Food Quality and Design Department

Leaching and Degradation Kinetics of Vitamin C in Mango (*Mangifera indica* L.) Cubes during Osmotic Dehydration

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ABSTRACT

Mango is a good source of nutrients, among which vitamin C is dominant. Due to its high moisture content, osmotic dehydration (OD) is preferred as an effective preservation method for fresh fruit with lower energy consumption and better product quality. In spite of the advantages, OD has a potential to induce leaching of vitamin C. Degradation of vitamin C caused by oxygen, heat, or light also possibly occurs. Many ways have been developed to improve the efficiency of OD process, as well as avoid the loss of beneficial components during OD process, such as applying vacuum impregnation (VI) prior to OD and adding pectin methylesterase (PME). The aim of this research is to study the leaching and degradation kinetics of vitamin C in mango and its osmotic solution during OD, also the effect of VI and PME addition on the kinetics. OD was carried out to maturity stage 4 Kent mango over 29h at 50°C in 60°Brix sucrose solution, mixed with 2% w/w calcium lactate. The dosage of PME commercial (*Aspergillus oryzae* recombinant, Novoshape® Novozymes, Reading, UK) added to OS was 0,48% v/v. VI was performed at 30°C with pressure of 50 mbar. Total ascorbic acid (TAA) and ascorbic acid (AA) content was determined using HPLC analysis and the kinetics was represented using multiresponse modelling. AA, DHA, and TAA content in fresh mango (0h) sample was, on average, 27.5 mg/100 g mango, 4 mg/100 g mango, and 31.8 mg/100 g mango, respectively. The amount of AA and TAA continually decreased with increasing immersion time. Compared to untreated OD sample at 2h, mango sample with VI pre-treatment gave significantly higher (P≤0.05) AA retention, lower DHA content, and higher AA/DHA ratio. AA loss in OD-V sample and OD sample after 2h immersion time were 29,8% and 41,5% respectively. Sample with added PME indicated significantly lower (P≤0.05) AA retention at the first 2h, while there were no significant effects (P>0.05) on DHA content and AA/DHA ratio compared to untreated OD sample. As VI pre-treatment gave better vitamin C retention than OD-PV sample, applying pretreatment of VI was already sufficient for reducing TAA loss at 2h OD time. The model proposed fits the TAA and AA data well. The degradation rate of TAA and AA were much higher than the leaching rate, supported by the data that described vitamin C loss was mostly (up to 80%) caused by degradation. There were no significant effects (P>0.05) of different treatment to the leaching and degradation rate of TAA and AA due to high standard deviation on each parameters. The average leaching rate constant and degradation rate constant were 0.002/h and 0.082/h respectively.

Keywords: *vitamin C; osmotic dehydration; mango; vacuum impregnation; pectin methylesterase*

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LIST OF ABBREVIATIONS

AA	=	Ascorbic acid
Aw	=	Water activity
DHA	=	Dehydroascorbic acid
EU	=	European Union
FAO	=	Food and Agricultural Organization
MPA	=	Metaphosporic acid
PEU	=	Pectin esterase unit
PME	=	Pectin methylesterase
OD	=	Osmotic dehydration
OS	=	Osmotic solution
OD-P	=	OD with PME treatment
OD-PV	=	OD with VI and PME treatment
OD-V	=	OD with VI treatment
SG	=	Solid gain
TSS	=	Total soluble solid
TTA	=	Total titratable acidity
VI	=	Vacuum impregnation
WL	=	Water loss

1. Introduction

Mango (*Mangifera indica* L.) is a popular tropical fruit, known and commonly consumed by people around the world. According to FAO (2014), mango is classified as major tropical fruit with high global production rate reaching 45.22 million metric tons in 2014. Besides that, mango becomes one of the fruits with highest consumption per capita in the world (Nassur Rde et al. 2015). As fresh fruit, mango is a good source of nutrients, among which vitamin C is dominant (Rymbai et al. 2015). However, the high moisture content of fresh mango (containing approximately 80% of moisture) increases susceptibility to deterioration, hence limits its shelf life. The storage time of mango is up to 8 days at room temperature and up to 3 days at 13°C with 85-90% relative humidity (Rimkeeree and Charoenrein 2014). This short shelf life brings a challenge in long distance transportation of commercial mango and becomes the main problem for off-season consumption. To overcome these problems, the production of dried mango is encouraged by applying various kinds of drying techniques. Thin mango slices are generally dried using convection dryer with electrical or gas oven at low temperatures to maintain flavour, colour and nutritional values of fresh mango. The major drawback of this treatment is the high operating cost.

Nowadays, osmotic dehydration (OD) is preferred as an effective preservation method over conventional drying due to its lower energy consumption and better product quality. It is reported that the application of OD improves nutritional, pro-health and sensory values of product (Ciurzyńska et al. 2016). Moreover, OD provides better appearance product as the infusion of soluble solids (sugars) increases the glass transition temperature, resulting in a more resistant structure (Khan et al. 2008). In spite of the advantages, the immersion of mango in osmotic solution for relatively long time induces loss of water-soluble components, including vitamin C, through leaching process (Guiamba et al. 2016). Besides that, degradation of vitamin C caused by oxygen, heat, or light possibly occurs during OD process. There is a large number of studies on osmotic dehydration could be found currently, but only a few focusing on the changing of nutritional value as the impact of OD process. Therefore, the modelling of vitamin C leaching and degradation kinetics in mango and osmotic solution during OD is necessary for optimising the drying process and maintaining good quality dried mango product.

Furthermore, many ways have been developed to improve the efficiency of OD process, as well as avoid the loss of beneficial components during OD process. One of the interesting techniques combined with OD is by applying vacuum impregnation prior to OD. Numerous studies on various kinds of fruits have confirmed that vacuum impregnation in combination with OD gives a positive effect on the mass transfer rate and improves product quality (Corrêa et al. 2010, Deng and Zhao 2008, Panadés et al. 2006). This study aims to investigate the effect of vacuum impregnation pre-treatment and pectin methylesterase addition on vitamin C leaching and degradation kinetics in OD Kent mango.

2. Background Information

2.1 Kent Mango

Originating from South Florida, Kent mangoes (Figure 1) have sweet, rich flavour, juicy, and tender flesh with limited fibers. The colour of the mango skin is dark green and often has a dark red blush at a certain part of the mango. The ripening cues are yellow undertones or dots that cover more of the mango as it ripens (National Mango Board, 2018). According to CBI Market Information Database (2014), Kent mangoes is regarded as favourite mango variant on the international market and becomes a reference for mangoes sold in the EU. The main suppliers are Peru, Brazil, Ecuador, Israel, and West Africa.

Figure 1. Kent Mango

2.2 Maturity Stages

Stage of maturity has a considerable influence to the final product quality. As a climacteric fruit, mangoes are harvested firm and mature but not ripe (ready-to-eat) (Nassur Rde et al. 2015). Physical and biochemical changes take part during the ripening process of mango fruit, which involves respiration, ethylene production, flavour, texture, aroma, and nutritional values. During the ripening process, the increase of carotenoid level and decrease of anthocyanin levels cause the change in colour. The conversion of carbohydrates and starch into sugars increases total soluble sugar level, hence effects the increase in sweetness level of mango. Besides that, the hydrolytic change of protopectin to pectin contributes to the textural softening of the fruit (Rimkeeree and Charoenrein 2014). The loss of vitamin C was detected after one week period of artificial ripening in mango (Vinci et al. 1995).

Internal flesh colour, firmness, degrees Brix, and fruit shape are frequently used as criteria to judge maturity stage of mango. In this study, firmness was used as judgement criteria for mango maturity. Table 1 shows the range of firmness and degrees Brix value that determines Kent mango maturity stage.

Table 1. Maturity Stage Index for Kent Mango (UFlorida and UC-Davis 2010)

Maturity	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Firmness (lbs.force)	19-22	14-18	11-13	5-8	2-4
Brix	8-10	9-11	12-13	12-14	14-15

2.3 Vitamin C

Vitamin C consists of two biologically active forms, which are L-ascorbic acid (AA) and L-dehydroascorbic acid (DHA). AA, as the reduced form of vitamin C, is an essential water-soluble antioxidant due to its polar characteristic. AA is reversibly oxidized forming DHA with the loss of two electrons (Figure 2) (Nisperos-Carriedo et al. 1992). Further oxidation of DHA generates diketogulonic acid which does not have any biological activity and this reaction is irreversible (Hernández et al. 2006). The reduction-oxidation reaction of vitamin C is shown in Figure 2.

