harvesting be done in early part of the morning when the fruit is dry or late hours of the day when it is cool. At that time, the temperatures are normally low and the rate of respiration and transpiration of the produce is low (Muhammad *et al*., 2012). The surface of the produce should be dry or be dried immediately as passion fruit should not be harvested when wet as this will encourage development and spread of disease (Ministry of Fisheries, 2004).

5.2 Effect of stage, time of harvesting, postharvest handling and storage treatments on quality attributes of passion fruit

The decline in weight of passion fruit harvested at the two color maturity indices may be attributed to transpiration water loss which is a major component of fresh produce tissue (Kitinoja, 2002). In this study, the differences in the weights of the fruits harvested at the two color maturity indices could be due to a number of reasons. Firstly, fruits harvested at 75% color maturity stage had higher accumulation of sugars compared to those harvested at 25% colour maturity stage. Sugars are osmotically active drawing in water across the semi permeable membrane of the fruits thus increasing their weight (Ahmad

and Siddiqui, 2015), Secondly, respiration rate of the produce is affected by stage of development of the fruit. Fruits at 75% CMS-write in full are more mature that those at 25% colour maturity stage (Aked, 2002). Immature fruit tissues have a higher rate of respiration than mature fruit tissues. Therefore, the higher the rate of respiration, the more weights the fruits losses. Thus in immature fruits, stored organic materials are metabolized giving off water, energy and CO_2 by products (Fonseca *et al*., 2000).

The high significance of the color stage at which passion fruit was harvested could have been among other factors due to the fact that concentration of soluble solids in a produce depend on maturity stage of the produce at harvest (Aked, 2002). Therefore, passion fruit harvested at 25% purple could not have accumulated sufficient total soluble solids compared to those harvested at 75% colour maturity stage. Thus, the lower soluble solids recorded in fruits harvested at 25% purple in agreement with (Arjona et al.,1991). Tingbani (2012) has also stated that the increase in soluble solids content is because of hydrolysis of sucrose which is a complex carbohydrate into sugars.

As relates to how color maturity stage affected the total titratable acidity in that fruit harvested at advanced maturity stage at 75% color stage had a low titratable acidity, the results of previous study (Nunes and Morais, 1995) have supported this study in that fully matured strawberries fruits showed lower titratable acidity. During advanced stages of ripening, organic acids are broken down with an aid of Kinase enzyme which facilitated the reduction in the acidity with progressive ripening (Han, et al., 2015).

Color maturity index used in the study had significant effect on pulp weight of the fruits. From the results presented in Table 5, passion fruit harvested at 75% CMS had the highest pulp weight compared to those harvested at 25% CMS. This could be attributed

to the fact that at 75% CMS, the fruits are mature and have accumulated sufficient biomass compared to those harvested at 25% CMS. Pulp weight in essence represent the edible portion of fruit in the fresh produce consumer market and therefore harvesting of fruit ought to be done at a maturity stage that yield as much edible portion as possible (Fernandes, 2009).

In this study, there was no significant effect of part in which passion fruit was detached on weight. However, the difference in the means of the two points of detachment indicates that detachment of the fruit at its shoulder will compromise its weight as any wounds created during detachment would create openings through which water is lost through evaporation thus a reduction in fruit weight (Tingbani, 2012)

As has been shown in this study, the brix content did not differ significantly between the two sections of detachment. However, there was significant effect of the part in which passion fruit was detached in the two sites. These may mean that the cultural practices in the two sites were different as relates to mineral nutrition of the crop which ultimately affected the brix (Ahmad and Siddiqui, 2015). The difference witnessed in the sites may have been partly due to difference in developmental stages of the fruits at the time of harvesting. It therefore indicates that brix concentration is dependent on the age of the crop (Tingbani, 2012)

The part in which passion fruit was detached was highly significant, with fruits detached at the fruit shoulder recording a higher titre volume compared to that which was detached leaving attached a 5cm long stricture while attached. This difference in effect on titratable acidity could be due to the fact that fruits detached at the fruit shoulder had a disruption on the normal ripening process. A normal ripening process involves production of

essential Kinase enzymes that are responsible for the breakdown of organic acids that end lowering the acidity of produce bringing it a neutral pH during storage (Kader, 2002).

Fruits stored under ambient condition were more susceptible to weight loss compared to those stored under polythene films. The role of the polythene films in weight loss reduction can be attributed to its role in maintaining a partially saturated region surrounding the produce, this creates some balance of vapor pressure within the produce and its surrounding external environment in such a scenario the rate of transpiration is reduced (Holcroft, 2015). In addition, the polythene film reduced respiration process by reducing concentration of oxygen around the produce thus the limited concentration of oxygen around the produce reduced the rate in which the metabolic substrates were broken down in fruits stored in polythene films (Rohani *et al*.,1997).

There was a high significance between the modes in which passion fruit was stored and total titratable acidy. The fruits stored under polythene films had highest titre volume compared to those under ambient conditions. A high titre volume indicates that more alkali was used to neutralize the acid. Therefore, the high titre volume for fruits stored under modified atmosphere storage indicates a high acid content for fruits stored under such conditions than those stored under ambient. This may be due to indirect effects of the mode of storage by reducing the level of oxygen around the stored fruits, thus reducing the rates of respiration and possibly led to partial anaerobic respirations leading to production of organic acids via physiological processes (Ahmad and Siddiqui, 2015). Thus, the lower the rate of respiration indicates that there is less reduction in substrate concentration in the fruit. In contrast, storage under ambient conditions where the fruit has been exposed to conditions favouring respiration and transpiration processes that

favor reduction in substrate concentration through the action of Kinase enzymes that act on acidic compounds takes place at faster rate thus lowering acidity (Norman, 1984). The significance of site as it affects the titratable acidity of the fruit is attributed to difference in climate conditions (light and temperatures) and mineral nutrition programme in the two sites right from soil analysis stages prior to planting, during planting, top dressing and foliar application stages. Temperature, light and mineral nutrition affects the composition of produce including the acidity of the produce (Tingbani, 2012).

Harvest time did not significantly affect the weight of the fruit although harvest time interactions with other factors did have some significance on postharvest life of passion fruit. Harvest time did not significantly affect weight, total soluble solids nor did it affect pulp weight of passion fruit. However, harvest time did significantly affect total titratable acidity of the fruit. Harvesting in the afternoon when the atmospheric temperatures are high caused build-up of heat load on the produce, the increase in the temperatures could have increased the rate of enzymes catalyzed reactions such as breakdown of acidic organic materials by Kinase enzyme thus the fruits harvested in the afternoon had the lowest titratable acidity compared to those harvested in the morning (Abeles and Salveit, 1992). It has been reported that the produce should be harvested in the cool hours of the day but then the produce surface should be dry or be wiped dry, this is because free water on the fruit promotes microbial growth resulting in decay and loss of produce (Holcroft, 2015).

Storage period did have significant effect on passion fruit quality in this study. The weight of the fruit decreased gradually during storage period as has been reported in studies with most fruits. This is majorly due to the fact that a produce is removed from its

natural supply of water hence the immediate effect is a reduction of saleable weight while continued water loss results in wilting and shriveling (Kays and Paull, 2004).