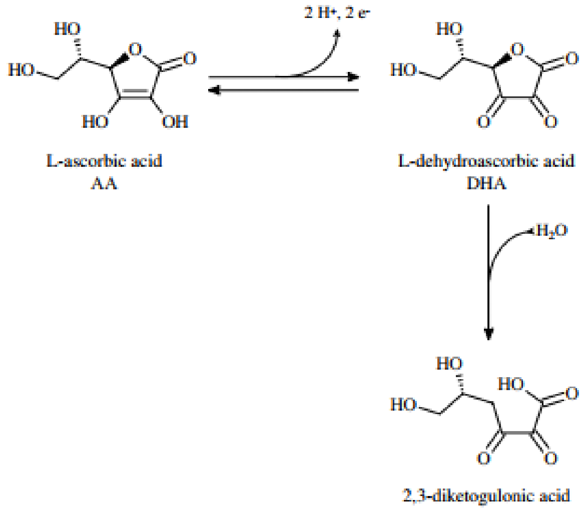

Figure 2. The reduction-oxidation reaction of vitamin C

The pure ascorbic acid is odourless, white crystalline, and stable when exposed to air, light, and ambient temperature for prolonged period. In spite of that, when it presents in foods or aqueous solution, the stability of AA depends on the composition of matrix and storage condition (Santos and Silva 2008). During processing of food products, degradation of vitamin C has been considered as one of the major causes of quality change. Many research has been performed to investigate the cause of vitamin C degradation. Vitamin C degradation can be easily caused by factors such as pH, temperature, light, and presence of enzymes, oxygen and metallic catalysers (Santos and Silva 2008). Heat treatment has a significant impact on the loss of vitamin C. As compared with mango dried at 70°C, a higher retention of vitamin C ($p \leq 0.05$) was observed in untreated mango dried at 50°C (Guiamba et al. 2016). The study by (Gamboa-Santos et al. 2014) proved that degradation of vitamin C can be caused by heating and oxygen presence. In addition, it was reported that the ascorbic acid degradation rate in liquid food was directly proportional to the initial concentration of dissolved oxygen (Robertson and Samaniego 1986).

Vitamin C content of mango (cv. Kent) with advanced maturity ranges between 30,65-49,09 mg/100g (Muiruri 2013). According to the result obtained by (Hernández et al. 2006), AA content in mango decreased significantly during ripening. On the measurement of vitamin C content, it is important to measure both AA and DHA in fruits for vitamin C activity since DHA can be easily converted into AA (Lee and Kader 2000). In some cases, it is reported that DHA did not account for more than 10% of total vitamin C in any of the analyzed fruits. Thus, many researchers have not taken into account DHA when reporting vitamin C levels (Santos and Silva 2008, Lee and Kader 2000).

2.4 Osmotic Dehydration

Many methods or combination of methods had been developed to extend the shelf life of highly perishable fruits and vegetables. Osmotic dehydration (OD) is one of the suitable methods to meet the demand (Yadav and Singh 2014). Several advantages of OD method are its low temperature operation resulted in minimal heat damage, low energy requirements, and better retention of initial sensory and nutritional characteristics in the final product (Monsalve-GonÁLez et al. 1993). OD is commonly applied as pre-treatment before air drying or freezing particularly for temperature sensitive products, like fruits. It involves immersion of fruit slices or cubes in a concentrated solution of soluble solutes, such as sugar or salt where both partial dehydration of the fruit and sugar uptake are obtained (Torres et al. 2006). Yadav and Singh (2014) called OD as a multicomponent diffusion process. The driving force of OD process is concentration difference between the osmotic solution and the interstitial fluid (Rahman 2008). Water and solute activity gradients across cell membranes attribute to mass transfer rates as both water and solutes seek equilibrium (Zhao and Xie 2004). Several factors affecting mass transfer rate are temperature, concentration of osmotic medium, size and geometry of the samples, sample to solution ratio, and degree of agitation of the solution (Torres et al. 2006). Below are types of counter current mass transfer in OD process (Chavan and Amarowicz 2012) (Figure 3):

1. Out flow of water from product to solution.
2. A solute transfer from solution to product, which could be in the form of preservative agent, any solute (generally sugar and salt) or nutritional interest to improve product quality.
3. Leaching out of water soluble component from product, such as sugar, organic acids, minerals, vitamins.

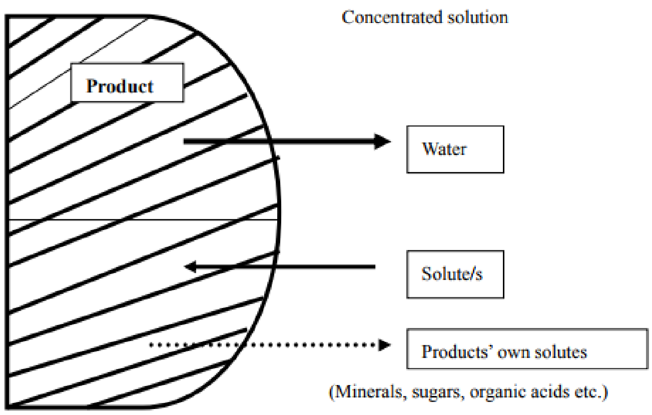

Figure 3. Schematic diagram of mass transfer during osmosis process (Raoult-Wack 1994)

The application of OD has been studied for a variety of fruits, such as mango (Azoubel and da Silva 2008, Nagai et al. 2015, Torres et al. 2006, Khan et al. 2008). Based on a study by Guiamba *et al.* (2016), OD prior to hot air-drying of mango is detrimental to vitamin C due to leaching into the osmotic solution. The loss of vitamin C during OD is highly influenced by processing time and temperature. At the range of 15-75°C, the loss occurs mainly due to the ascorbic acids diffusion to the solution at relatively low temperature whereas at relatively high temperature both leaching and chemical deterioration give significant impact to the loss (Cao et al. 2006).

2.5 Vacuum Impregnation

Vacuum impregnation (VI) is known as a beneficial new technique which has broad applications in fruit and vegetable processing (Zhao and Xie 2004). VI involves the exchange of internal gas or liquid occluded in open pores for an external liquid phase, facilitated by pressure changes that support hydrodynamic mechanisms (Fito et al. 2001). After immersing product in a tank containing liquid phase, two steps are performed. The first step is imposing vacuum pressure (50-100 mbar) for brief period in a closed tank to promote the expansion and outflow of product internal gas. The second step is restoring atmospheric pressure in the tank for certain period with compression causing a huge reduction in remaining pore gas volume, and subsequently support the influx of external liquid into the pores. In other words, the influx of external liquid occurs due to expansion or compression of the internal gas in a food product (Zhao and Xie 2004).

In many processes involving solid-liquid operations, like salting, OD, acidification, addition of preservatives, VI improves the mass transfer rate due to the coupled action of hydrodynamic mechanism and deformation relaxation phenomena (Shi et al. 1996). Studies have confirmed the useful effects of combining VI with osmotic treatment which causes the increase in the rate of water loss and the solid gain through incorporating osmotic substance to the porous food products (Ciurzyńska et al. 2016). During removal of oxygen from the pores of fruit, VI prevents discoloration caused by oxidative and enzymatic browning. Besides that, it is reported that the impregnation of certain solutes into pores could protect natural tissue structure, hence improving texture quality by limiting collapse and cellular disruption. Furthermore, VI pre-treatment may contribute to energy saving in product processing since water is removed in the liquid form with less heating (Zhao and Xie 2004).

On the attempt of developing high quality products, fruits and vegetables are suitable for VI processing. The intercellular spaces of the porous structure in fruit and vegetables that may contain a gas or liquid phase are susceptible to impregnation with an external solution (Zhao and Xie 2004).

2.6 Pectin methylesterase and Calcium Addition

Pectin is an important structural component of plant's cell wall mainly composed of homogalacturonan, a linear chain of galacturonic acid units. The galacturonic acid residues can be esterified with methanol (Van Buren 1979). Hydrolysis of pectin's methyl esters by the action of pectin methylesterase (PME) will generate free carboxyl groups that cross-linked with divalent ions such as Ca^{2+} (Figure 4) contributing to cell wall mechanical properties and fruit firmness (Jarvis et al. 2003). When calcium forms bonds between pectin and other cellular wall components, it will reduce the tissue permeability (Gras et al. 2003) and consequently may reduce leaching of vitamin C (Guiamba et al. 2016). A study showed a steady decrease in PME activity after an initial increase with progressive ripening and textural softening of mango (cv. Alphonso) (Prasanna et al. 2003).

Regarding to improvement of structural properties, calcium fortification of fruit in osmotic treatment has been reported by many authors (Gras et al. 2003, Torres et al. 2006, Guiamba et al. 2016). In this study, calcium lactate was added into the osmotic solution.

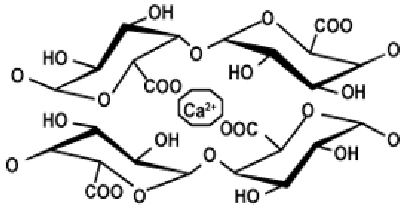

Figure 4. Crosslinking of free carboxyl groups with calcium ion

2.7 Multiresponse Modelling

Multiresponse modelling is used as a powerful tool for measuring several responses (concentration changes of reactants, intermediates, and end products) in food system simultaneously by involving all available information. The approach of this modelling to the kinetic of both reactants and products results in a better understanding of the mechanism of the reactions, insightful parameter estimation and hence more accurate model prediction (Quintas et al. 2007). It is highly robust to understand the mechanism of complex reactions and to identify the rate-determining steps of a series of reactions. Compared to the simple kinetic model that considers only one response, the main advantage of multi-response model is it can be tested more rigorously and provide more precise parameter estimation (Goncuoglu Tas and Gokmen 2017, Knol et al. 2010).