Total soluble solids did increase from the initial day of storage to the second storage interval but it finally dropped progressively in later stages. The reason for this could be attributed to the fact that at early storage period complex carbohydrate in the form of sucrose were being converted to simple sugars thus increasing soluble solids. However, with an increase in the storage period the soluble solids levels decreased as the sugars were being broken down thus releasing energy and water, this is because produce storage results in natural aging of the produce (Pongener *et al*., 2014)

Total titratable acidity decreased gradually across the storage interval but abnormally rose in fourth storage period. The decrease is attributed to breakdown of acidic compounds by Kinase enzyme thus the pH of the produce increased as the produce became even sweeter.

The drop in pulp weight of the produce along the storage period is attributed to both transpiration water losses of the produce as well as respiratory breakdown of organic compounds in the produce that released metabolic products such water, gaseous volatiles, CO_2 among other products (Holcroft, 2015).

5.3 Effect of colour maturity stage, point of detachment, mode of storage and harvest time on organoleptic attributes

Color was one of the organoleptic attributes accessed by the taste panel; fruit sample that was harvested at 25% purpling was disliked by the panelists. Chen and Paull (2014) confirm that harvesting at 25% purpling maturity stage may not be the best color maturity stage for passion. It has been reported that many produce show distinctive color changes

during maturation which have been correlated by the consumers with the development of other desirable quality attributes, so that the correct color of the skin is often the basis for a decision to purchase the commodity (FAO, 1989). Fruit in sample number one (a0b0c0d0) was also not appealing to the panelist. Just like fruit harvested at maturity stage above, it had been harvested at 25% purpling stage, at such a stage the hydrolytic enzymes had not broken down most organic acids responsible for acidity as well as chlorophyll thus unmasking hidden pigments (purple). Fruit sample number eight and fifteen was liked by majority of the panelist, this is attributed to the fact that it had been harvested at 75% purpling maturity stage when hydrolytic enzymes had acted upon most organic acids responsible for acidity and breakdown of carbohydrates to sugars thus making them sweet (Atwell *et al*., 1999).

The panelist's response to the appearance specifically size and shape of the fruits showed that fruit number nine and one were not eye appealing to the judges. In the first place it was harvested when it was still tender; such fruits are easily attacked pathogens that find soft entry point in the tender tissues. In addition detachment at fruit surface may have caused bruises on the surface of the fruits creating entry points for disease causing microorganisms that disfigured the peel. Moreover, such fruits lose a lot of water and shrink in size and its fresh shape is distorted. Size and shape are the major recognition factors used by consumers who will place a lower value on a commodity which lacks the expected characteristic size and shape (Atwell *et al*., 1999). In addition, the fruit samples had its moisture and vapor pressure higher than the prevailing room conditions hence there was immense moisture loss to the surrounding air which resulted in shriveling of the fruit thus compromising its visual quality. Such fruits do not fetch good prices if they

are destined for the fresh produce market (Gaturuku and Isutsa, 2011). Fruits samples that were harvested at a good maturity stage and in the morning as well as those that were stored under polythene sheets were appealing to the judges. Fully ripe produce are not prone to shriveling and are resistant to pathogens attack due to their tough peel (Watada, 1996). The modified environment which they were exposed to prevented rapid loss of moisture from the fruit surface as the air surrounding the produce was saturated with moisture hence limited transpiration water loss and therefore the general appearance was maintained (Chen and Paull, 2014). It has also been attested that modified atmosphere packaging plays a greater role in limiting respiration, as CO_2 accumulates in the region surrounding the produce its increase in concentration limits the action of ethylene a hormone that induces fruit ripening (Fonseca *et al*., 2000). The ripening process initiated by ethylene usually involves increased respiration in the fruits cells and synthesis of new enzymes which break down complex cell components into simpler subunits.

There was a significant effect of the treatments on flavor taste ($p<0.05$). In this study mode of storage had the greatest effect on flavor taste and this is true because all the fruits samples that had been stored under prevailing atmospheric conditions were either very much disliked, disliked by the judges or they could just be neutral about it. On the other hand, fruit samples stored under modified atmosphere had its flavor liked or very much liked. It has been stated that flavor comprises two factors; taste provoked by sugar and acidity of the produce and aroma provoked by volatile organic compounds and is detected by the nose (Atwell *et al*., 1999). Hence, the flavor of the produce that tasted good to the panelists was attributed to the practices that contributed to the maintenance of sugars and acidity of the produce. As has been noted, modified atmosphere packaging

fruits were liked or liked very much because the mode of storage contributed to a reduction in the degradation of sugars and the acids (Randolph, 2000).

All fruits whose texture was not liked by the panelists had been stored under ambient condition while samples that were commended by panelist had been stored under modified atmosphere packaging. The polythene sheets helped reduce the action of the hormone ethylene an agent for ripening meaning there was reduced ripening. Therefore as ripening reduced there was a reduction in the production of other enzymes which break down cell compounds into simpler components thus a reduced softening of the fruit tissue (Norman, 1984).

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

Most of the farmers in Uasin County have entered into passion fruit production enterprise without proper passion fruit postharvest handling knowledge. Slightly above half of the interviewed farmers harvested their produce at the recommended color maturity stage. In addition half of the interviewed farmers harvested their produce leaving attached a 5 cm long stricture attached. Almost half (44%) of the farmers harvested their produce in the early part of the morning when it is dry while about 20% stored their produce under modified atmosphere conditions.

The color at which passion fruit was harvested greatly affected its titratable acidity, pulp weight and its brix. In addition the mode of storage significantly impacted the fruit total titratable acidity, pulp weight and whole fruit weight. On the other hand the point at which the fruit was detached from the mother plant and the time of the day at which passion fruit was harvested did not significantly affect the measured quality attributes other than total titratable acidity.

The passion fruits harvested at 75% color maturity stage and stored under modified atmosphere packages were the most appealing to the organoleptic task panel.

6.2. Recommendations

The key aspects that the farmers in Uasin Gishu County should observe when harvesting the produce include; harvest the produce at 75% color maturity stage as well as employ the use of recommended modified atmosphere packaging material as this will greatly impact the fruits chemical and organoleptic quality attributes thus influencing its shelf life.

6.3. Suggestion for further study

There is need for further research on the effect of agronomic practices in the sub counties and how they affect quality attributes of passion fruit.

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APPENDICES

Appendix I: Anova table for the effect of postharvest handling treatments on total soluble solids of passion fruit

Source of variation	d.f.	S.s.	m.s.	v.r.	F pr.
Detachment	1	1.05	1.05	1.21	0.271
Harvest time	1	0.137	0.137	0.16	0.691
Mode of storage	1	0.002	0.002	0	0.96
Color	1	23.45	23.45	27.11	<.001
Storage_interval	4	671.7	167.9	194.2	<.001
Site	1	281.1	281.1	325	<.001
Detachment x harvest x time	1	0.001	0.001	0	0.969
Detachment x mode of storage	1	2.289	2.289	2.65	0.105
Harvest time x mode of storage	1	0.004	0.004	0	0.945
Detachment x color	1	0.146	0.146	0.17	0.681
Harvest time x color	1	0.688	0.688	0.8	0.373
Mode of storage x color	1	2.484	2.484	2.87	0.091
Detachment x storage interval	4	40.76	10.19	11.78	<.001
Harvest time x storage x interval	4	4.105	1.026	1.19	0.316

Mode of storage x storage interval	4	26.23	6.558	7.58	<.001
Color x storage interval	4	14.52	3.63	4.2	0.002
Detachment x site	1	0.452	0.452	0.52	0.47
Harvest time x site	1	10.98	10.98	12.69	<.001
Mode of storage x site	1	1.732	1.732	2	0.158
Color x site	1	45.61	45.61	52.74	<.001
Storage x interval x site	4	53.21	13.3	15.38	<.001
Detachment x harvest time x mode of storage	1	5.185	5.185	6	0.015
Detachment x harvest time x color	1	0.017	0.017	0.02	0.888
Detachment x mode of storage x color	1	4.806	4.806	5.56	0.019
Harvest time x mode of storage x color	1	1.886	1.886	2.18	0.141
Detachment x harvest time x storage interval	4	10.4	2.6	3.01	0.018
Detachment x mode of storage x storage interval	4	6.609	1.652	1.91	0.108
Harvest time x mode of storage x storage x interval	4	6.715	1.679	1.94	0.103
Detachment x color x storage interval	4	32.15	8.037	9.29	<.001
Harvest time x color x storage interval	4	5.84	1.46	1.69	0.152

Mode of storage x color x storage interval	4	9.87	2.468	2.85	0.024
Detachment x harvest time x site	1	1.335	1.335	1.54	0.215
Detachment x mode of storage x site	1	0.105	0.105	0.12	0.728
Harvest time x mode of storage x site	1	15.18	15.18	17.55	<.001
Detachment x color x site	1	5.472	5.472	6.33	0.012
Harvest time x color x site	1	9.266	9.266	10.71	0.001
Mode of storage x color x site	1	8.499	8.499	9.83	0.002
Detachment x storage interval x site	4	51.85	12.96	14.99	<.001
Harvest time x storage interval x site	4	5.05	1.262	1.46	0.214
Mode of storage x storage interval x site	4	9.271	2.318	2.68	0.032
Color x storage interval x site	4	42.28	10.57	12.22	<.001
Detachment x harvest time x mode of storage x color	1	0.714	0.714	0.83	0.364
Detachment x harvest time x mode of storage x storage interval	4	11.68	2.921	3.38	0.01
Detachment x harvest time x color x storage interval	4	3.369	0.842	0.97	0.422
Detachment x mode of storage x color x storage interval	4	3.848	0.962	1.11	0.35
Harvest time x mode of storage x color x storage interval	4	4.01	1.003	1.16	0.329

Detachment x harvest time x mode of storage x site	1	0.14	0.14	0.16	0.688
Detachment x harvest time x color x site	1	15.99	15.99	18.49	<.001
Detachment x mode of storage x color x site	1	0.497	0.497	0.58	0.449
Harvest time x mode of storage x color x site	1	0.052	0.052	0.06	0.807
Detachment x harvest time x storage interval x site	4	1.525	0.381	0.44	0.779
Detachment x mode of storage x storage x interval site	4	9.482	2.37	2.74	0.029
Harvest time x mode of storage x storage interval x site	4	14.58	3.645	4.21	0.002
Detachment x color x storage interval x site	4	11.79	2.948	3.41	0.009
Harvest time x color x storage interval x site	4	9.605	2.401	2.78	0.027
Mode of storage x color x storage interval x site	4	3.936	0.984	1.14	0.339
Residual	345	298.4	0.865		
Total	479	1802			

Appendix II: Anova table for the effect of postharvest handling practices on pulp weight of passion fruit

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Detachment	1	0.59	0.59	0.03	0.862
Harvest time	1	0.97	0.97	0.05	0.824
Mode of storage	1	569.37	569.37	29.31	<.001
Storage interval	4	615.48	153.87	7.92	<.001
Color	1	103.6	103.6	5.33	0.022
Site	1	8097.5	8097.51	416.83	<.001
Detachment x harvest time	1	2.4	2.4	0.12	0.725
Detachment x mode of storage	1	6.31	6.31	0.32	0.569
Harvest time x mode of storage	1	249.73	249.73	12.86	<.001
Detachment x storage interval	4	127.66	31.92	1.64	0.163
Harvest time x storage interval	4	115.93	28.98	1.49	0.204
Mode of storage x storage interval	4	234.99	58.75	3.02	0.018
Detachment x color	1	139.99	139.99	7.21	0.008
Harvest time x color	1	243.79	243.79	12.55	<.001
Mode of storage x color	1	7.74	7.74	0.4	0.528
Storage interval x color	4	63.91	15.98	0.82	0.512
Detachment x site	1	69.96	69.96	3.6	0.059
Harvest time x site	1	139.93	139.93	7.2	0.008
Mode of storage x site	1	2.91	2.91	0.15	0.699

Storage interval x site	4	204.28	51.07	2.63	0.034
Color x site	1	127.79	127.79	6.58	0.011
Detachment x harvest time x mode of storage	1	13.44	13.44	0.69	0.406
Detachment x harvest x time x storage interval	4	69.23	17.31	0.89	0.469
Detachment x mode of storage x storage interval	4	33.3	8.33	0.43	0.788
Harvest time x mode of storage x storage interval	4	24.51	6.13	0.32	0.868
Detachment x harvest x time x color	1	9.92	9.92	0.51	0.475
Detachment x mode of storage x color	1	66.62	66.62	3.43	0.065
Harvest time x mode of storage x color	1	35.52	35.52	1.83	0.177
Detachment x storage interval x color	4	33.56	8.39	0.43	0.786
Harvest time x storage interval x color	4	35.25	8.81	0.45	0.77
Mode of storage x storage interval x color	4	28.92	7.23	0.37	0.828
Detachment x harvest time x site	1	35.12	35.12	1.81	0.18
Detachment x mode of storage x site	1	7.08	7.08	0.36	0.546
Harvest time x mode of storage x site	1	59.14	59.14	3.04	0.082
Detachment x storage interval x site	4	78.39	19.6	1.01	0.403
Harvest time x storage interval x site	4	14.57	3.64	0.19	0.945

Mode of storage x storage interval x site	4	149.91	37.48	1.93	0.105
Detachment x color x site	1	4.9	4.9	0.25	0.616
Harvest time color x site	1	61.92	61.92	3.19	0.075
Mode of storage x color site	1	1.68	1.68	0.09	0.769
Storage interval x color x site	4	40.36	10.09	0.52	0.721
Detachment x harvest time x mode of storage x storage x interval	4	90.93	22.73	1.17	0.324
Detachment x harvest time x mode of storage x color	1	144.58	144.58	7.44	0.007
Detachment x harvest time x storage x interval color	4	55.23	13.81	0.71	0.585
Detachment x mode of storage x storage interval x color	4	141.44	35.36	1.82	0.124
Harvest time x mode of storage x storage interval x color	4	28.66	7.17	0.37	0.831
Detachment x harvest time x mode of storage x site	1	35.45	35.45	1.82	0.178
Detachment x harvest time x storage interval x site	4	98.84	24.71	1.27	0.281
Detachment x mode of storage x storage interval x site	4	16.97	4.24	0.22	0.928
Harvest time x mode of storage x	4	30.83	7.71	0.4	0.811

storage interval x site					
Detachment x harvest time x color x site	1	75.02	75.02	3.86	0.05
Detachment x mode of storage x color x site	1	0.05	0.05	0	0.959
Harvest time x mode of storage x color x site	1	183.8	183.8	9.46	0.002
Detachment x storage interval x color x site	4	21.48	5.37	0.28	0.893
Harvest time x storage interval x color site	4	18.08	4.52	0.23	0.92
Mode of storage x storage interval color x site	4	98.82	24.7	1.27	0.281
Residual	345	6702.1	19.43		
Total	479	19670			