3. Research Objectives and Questions

3.1 Objectives

The aim of this research is to study the leaching and degradation kinetics of vitamin C in mango and its osmotic solution during OD, the effect of VI, and PME addition on the kinetics.

3.2 Research questions

Question 1: How do the leaching and degradation kinetics of vitamin C in mango cubes and osmotic solution during OD?
Question 2: How do the leaching and degradation kinetics of vitamin C in mango cubes and osmotic solution during OD in combination with VI?
Question 3: How does PME in the presence of Calcium affect the leaching and degradation kinetics of vitamin C in mango cubes and osmotic solution during OD and OD-VI?

4. Materials and Methods

4.1 Materials

Fresh mango (*Mangifera indica* L. cv. Kent) with maturity stage 4 was purchased from Bakker Barendrecht, Netherlands. The mangoes were sorted by measuring the firmness using penetrometer with 8mm tip in duplicate at each side of mango cheek, the sorted mangoes were weighed. The average mango weight used in this study was in the range of 600-700 g per mango. After that, the sorted mangoes were cut into cubes (1,2 x 1,2 x 1,2 cm^3), mixed, and weighed. One OD time point required around 250 grams of mango cubes. The mango cubes were kept cold in a metal bowl placed on ice buckets, then exposed to four different treatments (OD without PME addition (OD), OD with PME addition (OD-P), OD-VI without PME addition (OD-V), and OD-VI with PME addition (OD-PV)). The dry matter content, Aw, pH, total soluble solid (TSS) and vitamin C analysis were conducted to mango cubes and osmotic solution. Total titratable acidity (TTA) was measured for profiling of fresh mango. PME activity of fresh mango cubes, 0.5h OD mango, and 29h OD-mango were also measured. All measurements were performed in duplicate. The experimental design was shown in the flow diagram in Figure 5.

4.2 Method

4.2.1 Osmotic Dehydration

Osmotic solution (OS) was prepared by mixing 2% w/w calcium lactate and 98% w/w sucrose solution, which consists of 60% w/w sucrose (commercial) and 40% w/w demi water. Heating at 50°C was applied to accelerate the dissolving process. The targeted soluble solid content of OS was 60°Brix. For the treatment with PME, 0,48% v/v PME commercial (*Aspergillus oryzae* recombinant, Novoshape® Novozymes, Reading, UK) was added to the OS right before the mango cubes immersion. The solution was stirred with a magnetic stirrer at 50°C and kept in a water bath before use. After weighing both OS and mango cubes with a ratio of 4:1 (w/w), mango cubes were immersed into the OS in 2L beaker and covered by aluminium foil. A metal plate was also placed inside the beaker to immerse the cubes in the solution. Then the beaker was moved into the waterbath. During OD process, the temperature of 50°C was maintained with constant agitation. Fixed parameter for OD treatment were shown in Table 2.

Table 2. Fixed parameter and variable for OD treatment

	Description	Value	Reference
Fixed	Sample size	1,2 cm x 1,2 cm x 1,2 cm	Grunsven, 2015
	Solute solution	60°Brix sucrose solution	Silva, *et al.,* 2013
	Ratio solution:fruit (w/w)	4:1	Super, 2014
	Temperature	50°C	Super, 2014
	Calcium concentration	2%	Torres, *et al.*, 2006
Variable	PME addition	0%, 0.48%	Grunsven, 2015
	Pre-treatment	None, VI	
	OD time points	0, 0.5, 1, 2, 4, 8, 23, 29 hours	Kong, 2017

When desired time point was reached, the mango cubes were removed from the solution, kept cold to prevent the possibility of further vitamin C degradation by heat, then wiped shortly using paper towel to remove remaining OS on the surface of mango cubes. The weight of mango cubes and osmotic

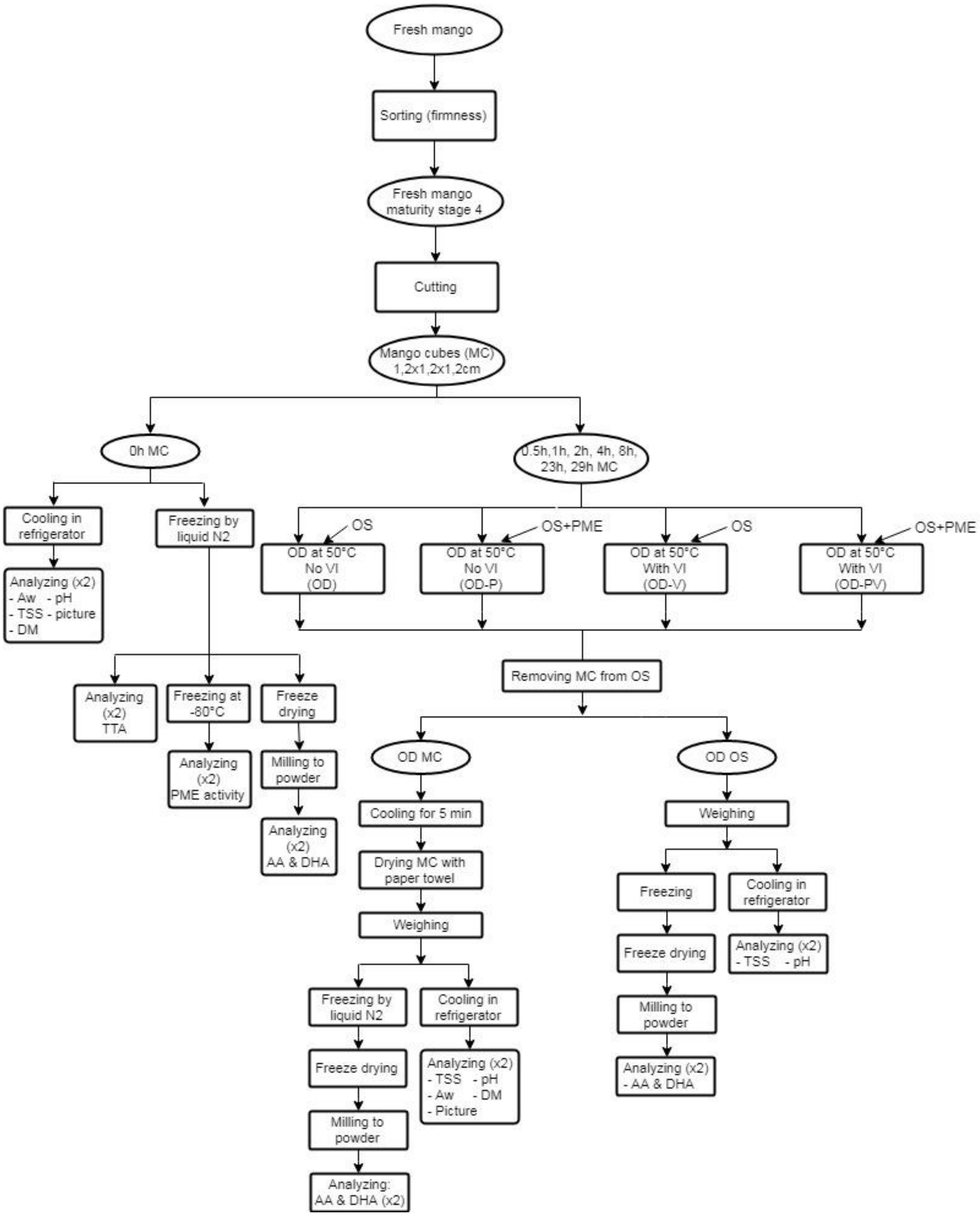

Figure 5. Flow diagram of experiment

solution were recorded to calculate water loss and sugar gain during OD. The mango cubes sampleswere separated into two parts; 30 grams were stored in fridge and used for total soluble solid (TSS), pH, Aw, and dry matter content analysis, the other 50 grams were frozen immediately by adding liquid nitrogen then freeze dried for vitamin C analysis. For fresh mango cubes (0h), another 30 grams of samples were frozen by adding liquid nitrogen for total titratable acidity (TTA) analysis. Moreover, another 30 grams of fresh, 0.5h, and 29h mango cubes sample were kept at -80°C for PME analysis. The osmotic solution was separated into two parts; about 100 ml was freeze dried for vitamin C analysis and the other 100 ml was stored in fridge prior to pH and TSS analysis.