Appendix III: Anova table for effect of postharvest handling treatments on weight of passion fruit

Source of variation	d.f.	s.s.	m.s.	v.r.	f pr.
Detachment	1	38.21	38.21	1.97	0.161
Harvest time	1	17.13	17.13	0.88	0.348
Mode of storage	1	3748.99	3748.99	193.6	<.001
Storage interval	4	4062.32	1015.58	52.44	<.001
Color	1	82.49	82.49	4.26	0.04
Site	1	35881.3	35881.3	1853	<.001
Detachment x harvest time	1	0.68	0.68	0.04	0.852
Detachment x mode of storage	1	32.44	32.44	1.67	0.196
Harvest time x mode of storage	1	270.18	270.18	13.95	<.001
Detachment x storage interval	4	10.74	2.68	0.14	0.968
Harvest time x storage interval	4	7.43	1.86	0.1	0.984
Mode of storage x storage interval	4	2232.51	558.13	28.82	<.001
Detachment x color	1	451.98	451.98	23.34	<.001
Harvest time x color	1	170.12	170.12	8.78	0.003
Mode x of storage x color	1	1.11	1.11	0.06	0.811
Storage x interval x color	4	13.89	3.47	0.18	0.949
Detachment x site	1	77.46	77.46	4	0.046
Harvest time x site	1	270.72	270.72	13.98	<.001
Mode x of storage x site	1	1.82	1.82	0.09	0.76
Storage x interval x site	4	2220.96	555.24	28.67	<.001

Color. Site	1	220.84	220.84	11.4	<.001
Detachment x harvest time x mode of storage	1	37.63	37.63	1.94	0.164
Detachment x harvest time x storage interval	4	1.94	0.49	0.03	0.999
Detachment x mode of storage x storage interval	4	6.77	1.69	0.09	0.986
Harvest time x mode of storage x storage interval	4	2.98	0.75	0.04	0.997
Detachment x harvest time x color	1	31.58	31.58	1.63	0.202
Detachment x mode of storage x color	1	7.02	7.02	0.36	0.547
Harvest time x mode of storage x color	1	76.96	76.96	3.97	0.047
Detachment x storage interval x color	4	5.49	1.37	0.07	0.991
Harvest time x storage interval x color	4	5.19	1.3	0.07	0.992
Mode of storage x storage interval x color	4	28.74	7.19	0.37	0.829
Detachment x harvest time x site	1	135.51	135.51	7	0.009
Detachment x mode of storage x site	1	7.75	7.75	0.4	0.528
Harvest x time mode of storage site	1	40.18	40.18	2.07	0.151
Detachment x storage interval x site	4	1.97	0.49	0.03	0.999
Harvest time x storage interval x site	4	3.91	0.98	0.05	0.995
Mode of storage x storage interval x site	4	1305.05	326.26	16.85	<.001

Detachment x color x site	1	73.93	73.93	3.82	0.052
Harvest time x color x site	1	117.26	117.26	6.05	0.014
Mode x of x storage x color x site	1	14.74	14.74	0.76	0.384
Storage interval x color x site	4	23.09	5.77	0.3	0.879
Detachment x harvest time x mode of storage x storage interval	4	4.38	1.09	0.06	0.994
Detachment x harvest time x mode of storage x color	1	26.1	26.1	1.35	0.247
Detachment x harvest time x storage interval x color	4	5.04	1.26	0.07	0.992
Detachment x mode of storage x storage interval x color	4	20.38	5.09	0.26	0.902
Harvest time x mode of storage x storage interval x color	4	2.27	0.57	0.03	0.998
Detachment x harvest time x mode of storage x site	1	61.49	61.49	3.17	0.076
Detachment x harvest time x storage x interval x site	4	4.35	1.09	0.06	0.994
Detachment x mode of storage x storage interval x site	4	3.16	0.79	0.04	0.997
Harvest time x mode of storage x storage interval x site	4	29.6	7.4	0.38	0.821
Detachment x harvest time x color x site	1	451.4	451.4	23.31	<.001

Detachment x mode of storage x color site	1	14.61	14.61	0.75	0.386
Harvest time x mode of storage color x site	1	114.08	114.08	5.89	0.016
Detachment x storage interval x color x site	4	3.94	0.99	0.05	0.995
Harvest time storage x interval x color x site	4	7.94	1.99	0.1	0.982
Mode of storage x storage interval x color x site	4	17.96	4.49	0.23	0.92
Residual	345	6681.88	19.37		
Total	479	59189.5			

Appendix IV: Anova table for effect of postharvest handling treatments on titratable acidity of passion fruit

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Detachment	1	115.739	115.739	14.87	<.001
Harvest time	1	90.22	90.22	11.6	<.001
Mode of storage	1	409.406	409.406	52.62	<.001
Storage interval	4	41660.31	10415.08	1338.55	<.001
Color	1	2000.425	2000.425	257.1	<.001
Site	1	13109.53	13109.53	1684.84	<.001
Detachment x harvest time	1	16.838	16.838	2.16	0.142
Detachment x mode of storage	1	6.84	6.84	0.88	0.349
Harvest time x Mode of storage	1	225.365	225.365	28.96	<.001
Detachment x storage interval	4	21.254	5.314	0.68	0.604
Harvest time x storage interval	4	481.926	120.482	15.48	<.001
Mode of storage x storage interval	4	465.195	116.299	14.95	<.001
Detachment x color	1	0.144	0.144	0.02	0.892
Harvest time x color	1	73.869	73.869	9.49	0.002
Mode of storage x color	1	14.249	14.249	1.83	0.177
Storage interval x color	4	421.492	105.373	13.54	<.001
Detachment x site	1	128.858	128.858	16.56	<.001
Harvest time x site	1	520.625	520.625	66.91	<.001
Mode of storage x site	1	220.73	220.73	28.37	<.001

Storage interval x site	4	15059.64	3764.909	483.87	<.001
Color x site	1	914.388	914.388	117.52	<.001
Detachment x harvest time x mode of storage	1	114.368	114.368	14.7	<.001
Detachment x harvest time x storage interval	4	17.743	4.436	0.57	0.685
Detachment x mode of storage x storage interval	4	104.547	26.137	3.36	0.01
Harvest time x mode of storage x storage interval	4	595.261	148.815	19.13	<.001
Detachment x harvest time x color	1	12.708	12.708	1.63	0.202
Detachment x mode of storage x color	1	192.914	192.914	24.79	<.001
Harvest time x mode of storage x color	1	10.179	10.179	1.31	0.254
Detachment x storage interval x color	4	161.367	40.342	5.18	<.001
Harvest time x storage interval x color	4	236.45	59.112	7.6	<.001
Mode of storage x storage interval x color	4	277.635	69.409	8.92	<.001
Detachment x harvest time x site	1	23.276	23.276	2.99	0.085

Detachment x mode of storage x site	1	62.28	62.28	8	0.005
Harvest time x mode of storage site	1	0.196	0.196	0.03	0.874
Detachment x storage interval x site	4	202.657	50.664	6.51	<.001
Harvest time x storage interval x site	4	362.462	90.616	11.65	<.001
Mode of storage x storage interval x site	4	116.365	29.091	3.74	0.005
Detachment x color x site	1	0.54	0.54	0.07	0.792
Harvest time x color x site	1	4.126	4.126	0.53	0.467
Mode of storage x color x site	1	304.168	304.168	39.09	<.001
Storage interval x color x site	4	737.36	184.34	23.69	<.001
Detachment x harvest time x mode of storage x storage interval	4	56.788	14.197	1.82	0.124
Detachment x harvest time x mode of storage x color	1	427.33	427.33	54.92	<.001
Detachment x harvest time x storage interval x color	4	338.06	84.515	10.86	<.001
Detachment x mode of storage x storage x interval x color	4	21.704	5.426	0.7	0.594

Harvest time x mode of storage x storage interval x color	4	12.902	3.225	0.41	0.798
Detachment x harvest time x mode of storage site	1	23.013	23.013	2.96	0.086
Detachment x harvest time x storage interval x site	4	15.101	3.775	0.49	0.747
Detachment x mode of storage x storage interval x site	4	218.705	54.676	7.03	<.001
Harvest time x mode of storage x storage interval x site	4	93.759	23.44	3.01	0.018
Detachment x harvest time x color x site	1	93.545	93.545	12.02	<.001
Detachment x mode of storage color x site	1	249.841	249.841	32.11	<.001
Harvest x time x mode of storage color x site	1	20.049	20.049	2.58	0.109
Detachment x storage interval x color x site	4	212.584	53.146	6.83	<.001
Harvest time x storage interval x color x site	4	40.105	10.026	1.29	0.274
Mode of storage x storage interval x color x site	4	338.011	84.503	10.86	<.001
Residual	345	2684.399	7.781		
Total	479	84339.53			

Appendix V: Showing the effect of treatments on perceived color

		Response to color					
		Dislike very much	Dislike	Neutral	Like	Like very much	Total
a0b0c0d0	Count	4	23	2	8	3	40
	%within Treatments	10.00%	57.50%	5.00%	20.00%	7.50%	100.00%
	%within Response to color	5.10%	16.70%	1.70%	3.90%	3.00%	6.30%
	% of Total	0.60%	3.60%	0.30%	1.30%	0.50%	6.30%
a0b0c1d0	Count	0	11	6	13	10	40
	% within Treatments	0.00%	27.50%	15.00%	32.50%	25.00%	100.00%
	% within Response to color	0.00%	8.00%	5.20%	6.30%	9.90%	6.30%
	% of Total	0.00%	1.70%	0.90%	2.00%	1.60%	6.30%
a0b0c0d1	Count	13	7	13	6	1	40
	% within Treatments	32.50%	17.50%	32.50%	15.00%	2.50%	100.00%
	% within Response to color	16.50%	5.10%	11.20%	2.90%	1.00%	6.30%
	% of Total	2.00%	1.10%	2.00%	0.90%	0.20%	6.30%
a0b0c1d1	Count	1	4	6	25	4	40
	% within Treatments	2.50%	10.00%	15.00%	62.50%	10.00%	100.00%
	% within Response to color	1.30%	2.90%	5.20%	12.10%	4.00%	6.30%
	% of Total	0.20%	0.60%	0.90%	3.90%	0.60%	6.30%
a1b0c0	Count	6	11	7	14	2	40

d0	% within Treatments	15.00%	27.50%	17.50%	35.00%	5.00%	100.00%
	% within Response to color	7.60%	8.00%	6.00%	6.80%	2.00%	6.30%
	% of Total	0.90%	1.70%	1.10%	2.20%	0.30%	6.30%
a1b0c1do	Count	0	8	2	21	9	40
	% within Treatments	0.00%	20.00%	5.00%	52.50%	22.50%	100.00%
	% within Response to color	0.00%	5.80%	1.70%	10.20%	8.90%	6.30%
	% of Total	0.00%	1.30%	0.30%	3.30%	1.40%	6.30%
a1b0c0d1	Count	6	11	6	7	10	40
	% within Treatments	15.00%	27.50%	15.00%	17.50%	25.00%	100.00%
	% within Response to color	7.60%	8.00%	5.20%	3.40%	9.90%	6.30%
	% of Total	0.90%	1.70%	0.90%	1.10%	1.60%	6.30%
a1b0c1d1	Count	1	4	1	32	2	40
	% within Treatments	2.50%	10.00%	2.50%	80.00%	5.00%	100.00%
	% within Response to color	1.30%	2.90%	0.90%	15.50%	2.00%	6.30%
	% of Total	0.20%	0.60%	0.20%	5.00%	0.30%	6.30%
a0b1c0d0	Count	25	6	1	7	1	40
	% within Treatments	62.50%	15.00%	2.50%	17.50%	2.50%	100.00%
	% within Response to color	31.60%	4.30%	0.90%	3.40%	1.00%	6.30%
	% of Total	3.90%	0.90%	0.20%	1.10%	0.20%	6.30%
a0b1c0	Count	12	10	23	21	14	80

d1	% within Treatments	15.00%	12.50%	28.80%	26.30%	17.50%	100.00%
	% within Response to color	15.20%	7.20%	19.80%	10.20%	13.90%	12.50%
	% of Total	1.90%	1.60%	3.60%	3.30%	2.20%	12.50%
a0b1c1d1	Count	4	8	13	8	7	40
	% within Treatments	10.00%	20.00%	32.50%	20.00%	17.50%	100.00%
	% within Response to color	5.10%	5.80%	11.20%	3.90%	6.90%	6.30%
	% of Total	0.60%	1.30%	2.00%	1.30%	1.10%	6.30%
a1b1c0d0	Count	4	17	7	12	0	40
	% within Treatments	10.00%	42.50%	17.50%	30.00%	0.00%	100.00%
	% within Response to color	5.10%	12.30%	6.00%	5.80%	0.00%	6.30%
	% of Total	0.60%	2.70%	1.10%	1.90%	0.00%	6.30%
a1b1c1d0	Count	0	8	6	12	14	40
	% within Treatments	0.00%	20.00%	15.00%	30.00%	35.00%	100.00%
	% within Response to color	0.00%	5.80%	5.20%	5.80%	13.90%	6.30%
	% of Total	0.00%	1.30%	0.90%	1.90%	2.20%	6.30%
a1b1c0d1	Count	2	6	6	9	17	40
	% within Treatments	5.00%	15.00%	15.00%	22.50%	42.50%	100.00%
	% within Response to color	2.50%	4.30%	5.20%	4.40%	16.80%	6.30%
	% of Total	0.30%	0.90%	0.90%	1.40%	2.70%	6.30%
a1b1c1	Count	1	4	17	11	7	40

d1	% within Treatments	2.50%	10.00%	42.50%	27.50%	17.50%	100.00%
	% within Response to color	1.30%	2.90%	14.70%	5.30%	6.90%	6.30%
	% of Total	0.20%	0.60%	2.70%	1.70%	1.10%	6.30%
Total	Count	79	138	116	206	101	640
	% within Treatments	12.30%	21.60%	18.10%	32.20%	15.80%	100.00%
	% within Response to color	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	% of Total	12.30%	21.60%	18.10%	32.20%	15.80%	100.00%

Appendix VI: Showing effect of postharvest handling and treatments on appearance of passion fruit