4.2.2 Vacuum Impregnation

VI treatment was performed using Binder Vacuum Oven VD53 and Knf Lab Vacuum Pump SC950, according to Food Quality & Design Laboratory Protocol No. 66. The temperature of the oven was set to 30°C, while the pump was set at 50 mbar. Once the temperature has been reached, the beakers containing mango cubes in osmotic solution were put into the oven and vacuumed for 15 minutes, followed by approximately 10 minutes of total relaxation time.

4.2.3 Analysis

4.2.3.1 Ascorbic Acids (AA) and Dehydroascorbic Acids (DHA) Analysis

AA and DHA analysis in mango was performed according to Food Quality & Design Laboratory Protocol No. 35A2. Prior to AA extraction step, mango and OS sample was freeze dried using Christ Alpha 1-4 LD Plus freeze drier with Vacuubrand RZ 6 vacuum pump (Laboratory Protocol No. 50) and big (Geraets) freeze drier with Edwards high vacuum pump model E2M18 (Laboratory Protocol No. 51). After freeze drying process, liquid nitrogen was added into the freeze-dried sample, then was milled into powder using IKA A11 Basic batch miller. Approximately 0.5-0.7 grams of freeze dried mango sample was mixed with 3,5 ml 3% MPA, 1 mM THBQ solution. The mixture was homogenized using Ultra Turrax T25 at highest speed for 1 minute and centrifuged at 4°C, 3000 rpm, for 5 minutes using Heraeus Multifuge x3R. The mango supernatant was collected in pre-weighed 15 ml centrifuge tube. The treatment step from adding 3% MPA, 1 mM THBQ solution to collecting supernatant was repeated three times in total. The weigh of tube and supernatant was recorded. Then, the supernatant was moved to 5 ml Eppendorf tube, centrifuged at 4°C, 10.500 rpm, for 10 minutes using Eppendorf 5430R centrifuge, and filtered using Sartorius CA 0.45 µm, 15 mm filter. About 2 ml of prepared sample was filled into an amber vial for AA measurement while for total AA (TAA) measurement, 1,485 ml sample was added with 15 µL of Tris-2-carboxyethyl phosphine solution into the amber vial. The analysis was run on HPLC system 1 with Polaris C18a (4,6*150mm 5µm) guard column. For the OS, approximately 5 grams of freeze dried OS sample was mixed with 10,5 ml 3% MPA, 1 mM THBQ solution, without three times MPA treatment (only treated once). The rest of the procedure for OS was the same as mango sample. The DHA concentration was determined by subtracting AA concentration from the TAA concentration.

The standard series were prepared by adding 10mg/ml ascorbic acid powder to the 3% MPA, 1 mM THBQ solution. After that, the stock solution was diluted to the concentration of 100, 50, 25, 12.5, 6.25, 3.125, 1.56, 0.78, and 0.39 µg/ml. About 2ml of the dilutions was transferred into amber HPLC vials.

4.2.3.2 Water loss, soluble solid gain, and OD performance index

Water loss and soluble solid gain were determined based on dry matter content of mango cubes and osmotic solution. Dry matter content was measured according to Food Quality & Design Laboratory Protocol No. 1. About 0.5 to 1 gram of sample was weighed on a pre-weighed aluminium box. Then it was dried over night in the oven at 100°C, followed by 1 hour in the excicator. Water loss was calculated using mass fraction of water content (Eq1) which was obtained by measuring dry matter content. On the other hand, the soluble solid gain was calculated using mass fraction of solid content (Eq2) which was determined by the total soluble solid amount of the sample. OD performance index indicated process efficiency which was calculated by the ratio between water loss and soluble solid gain (Eq3).

$$Water\ Loss = \frac{(M_t)(x_{w,t}) - (M_o)(x_{w,o})}{Mo} \quad \text{(Eq. 1)}$$

$$Soluble\ Solid\ Gain = \frac{(M_t)(x_{s,t}) - (M_o)(x_{s,o})}{M_o} \quad \text{(Eq. 2)}$$

$$OD\ Performance\ Index = \frac{Water\ Loss}{Soluble\ Solid\ Gain} \quad \text{(Eq. 3)}$$

M_0: initial weight of sample (g)
M_t: weight of sample at time t (g)
$x_{w,0}$: mass fraction of initial water content
$x_{w,t}$: mass fraction of water content at time t
$x_{s,0}$: mass fraction of initial solid content
$x_{s,t}$: mass fraction of solid content at each sampling times

4.2.3.3 Water Activity

Water activity analysis was performed to mango sample using Novasina Labmaster-Aw meter, according to Food Quality & Design Laboratory Protocol No. 32. The mango sample was cut into small pieces, filled precisely into the sample plastic can, and put inside the Aw meter. For mango sample, the time was set to 3 minutes for temperature stabilisation and 2 minutes for the stability of Aw measurement.

4.2.3.4 pH Analysis

About 8 grams of mango sample was homogenized using blender by adding 72 ml distilled water (10 times dilution) then centrifuged for 10 minutes at 2.500 rpm. The pH of the supernatant was measured using pHenomenal 1000L pH-meter and pH-electrode SenTix Sp at room temperature. The pH measurement of the osmotic solution was performed directly by placing the pH-electrode in the solution.

4.2.3.5 Total Soluble Solids (TSS) Analysis

TSS analysis of the mango cubes and the osmotic solution was conducted using HANNA refractometer. The TSS value represented sucrose content in the sample. Mango supernatant was obtained by centrifuging mango juice with 10 times dilution for 10 minutes at 2.500 rpm.

4.2.3.6 Total Titratable Acid (TTA) Analysis

Total titratable acidity analysis was carried out by squeezing 10 mL of mango juice from fresh mango sample through cheese cloth. The juice was titrated with 0.1N NaOH until pH 8.1 was reached. The percentage of acid and sugar acid ratio was calculated using Equation 4 and 5.

$$\%\ of\ acid = \frac{mL\ of\ NaOH\ x\ 0.0064\ x\ 100}{10\ mL\ mango\ juice} \quad \text{(Eq. 4)}$$

$$Sugar\ acid\ ratio = \frac{°Brix}{\%\ of\ acid} \quad \text{(Eq. 5)}$$

4.2.3.7 Pectin methylesterase (PME) Activity

PME activity measurement was performed according to PEU test method in Kimball (1999). Prior to analysis, the mango sample and PME commercial sample (*Aspergillus oryzae* recombinant, Novoshape® Novozymes, Reading, UK) were preserved at -80°C. The analysis was started by doing an extraction step. About 10 grams of mango sample was homogenized with 20 mL cold buffer solution (0.1 M NaCl, 0.02M Tris - 6M HCl pH 7.5 for fresh mango sample, 0.1 M NaCl, 0.25 M acetate buffer pH 4.8 for dried mango sample) using Ultra Turrax T25 at highest speed for 1 minute. The sample was subsequently centrifuged using rotor JA 25.50 and Beckman Coulter TM, Avanti J-26 XP centrifuge at 4°C, 20.000 g, for 30 minutes. The pH of the supernatant was adjusted to 4.8 using 1N NaOH just before each assay. This supernatant then can be called crude extract of PME enzyme. PME activity was analyzed using 4 mL of mango sample in 40 mL of 1% HM apple pectin in 0.1M NaCl, at pH 4.8 and 50°C with constant agitation. When the pH was 4.8, a known amount (0.1 or 0.2 mL) of 0.05N NaOH was added to the mixture. The time needed for regaining pH 4.8 was recorded. PME activity was represented by the rate of acid formation which was calculated using pectin esterase unit (PEU) formula (Eq. 6). The analysis was performed in duplicate.

$$PEU = \frac{(0.05\ N\ NaOH)(mL\ of\ added\ NaOH)}{(mL\ of\ added\ sample)(minutes)} \qquad (Eq.\ 6)$$

4.2.4 Modelling Procedure

Degradation and leaching kinetics of vitamin C (TAA and AA) during OD were described using multiresponse kinetic modelling. The scheme presented in Figure 6 is a representation of proposed mechanism, which are divided into two processes; leaching process from mango into OS until reaching equilibrium and degradation process. Leaching process also involves a decrease in mango weight and increase in OS weight.

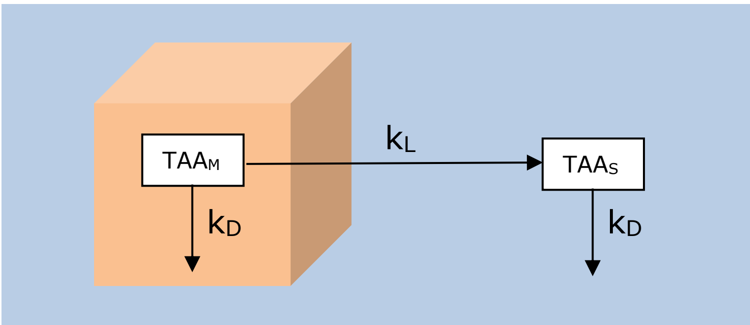

Figure 6. Proposed mechanism for the loss of vitamin C

Leaching process of vitamin C from mango into OS is proportional to the concentration difference between TAA of mango and OS, following Equation 7:

$$Y_L = k_L \,.(TAA_M - TAA_S) \qquad (Eq.\ 7)$$

where k_L is leaching rate constant (h^{-1}), TAA_M is TAA concentration in mango (mg/100g), and TAA_S is TAA concentration in OS (mg/100g).

Degradation was expressed by first order reaction, given in Equation 8, which is similarly applied for TAA in mango and in OS (Serpen and Gökmen 2007, Frías and Oliveira 2001, Johnson et al. 1995):

$$Y_D = k_D \, . TAA \qquad (Eq.\ 8)$$

where k_D is degradation rate constant (h^{-1}) and TAA is TAA concentration (mg/100g).

The corresponding differential equations, that define the rate of reactions are enumerated in Equations 9-11:

$$\frac{dTAA_M}{dt} = -Y_L - Y_D \qquad (Eq.\ 9)$$

$$\frac{dTAA_S}{dt} = +Y_L \, . \frac{M_S}{M_M} - Y_D \qquad (Eq.\ 10)$$

$$\frac{dTAA_M}{dt} \simeq \frac{\Delta TAA}{\Delta t}, so\ \Delta TAA = \frac{dTAA}{dt} \, . \Delta t \qquad (Eq.\ 11)$$

where M_M is mango weight (g), M_S is OS weight (g), and Δt is difference in time (h).

Concentration changes (ΔTAA) were calculated using small time steps (Δt). Higher weight factor was applied to sum of squares of the residuals of OS due to much smaller concentration in OS, in order to have comparable relative residuals. The parameters of the model were estimated based on minimization of the residual sum of squares (SSR) of the two responses (Mango and OS concentrations), the correlations coefficients of the parameters and visual inspection of residuals' randomness.

4.2.5 Statistical Analysis

Means and standard deviations were reported and differences between means were tested for significance using one-way analysis of variance (ANOVA) and Tukey post hoc multiple range test ($p<0.05$).

5. Results and Discussion

The analyses result and discussion on them will be presented in this chapter. The results of analyses, such as PME activity, TTA, pH, Aw, TSS, water loss (WL), solid gain (SG), and OD performance index were collected as supporting data to gain better understanding on the vitamin C result. PME activity analysis in mango was carried out to confirm the PME addition in OS took effect on the OD mango. TTA data was collected for fresh mango for profiling purpose. The pH data is correlated to vitamin C content in which pH will increase, along with the decrease in vitamin C content. Water activity (Aw) data was included as it is an important parameter for dried product. TSS, WL, SG, and OD performance index data were highly necessary to study the mass transfer occurred during osmotic dehydration process and to specifically link to the vitamin C changes during the treatment.

5.1 PME Activity

PME activity analysis in mango was carried out to confirm the PME addition in OS took effect on the OD mango. In this analysis, PME activity was indicated by the rate of acid formation and represented by pectin esterase unit (PEU). PEU refers to the milliequivalent of ester hydrolized per minute per ml of the sample or one unit of PE is the amount of enzyme which liberates 1 µmole of carboxyl groups per minute (Askar and Treptow 2013). According to (Kimball 1999)), the PEU values of most processed fruit juices is from $1x10^{-6}$ to $1x10^{-4}$. If the PEU value is higher than this, the tendency towards gelation of product will increase. Figure 7 showed the pectin esterase unit (PEU) of fresh mango (0h), 0.5h OD mango, and 29h OD mango subjected to different OD treatment. The PEU values of OD, OD-V, OD-P 0h, and OD-PV 0h mango were relatively low since there were no added PME. Thus, the values shown for those samples were only accounted for endogenous PME.

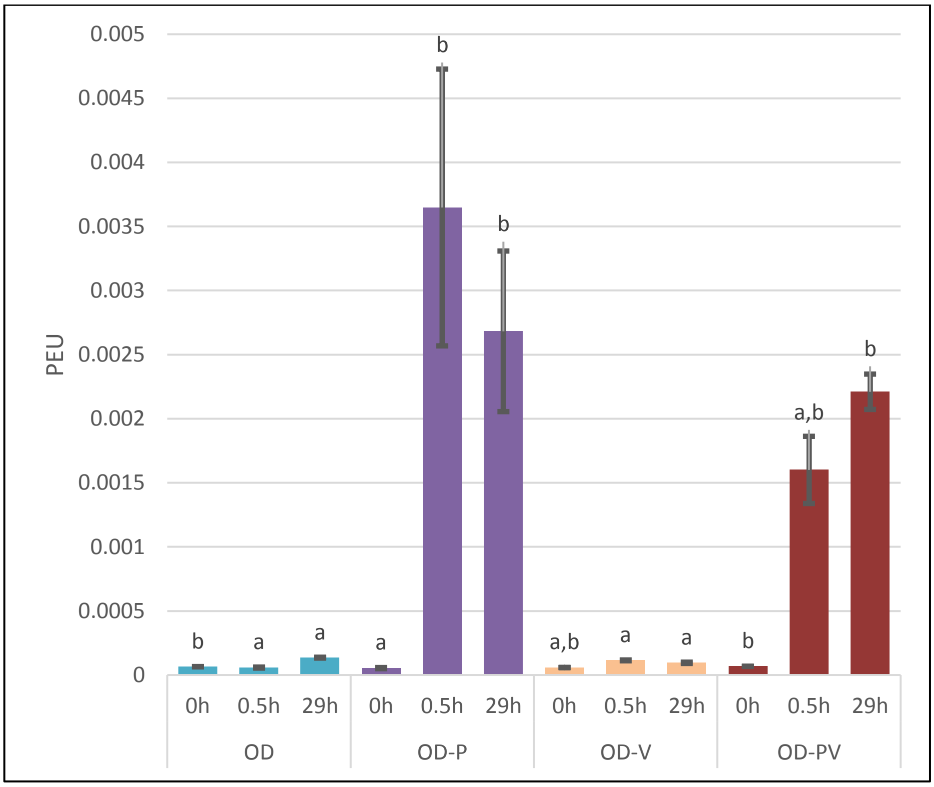

Figure 7. Pectin esterase unit (PEU) of mango with different treatment and time. Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

On the contrary, the PEU values of mango sample with added PME (OD-P and OD-PV at 0.5 hours and 29 hours) were significantly higher (P≤0.05) than the PEU values of mango sample without added PME (OD and OD-V at the same time point). The result confirmed that the added PME was transferred from OS to the intercellular spaces of mango cubes. Moreover, the PEU values of mango samples which were more than 10^{-4} indicated higher tendency towards gelation. Gelation occurs when free carboxyl groups resulted from pectin demethoxylation by the action of PME crosslinks with divalent ions, such as Ca^{2+} (Van Buren 1979). The fortifying network was expected to contribute in better textural properties and prevention towards leaching of vitamin C.

5.2 Total Soluble Solid

The result of total soluble solid (TSS) in mango was given in Figure 8. The increase in mango TSS which indicated an incorporation of sucrose during OD process, was in accordance with previous research (Nagai et al. 2015, Torres et al. 2006, Guiamba et al. 2016). The initial TSS of the Kent mango was within the range of judgement criteria for maturity stage 4 mango which was between 12-14°Brix (UFlorida and UC-Davis 2010). A remarkable increase of TSS was observed until the eighth hour of OD process, with the highest increase on sample with combination of VI and PME treatment. The increase of TSS at 8h on OD, OD-P, OD-V and OD-PV treatment were 3.4x, 3.6x, 3.1x, and 3.9x respectively compared to the TSS of 0h mango. There were also significant differences (P≤0.05) between TSS of mango sample with combination of VI and PME treatment and untreated sample at 8h. The highest TSS of OD-PV mango at 8h could be contributed by the combination of VI pre-treatment which improved mass transfer rate and PME addition that contributed in reducing water loss. The addition of PME, together with Ca^{2+}, was expected to give firmer textural properties, resulting in lower water loss (Guiamba et al. 2016, Silva et al. 2014). Flow of water coming out from fruit cells was possible to hinder sugar penetration into cell (Marcotte and Maguer 1992), thus lower water loss might enhance sugar uptake. Furthermore, greater sucrose uptake on OD-PV mango at 8h could be explained by higher permeability of disrupted fruit tissue due to long processing time (more than 2 hours) and high solution concentration (Silva et al. 2014, Rincon and Kerr 2010). The highest final TSS at 29h was 48.5°Brix on OD-P mango. Compared to the result of Kong (2017) on OD Kent mango maturity stage 5 with added PME, the final TSS at 29h was 54.8°Brix. The different maturity stage might be attributed to the higher TSS value.