		Appearance of the fruit					
		Dislike very much	Dislike	Neutral	Like	Like very much	Total
a0b0c0d0	Count	6	19	5	4	6	40
	% within Treatments	15.00%	47.50%	12.50%	10.00%	15.00%	100.00%
	% within Appearance of the fruit	7.70%	13.60%	3.70%	2.00%	7.00%	6.30%
	% of Total	0.90%	3.00%	0.80%	0.60%	0.90%	6.30%
a0b0c1d0	Count	0	6	12	8	14	40
	% within Treatments	0.00%	15.00%	30.00%	20.00%	35.00%	100.00%
	% within Appearance of the fruit	0.00%	4.30%	8.80%	4.00%	16.30%	6.30%
	% of Total	0.00%	0.90%	1.90%	1.30%	2.20%	6.30%
a0b0c0d1	Count	6	19	9	6	0	40
	% within Treatments	15.00%	47.50%	22.50%	15.00%	0.00%	100.00%
	% within Appearance of the fruit	7.70%	13.60%	6.60%	3.00%	0.00%	6.30%
	% of Total	0.90%	3.00%	1.40%	0.90%	0.00%	6.30%
a0b0c1d1	Count	3	4	5	18	10	40
	% within Treatments	7.50%	10.00%	12.50%	45.00%	25.00%	100.00%

	% within Appearance of the fruit	3.80%	2.90%	3.70%	9.00%	11.60%	6.30%
	% of Total	0.50%	0.60%	0.80%	2.80%	1.60%	6.30%
a1b0c0d0	Count	5	9	13	5	8	40
	% within Treatments	12.50%	22.50%	32.50%	12.50%	20.00%	100.00%
	% within Appearance of the fruit	6.40%	6.40%	9.60%	2.50%	9.30%	6.30%
	% of Total	0.80%	1.40%	2.00%	0.80%	1.30%	6.30%
a1b0c1do	Count	0	2	11	22	5	40
	% within Treatments	0.00%	5.00%	27.50%	55.00%	12.50%	100.00%
	% within Appearance of the fruit	0.00%	1.40%	8.10%	11.00%	5.80%	6.30%
	% of Total	0.00%	0.30%	1.70%	3.40%	0.80%	6.30%
a1b0c0d1	Count	16	8	6	6	4	40
	% within Treatments	40.00%	20.00%	15.00%	15.00%	10.00%	100.00%
	% within Appearance of the fruit	20.50%	5.70%	4.40%	3.00%	4.70%	6.30%
	% of Total	2.50%	1.30%	0.90%	0.90%	0.60%	6.30%
a1b0c1d1	Count	1	8	4	27	0	40
	% within Treatments	2.50%	20.00%	10.00%	67.50%	0.00%	100.00%
	% within Appearance of the fruit	1.30%	5.70%	2.90%	13.50%	0.00%	6.30%
	% of Total	0.20%	1.30%	0.60%	4.20%	0.00%	6.30%

a0b1c0d0	Count	19	14	0	6	1	40
	% within Treatments	47.50%	35.00%	0.00%	15.00%	2.50%	100.00%
	% within Appearance of the fruit	24.40%	10.00%	0.00%	3.00%	1.20%	6.30%
	% of Total	3.00%	2.20%	0.00%	0.90%	0.20%	6.30%
a0b1c0d1	Count	5	19	19	23	14	80
	% within Treatments	6.30%	23.80%	23.80%	28.80%	17.50%	100.00%
	% within Appearance of the fruit	6.40%	13.60%	14.00%	11.50%	16.30%	12.50%
	% of Total	0.80%	3.00%	3.00%	3.60%	2.20%	12.50%
a0b1c1d1	Count	0	4	9	20	7	40
	% within Treatments	0.00%	10.00%	22.50%	50.00%	17.50%	100.00%
	% within Appearance of the fruit	0.00%	2.90%	6.60%	10.00%	8.10%	6.30%
	% of Total	0.00%	0.60%	1.40%	3.10%	1.10%	6.30%
a1b1c0d0	Count	13	12	10	5	0	40
	% within Treatments	32.50%	30.00%	25.00%	12.50%	0.00%	100.00%
	% within Appearance of the fruit	16.70%	8.60%	7.40%	2.50%	0.00%	6.30%
	% of Total	2.00%	1.90%	1.60%	0.80%	0.00%	6.30%
a1b1c1d0	Count	0	1	11	20	8	40
	% within Treatments	0.00%	2.50%	27.50%	50.00%	20.00%	100.00%

	% within Appearance of the fruit	0.00%	0.70%	8.10%	10.00%	9.30%	6.30%
	% of Total	0.00%	0.20%	1.70%	3.10%	1.30%	6.30%
a1b1c0d1	Count	4	11	11	13	1	40
	% within Treatments	10.00%	27.50%	27.50%	32.50%	2.50%	100.00%
	% within Appearance of the fruit	5.10%	7.90%	8.10%	6.50%	1.20%	6.30%
	% of Total	0.60%	1.70%	1.70%	2.00%	0.20%	6.30%
a1b1c1d1	Count	0	4	11	17	8	40
	% within Treatments	0.00%	10.00%	27.50%	42.50%	20.00%	100.00%
	% within Appearance of the fruit	0.00%	2.90%	8.10%	8.50%	9.30%	6.30%
	% of Total	0.00%	0.60%	1.70%	2.70%	1.30%	6.30%
Total	Count	78	140	136	200	86	640
	% within Treatments	12.20%	21.90%	21.30%	31.30%	13.40%	100.00%
	% within Appearance of the fruit	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	% of Total	12.20%	21.90%	21.30%	31.30%	13.40%	100.00%

Appendix VII : Showing the effect of treatments on textural quality of passion fruit

		Surface texture					
		Dislike very much	Dislike	Neutral	Like	Like very much	Total
a0b0c0d0	Count	5	6	15	11	3	40
	% within Treatments	12.50%	15.00%	37.50%	27.50%	7.50%	100.00%
	% within Surface texture	6.10%	5.40%	10.00%	5.10%	3.70%	6.30%
	% of Total	0.80%	0.90%	2.30%	1.70%	0.50%	6.30%
a0b0c1d0	Count	0	4	14	18	4	40
	% within Treatments	0.00%	10.00%	35.00%	45.00%	10.00%	100.00%
	% within Surface texture	0.00%	3.60%	9.30%	8.40%	4.90%	6.30%
	% of Total	0.00%	0.60%	2.20%	2.80%	0.60%	6.30%
a0b0c0d1	Count	11	10	14	5	0	40
	% within Treatments	27.50%	25.00%	35.00%	12.50%	0.00%	100.00%
	% within Surface texture	13.40%	9.00%	9.30%	2.30%	0.00%	6.30%
	% of Total	1.70%	1.60%	2.20%	0.80%	0.00%	6.30%
a0b0c1d1	Count	0	3	6	27	4	40
	% within Treatments	0.00%	7.50%	15.00%	67.50%	10.00%	100.00%
	% within Surface texture	0.00%	2.70%	4.00%	12.60%	4.90%	6.30%
	% of Total	0.00%	0.50%	0.90%	4.20%	0.60%	6.30%
a1b0c0d	Count	6	7	15	4	8	40