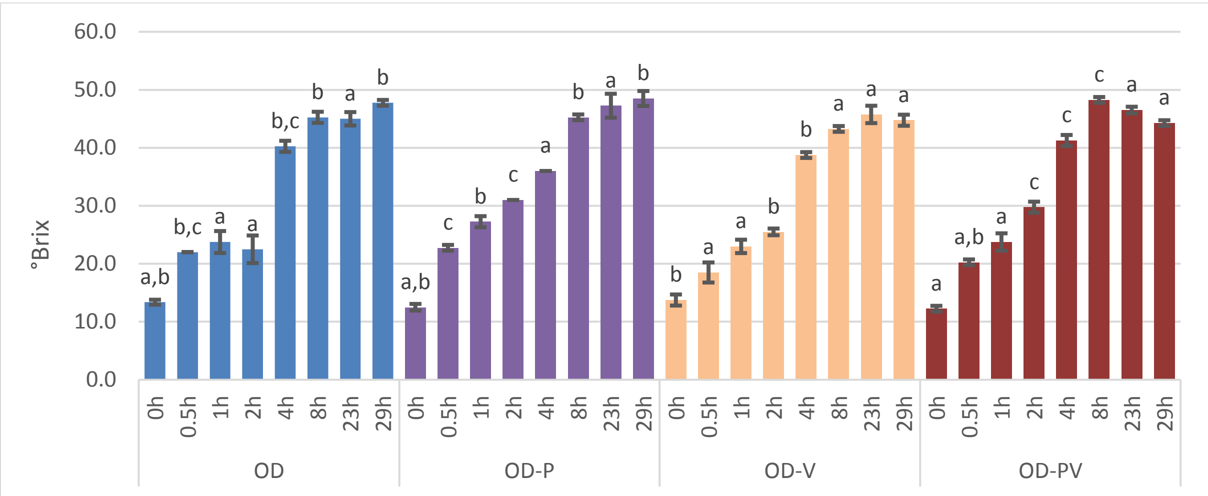

Figure 8. Total soluble solid of mango with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

On the other hand, the TSS of OS (Figure 9) decreased from 60°Brix to approximately 52°Brix during OD process. This was due to diffusion of sucrose from the OS into the fruit tissue (Rastogi et al. 2002). The TSS value remained constant from 8h onwards.

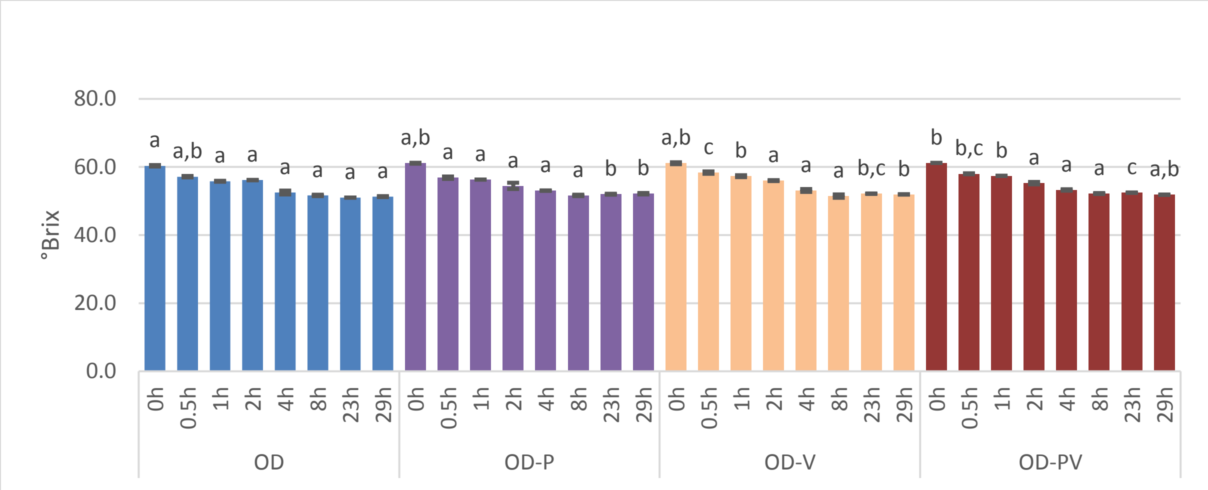

Figure 9. Total soluble solid of OS with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

5.3 Total titratable acidity, pH, Water Activity

Total titratable acidity (TTA) of fresh mango was represented by citric acid percentage. Due to the utilization as a substrate for respiration activities of mango fruit, citric acid was considered to be the major organic acid responsible for titratable acidity (Siddiq et al. 2017). Table 3 presented the citric acid percentage and sugar acid ratio of fresh mango. The results of previous study showed citric acid percentage and sugar acid ratio of Kent mango maturity stage 4 were 0.59 and 26.38 respectively (Alarcón 2016). Variability in results was expected since mango was natural product.

Table 3. Citric acid percentage and sugar acid ratio of fresh Kent mango

Sample	%citric acid	Sugar/acid ratio
Fresh mango for OD	0.64 ± 0.04	21.02 ± 1.31
Fresh mango for OD-P	0.79 ± 0.02	15.85 ± 0.45
Fresh mango for OD-V	0.61 ± 0.01	22.59 ± 0.34
Fresh mango for OD-PV	0.72 ± 0.04	17.14 ± 1.06

Figure 10 showed the change of pH value of mango during OD process. Based on the result, the average pH of fresh mango was 4.3. Previous study showed similar result with pH of 4.1 (Kong 2017). Increase in pH of OD, OD-V, and OD-PV mangoes were observed to the value of 5.2. It could be caused by combination of two factors; leaching of water soluble acids through water diffusion and chemical degradation (Phisut et al. 2013). In contrast, the pH of mango sample with PME treatment did not show any increase, it was probably due to the formation of gel network as the impact of PME addition which minimalize the leaching of water soluble acids.

The change of pH value of OS during OD process was given in Figure 11. The initial pH of OS was in the range of 6.7-6.9. A sharp decrease was observed in the first two hours of OD process due to the leaching of water soluble acids from mango into the OS. It was in accordance with earlier findings that mass transfer was mainly occurred during the first two hours of OD process (Raoult-Wack 1994). Slight decrease was identified subsequently reaching a constant value at 23h onwards. There were no significant differences (P>0.05) between pH of OS from each treatment.

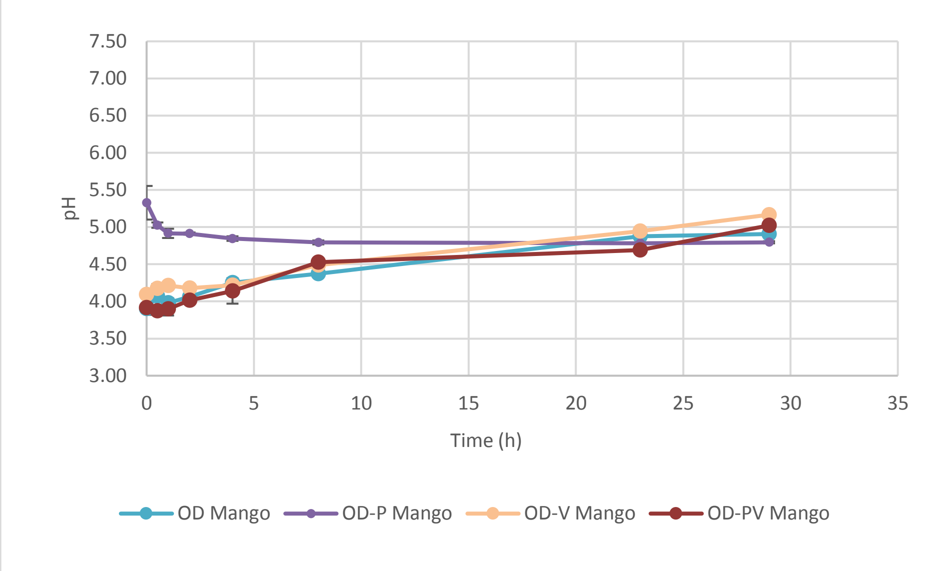

Figure 10. pH of mango with different treatment and time

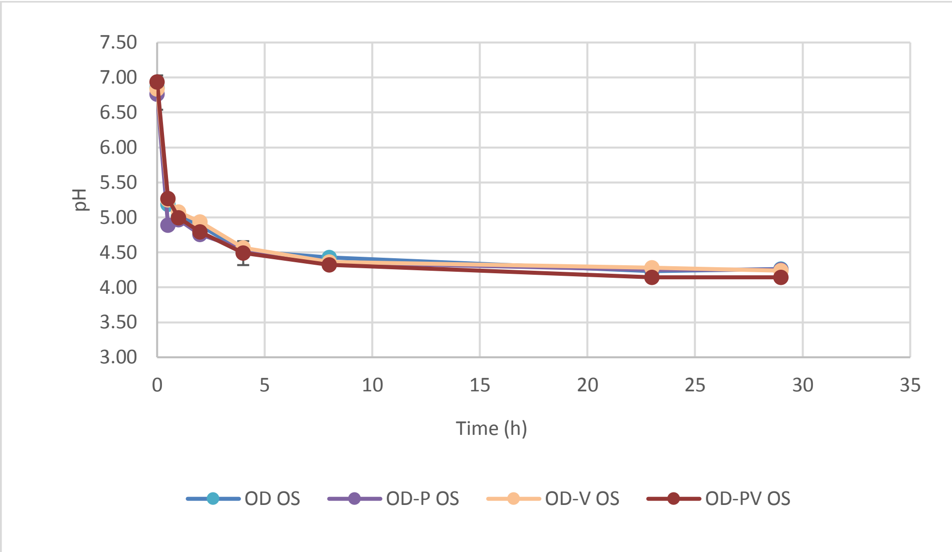

Figure 11. pH of OS with different treatment and time

A decrease in water activity (Aw), given in Figure 12, was observed from the value of 0.99 to 0.92. The water activity of dried product should be relatively low to inhibit microbiological growth. Bacteria will not grow on Aw below 0.85, yeasts below 0.7, and molds below 0.65 (Perera 2005). Thus, it was implied that the Aw reduction by OD was not sufficient to hinder the growth of microorganisms. OD was able to extend the shelf life of product to certain degree but it did not preserve it enough, so a combination with other preservations method, such as high hydrostatic pressure (HHP) was necessary (Pérez-Won et al. 2016).