0	% within Treatments	15.00%	17.50%	37.50%	10.00%	20.00%	100.00%
	% within Surface texture	7.30%	6.30%	10.00%	1.90%	9.80%	6.30%
	% of Total	0.90%	1.10%	2.30%	0.60%	1.30%	6.30%
a1b0c1d0	Count	1	1	9	19	10	40
	% within Treatments	2.50%	2.50%	22.50%	47.50%	25.00%	100.00%
	% within Surface texture	1.20%	0.90%	6.00%	8.80%	12.20%	6.30%
	% of Total	0.20%	0.20%	1.40%	3.00%	1.60%	6.30%
a1b0c0d1	Count	14	4	11	9	2	40
	% within Treatments	35.00%	10.00%	27.50%	22.50%	5.00%	100.00%
	% within Surface texture	17.10%	3.60%	7.30%	4.20%	2.40%	6.30%
	% of Total	2.20%	0.60%	1.70%	1.40%	0.30%	6.30%
a1b0c1d1	Count	0	7	7	23	3	40
	% within Treatments	0.00%	17.50%	17.50%	57.50%	7.50%	100.00%
	% within Surface texture	0.00%	6.30%	4.70%	10.70%	3.70%	6.30%
	% of Total	0.00%	1.10%	1.10%	3.60%	0.50%	6.30%
a0b1c0d0	Count	18	11	5	5	1	40
	% within Treatments	45.00%	27.50%	12.50%	12.50%	2.50%	100.00%
	% within Surface texture	22.00%	9.90%	3.30%	2.30%	1.20%	6.30%
	% of Total	2.80%	1.70%	0.80%	0.80%	0.20%	6.30%
a0b1c0d	Count	6	18	22	17	17	80

1	% within Treatments	7.50%	22.50%	27.50%	21.30%	21.30%	100.00%
	% within Surface texture	7.30%	16.20%	14.70%	7.90%	20.70%	12.50%
	% of Total	0.90%	2.80%	3.40%	2.70%	2.70%	12.50%
a0b1c1d1	Count	0	4	7	15	14	40
	% within Treatments	0.00%	10.00%	17.50%	37.50%	35.00%	100.00%
	% within Surface texture	0.00%	3.60%	4.70%	7.00%	17.10%	6.30%
	% of Total	0.00%	0.60%	1.10%	2.30%	2.20%	6.30%
a1b1c0d0	Count	10	13	3	8	6	40
	% within Treatments	25.00%	32.50%	7.50%	20.00%	15.00%	100.00%
	% within Surface texture	12.20%	11.70%	2.00%	3.70%	7.30%	6.30%
	% of Total	1.60%	2.00%	0.50%	1.30%	0.90%	6.30%
a1b1c1d0	Count	0	6	6	27	1	40
	% within Treatments	0.00%	15.00%	15.00%	67.50%	2.50%	100.00%
	% within Surface texture	0.00%	5.40%	4.00%	12.60%	1.20%	6.30%
	% of Total	0.00%	0.90%	0.90%	4.20%	0.20%	6.30%
a1b1c0d1	Count	11	12	12	2	3	40
	% within Treatments	27.50%	30.00%	30.00%	5.00%	7.50%	100.00%
	% within Surface texture	13.40%	10.80%	8.00%	0.90%	3.70%	6.30%
	% of Total	1.70%	1.90%	1.90%	0.30%	0.50%	6.30%
a1b1c1d	Count	0	5	4	25	6	40

1	% within Treatments	0.00%	12.50%	10.00%	62.50%	15.00%	100.00%
	% within Surface texture	0.00%	4.50%	2.70%	11.60%	7.30%	6.30%
	% of Total	0.00%	0.80%	0.60%	3.90%	0.90%	6.30%
Total	Count	82	111	150	215	82	640
	% within Treatments	12.80%	17.30%	23.40%	33.60%	12.80%	100.00%
	% of Total	12.80%	17.30%	23.40%	33.60%	12.80%	100.00%

Appendix VIII : Panelists' overall liking of the Fruit Samples

		Overall liking					Total
		Dislike very much	Dislike	Neutral	Like	Like very much	
0 days	Count	1	13	46	52	16	128
	% within Storage interval(days)	0.80%	10.20%	35.90%	40.60%	12.50%	100.00%
	% within Overall liking	4.00%	11.50%	22.20%	22.60%	24.60%	20.00%
	% of Total	0.20%	2.00%	7.20%	8.10%	2.50%	20.00%
7 days	Count	1	13	58	53	3	128
	% within Storage interval(days)	0.80%	10.20%	45.30%	41.40%	2.30%	100.00%
	% within Overall liking	4.00%	11.50%	28.00%	23.00%	4.60%	20.00%
	% of Total	0.20%	2.00%	9.10%	8.30%	0.50%	20.00%
14 days	Count	8	25	55	34	6	128
	% within Storage interval(days)	6.30%	19.50%	43.00%	26.60%	4.70%	100.00%
	% within Overall liking	32.00%	22.10%	26.60%	14.80%	9.20%	20.00%
	% of Total	1.30%	3.90%	8.60%	5.30%	0.90%	20.00%
21 days	Count	5	27	37	49	10	128
	% within Storage interval(days)	3.90%	21.10%	28.90%	38.30%	7.80%	100.00%

	% within Overal liking	20.00%	23.90%	17.90%	21.30%	15.40%	20.00%
	% of Total	0.80%	4.20%	5.80%	7.70%	1.60%	20.00%
28 days	Count	10	35	11	42	30	128
	% within Storage interval(days)	7.80%	27.30%	8.60%	32.80%	23.40%	100.00%
	% within Overall liking	40.00%	31.00%	5.30%	18.30%	46.20%	20.00%
	% of Total	1.60%	5.50%	1.70%	6.60%	4.70%	20.00%
Total	Count	25	113	207	230	65	640
	% within Storage interval(days)	3.90%	17.70%	32.30%	35.90%	10.20%	100.00%
	% within Overall liking	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	% of Total	3.90%	17.70%	32.30%	35.90%	10.20%	100.00%

Appendix IX : Survey Purple passion fruit questionnaire

The purpose of this study is to do an evaluation on the effect of post-harvest handling and treatment on shelf life of passion fruit. The information availed will assist in making necessary policy recommendations based on the findings. The information needed is for the period January-December; 2016.All information provided will be treated as confidential.

Interviewer number Farmers Name Address

Contact Telephone Number Interviewer's name

Q1. Which if any of the following crops are you currently growing on this farm?

Maize	1
Oranges	2
Mangoes	3
Cashewnuts	4
Passion fruit	5
Lemon	6
Avocado	7

If Passion fruit is not mentioned Ask

Q1b. Did you grow any Passion fruit on your farm in the past year?

Yes.....1 Go to Q2

No..... 2 Close.

Q2. Who is mainly in charge of running the fruit part of this farm?

Respondent his/herself	1	Continue
Spouse	2	Find spouse
Other write in relation with owner	3	Find other person

Q3. How many passion vines do you have on your farm?

		Test	Control
1-9	1	Close	Close
10-19	2	Continue	
20-29	3		
30-49	4		
50-99	5		
100+	6		

Q4. Into which ages range do you fall?

18-19	1
20-24	2
25-29	3
30-34	4
35-39	5
40-44	6
45-49	7
50-54	8
55-59	9

60+	10

If refused/ don't know, code below and estimate

Refused so estimated	1
Don't know	2

Q5 (a) How many years of education did you manage to complete?