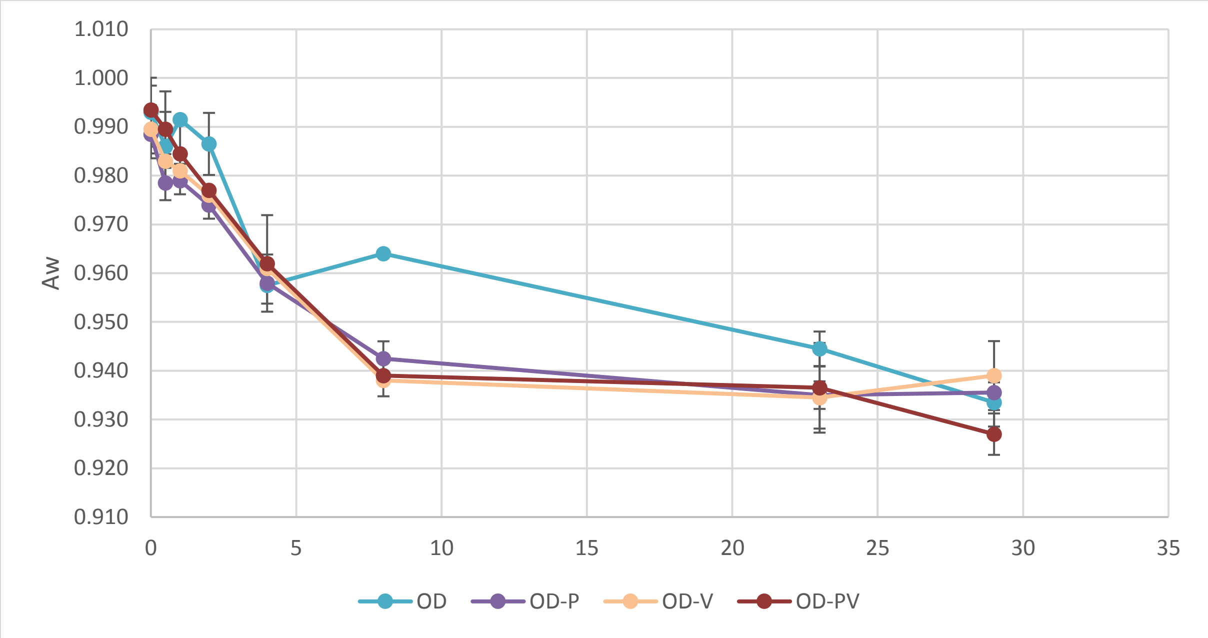

Figure 12. Water activity of OD mango with different treatment and time

5.4 Water Loss, Soluble Solid Gain, OD Performance Index

Osmotic dehydration involves partial dehydration of the fruit and solid uptake from the osmotic solution (Torres et al. 2006). The data on water loss (g water/g) by mango cubes and OS during OD were presented in Figure 13 and 14 respectively, whereas the data on soluble solid gain (g solid/g) by mango cubes and OS during OD were presented in Figure 15 and 16 respectively. The negative value means the opposite conditions which leads to water gain (Figure 14) and solid loss (Figure 16) in OS.

Most transfers, both water loss and solid gain, occurred at first 4 hours of the process then it became progressively slower over time before reaching constant value. It was in accordance with the findings of Monsalve-GonÁLez *et al*. (1993), mentioning three phases of mass transfer rate; the rapid phase of sugar gain and water loss (1-2 hr), followed by a phase of decreased sugar gain and water loss and tended to reach pseudo-equilibrium (2-8 hr), and a phase of practical end point of process indicated by diminished net rate of weight loss and continuous but low sugar uptake.

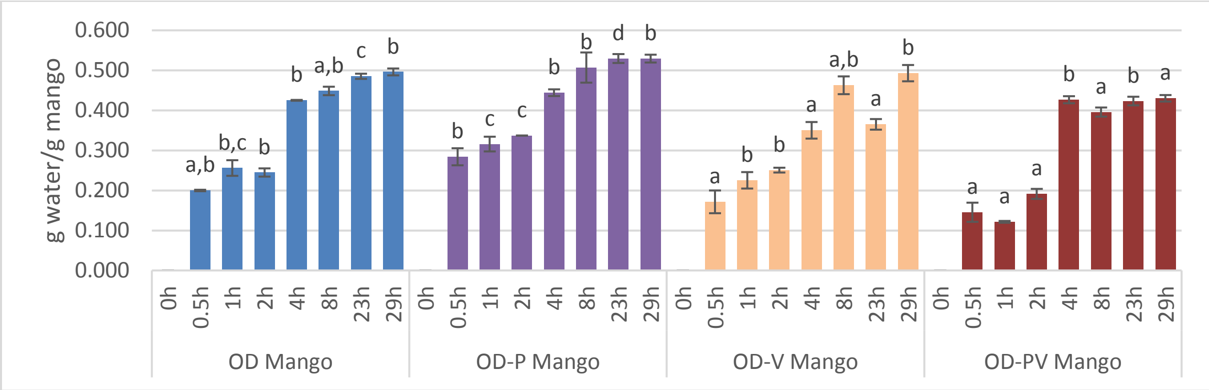

Figure 13. Water loss of OD mango with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

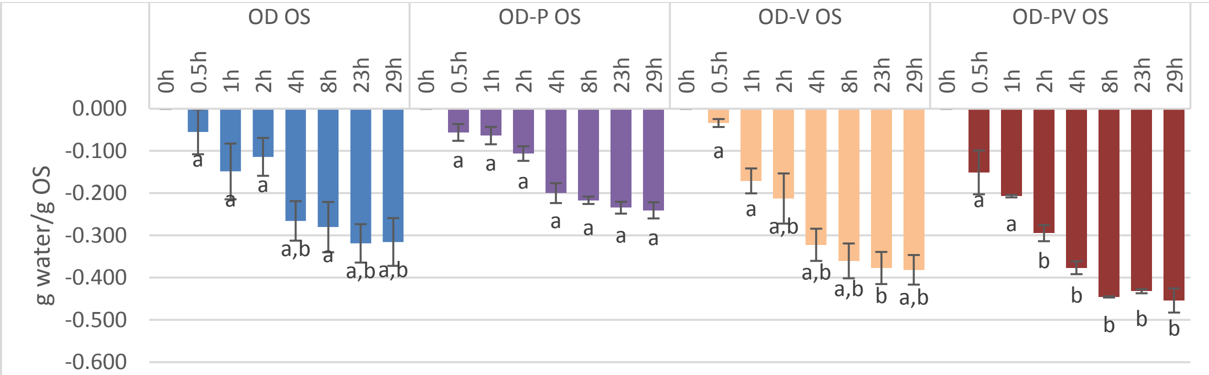

Figure 14. Water gain of OS with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

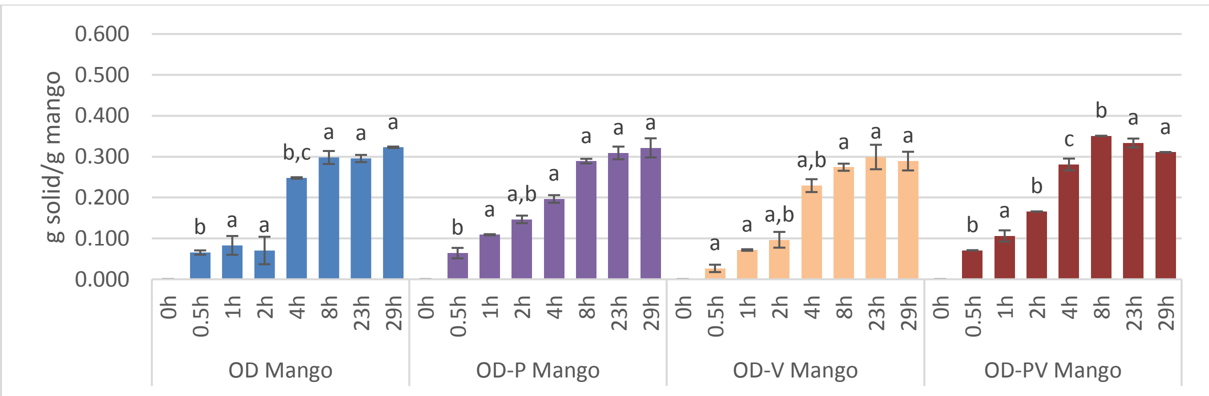

Figure 15. Soluble solid gain of OD mango with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