None	1
Less than 1	2
1-2	3
3-4	4
5-6	5
7-8	6
9-10	7
11-12	8
13-14	9
15+	10

(b)

None	1
Nursery	2
Incomplete Primary	3
Completed Primary	4
Did not complete secondary	5
Completed secondary	6

A Levels	7
Higher education(Diploma or Degree)	8
Other Technical or Training	9

Q6. Gender

Male 1

Female 2

ASK ALL

CODE ALL GROWN IN FRUIT GRID BELOW

Q7. How many mature vines of do you have. That is those that yielded fruit in the most recent season?

RECORD NUMBER IN FRUIT GRID BELOW

Q8. How many vines are young and yet to yield?

RECORD NUMBER IN FRUIT GRID BELOW

Q9. What is the average number of fruits per vine for each variety you grow?

RECORD NUMBER IN FRUIT GRID BELOW

Q10. What was the price per piece the last time you sold?

RECORD PRICE IN FRUIT GRID BELOW

Q11. How do you measure the amount of passion produced and sold? RECORD IN FRUIT GRID USING CODES SHOWN.

By the Piece (Single fruit) ----1

By the Kilo 2

By the Bag 3

Other write 4

PASSION FRUIT GRID 1

	Number yielding fruit Q7	Number of young and have not yet yielded Q8	Average number of passion fruit per vine Q9	Price per piece the last time you sold Q10	Normal unit of measure Q11
Purple					

Q12. Where do you source your planting materials? Circle as appropriate

Own seed/seedlings	Local nursery	Research institution	Others(Specify)

Q13. Passion fruit nutrition (Tick as appropriate)

Fertilizer applied at planting? Yes No

Do you top dress? Yes No

Do you Foliar Feed? Yes No

Q14. Field observation

Assessment of general agronomic and farm management practises (researcher to observe and assess this on a 1-5 scale;1=Poor;2=Fair;3=Good;4=Very good;5=Excellent)

Practice	Tick if done	Score
Training of vines and pruning		
Weeding(Indicate manual/herbicide)		
Removal of infected plants		
Watering		
Manure application		
Other Practices		

Q15. Information on inputs utilised

What is the number of purple passion bought and the cost of each? No-------- Cost (Kshs).....

What is the labour used in the passion fruit enterprise in the last one year? (Man days)

Activity	Labour F= family H= Hired	Quantity(Hours, days, months)	Cost(Kshs)
Totals			

Activity;

Clearingofland,Ploughing,Planting,trellising,Watering,Weeding,Spraying,Pruning,Harvesting,Transportation(from farm and to market),grading, packing and others Specify.

Average cost of each man day...

What are the amounts of fertilizers used and their respective costs?

Type	Quantity bought kg/Ltrs	Cost per kg/ltr(kshs)	Total cost

What are the amounts of pesticides used and their respective costs?

Type	Amount bought(kg/ltrs)	Cost per kg/ltr(kshs)	Frequency of spraying	Number of pumps	Size of pump
1					
2					
3					
4					
Totals					

Did you receive any extension advice on the purple passion enterprise?1= Yes 0= No

How many times have you received extension advice? ---------- (Last season).

Did you borrow any money for purple passion fruit enterprise? 1= Yes;2=No

If yes, what amount did you use on purple passion fruit enterprise... Kshs.

Q16. Are you a member of any farmers' association which deals with purple passion fruit? 1=Yes;2=No

Q17. If yes in Q16 above what services do you get from the association

1= financial advice

2= monetary credit

3= crop management

4=identifying and control of pests and diseases

5= Marketing of produce

6=Inputs (seedlings, fertilizer, pesticides, propping materials etc)

7= others specify.....

Q18. Do you have knowledge on the following?

Knowledge of pests, diseases and control?

Knowledge of recommended inputs amounts?

Knowledge of irrigation systems?

Do you use irrigation on the enterprise? 1= Yes;2= No

If yes in m above, what method do you use? 1=sprinkler2=manual;3=other-specify

Q19.During what time of day do you do the harvesting?(Circle as appropriate)

Morning-when fruit is dry	Morning-when fruit is wet	Afternoon-when fruit is dry	Afternoon-when fruit is wet	Other (specify).....

Q20.At what point do you detach your fruit from the mother plant during harvest? (Circle the part detached).

0 cm(Fruit shoulder)	5cm(stricture left attached on the fruit)	When the fruit is dropped to the ground	Other (specify).....

Q21.Do you use a tool when harvesting your Passion (Tick as appropriate)

Is tool used?	Yes	No	Both

Q21.Where do you place your harvested fruit as you do the harvesting?

On a sack	On a Plastic Bucket	Other

Q22. At what colour maturity index do you do the harvesting (Circle the colour index**)**

Colour maturity index	Green Mature	Purple	Other (specify.....

Q23. What mode of storage do you employ for your Passion fruit(Circle the mode)

Mode of storage	Ambient conditions	Modified atmosphere packaging	Others

Q24. Do you have any information on soil type of your location? 1=Yes 2=No

Q25. If yes in Q24 above, who analysed your soil? 1= Self; 2= Ministry; 3=Research institution; 4=University

Q26. If yes in Q24 above what is the soil type of your farm

INSTRUCTION: HELP THE FARMER GO THROUGH Q28 TO Q32 ARE RECORDED.

Q27. Can you tell what was the number picked in the last consecutive harvest months? CONVERT THE UNITS GIVEN BY THE FARMER TO PIECES OF FRUIT.

Q28. What was the number sold in last two consecutive harvest months?

Q29. Who was your main buyer? READ OUT CODES AND CODE ANSWERS IN GRID BELOW

Direct to exporter.....1

Broker selling to exporter.....2

Broker selling in Kenya.....3

Local traders selling in Kenya.....4

Direct to consumers.....5

Wholesale markets.....6

Shop/ supermarkets.....7

Fruit processor factory.....8

Another farmer.....10

Other (Specify).....11

Q30.What challenges do you face in Passion fruit farming? Rank in order of importance by numbering beginning with most important.

Challenges faced	Rank
Lack of clean planting material	
Pests and diseases	

Labour	
Extension services	
Irrigation water	
Market	
Other(SPECIFY)	

Appendix X : Organoleptic taste questionnaire

Introduction

This research is intended to determine the consumer quality perception of Passion fruit. It is a course requirement for University of Eldoret and any information will be treated with confidentiality.

Provide as accurate information as possible and participation is voluntary. Tick below where applicable.

Quality grading of Passion fruit given various Postharvest handling treatments

(Please indicate the quality number against the quality attribute and please check one box please ensuring that all the parameters are answered.)

Dislike very much

Dislike

Neutral

Like

Like very much

1. $a_0b_0c_0d_0$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

2. $a_0b_0c_1d_0$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

3. $a_0b_0c_0d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

4. $a_0b_0c_1d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

5. $a_1b_0c_0d_0$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

6. $a_1b_0c_1d_o$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

7. $a_1b_0c_0d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

8. $a_1b_0c_1d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

9. $a_0b_1c_0d_0$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

10. $a_0b_1c_1d_0$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

11. $a_0b_1c_0d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

12. $a_0b_1c_1d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

13. $a_1b_1c_0d_0$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

14. $a_1b_1c_1d_0$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

15. $a_1b_1c_0d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]

16. $a_1b_1c_1d_1$

Color	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Wholeness	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Taste	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Smell	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]
Texture	1. [ ]	2.[ ]	3.[ ]	4.[ ]	5.[ ]