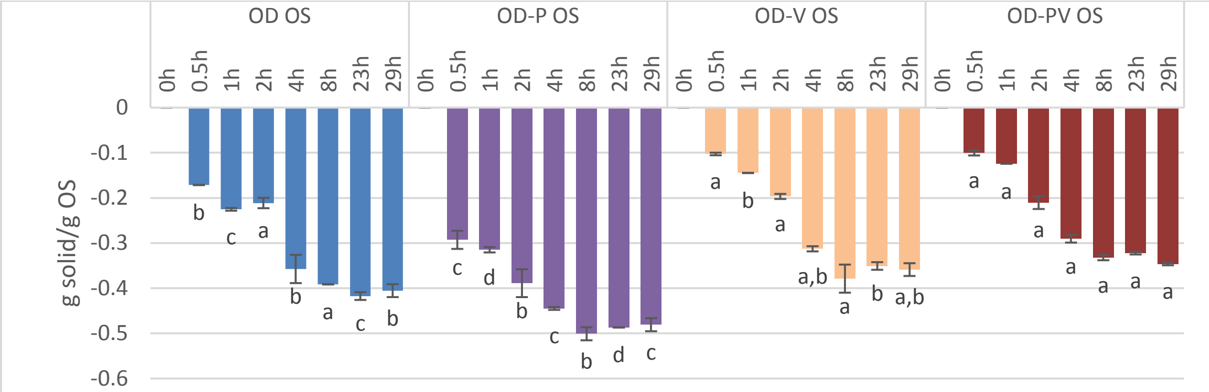

Figure 16. Soluble solid loss of OS with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

Based on the data obtained, there were no significant difference (P>0.05) on water loss and solid gain of mango sample with VI pre-treatment compared to untreated sample at 2h. Water loss of OD-P sample was significantly higher than OD sample at 2h, while no significant difference was observed in solid gain. Shen (2017) and Alarcón (2016) reported that the addition of PME has no significant effect to water loss and solid gain of OD mango. Lower water loss was expected by the addition of PME. The contrast result might be caused by insufficient amount of added PME to give subsequent effect on network formation and reduction in tissue permeability. On the other hand, there was a significant effect (P≤0.05) on water loss of mango sample with combination of VI and PME treatment compared to untreated OD sample. Mango sample with combination of VI and PME treatment had lower water loss and higher solid gain compared to untreated OD sample. The highest soluble solid gain of OD-PV sample corresponded to its highest TSS at 8h. The similar observation was also obtained by Torres et al. (2006). According to Gras et al. (2003), the interaction between calcium and fruit cellular matrix could modify VI response resulting in different mass transport mechanism due to structural changes. This was associated with enhancement in solid gain and limitation of water loss.

At 29h, the amount of water loss was in the range of 0.43-0.53 g water/g mango and the amount of solid gain was in the range of 0.28-0.33 g solid/g mango. The similar range was also observed by Raoult-Wack (1994). It was mentioned that OD generally leads to significant water removal (0.4-0.7 grams of water is lost per gram of initial product) with limited and controlled solute incorporation (0.05-0.25 grams of solute is gained per gram of initial product). Moreover, the amount of water loss was higher than solid gain. Based on former observations, it was proved that water can diffuse easier than solutes through cell membrane, hence osmotic equilibrium is achieved more by flow of water from cell rather than solids transport (Rahman and Lamb 1990). Besides that, water coming out from surface cells has a potential to restrict sugar penetration into cell (Marcotte and Maguer 1992). Parjoko et al. (1996) also explained the relationship between water loss and solid gain in reaching equilibrium. It was stated that if water loss is higher then solid gain must be lower (Parjoko et al. 1996).

The amount of water gained by OS tended to be lower than the amount of water lost from mango cubes while the amount of solid lost from the OS tended to be higher than the amount of solid gained by the mango. The differences were probably due to different unit used in calculation. For the mango, the amount of water loss and solid uptake were calculated per gram of mango while for the OS, they were calculated per gram of OS. The amount of water in one gram of OS was different from the amount of water in one gram of OD mango.

The OD performance index in mango was given in Figure 17, indicating the efficiency of OD process. The result showed that there were no significant effect (P>0.05) of different treatment on OD performance index at 2h. At 0.5h, it was observed that OD performance index of OD-V mango was significantly higher than OD-PV mango. The OD performance index in OS (Figure 18) was relatively low due to more transfer of soluble solid from OS occurred rather than flow of water into the OS.

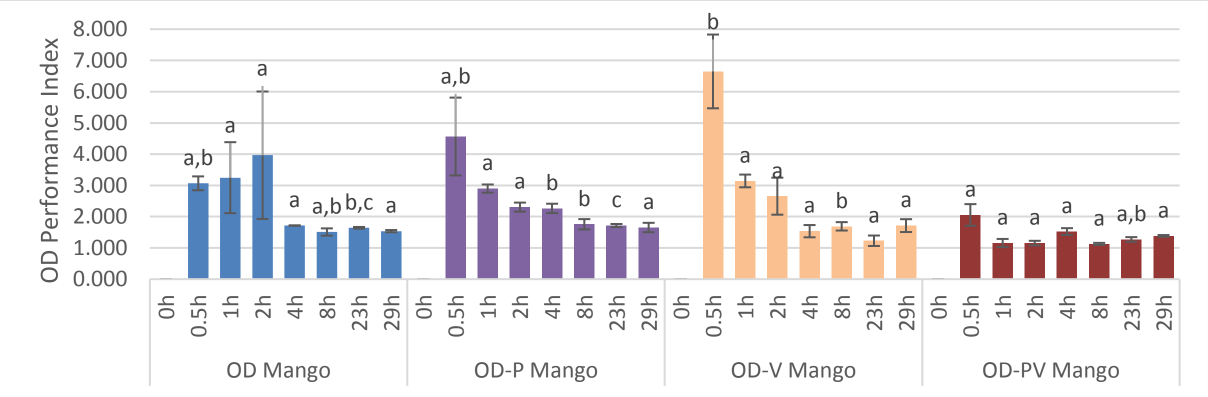

Figure 17. OD performance index in OD mango with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

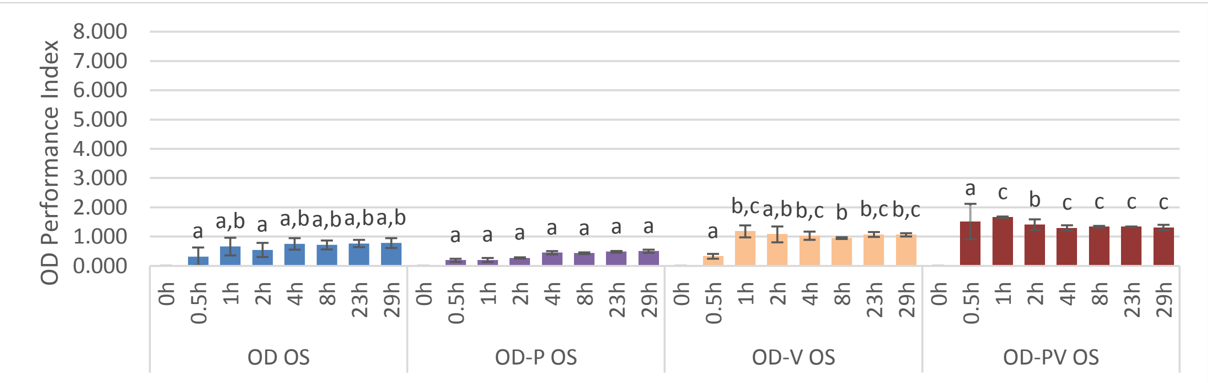

Figure 18. OD performance index in OS with different treatment and time
Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

5.5 Vitamin C

5.5.1 Experimental Results

Vitamin C, comprising ascorbic acid (AA) and its oxidized form, dehydroascorbic acid (DHA), is one of the potent natural antioxidant presents in fresh fruits and vegetables (Cantwell et al. 2016, Dorofejeva et al. 2011). The change in ascorbic acid (AA), dehydroascorbic acid (DHA), AA/DHA ratio and total ascorbic acid (TAA) content in mango and OS during OD were given in Figure 19, 20, 21, and 22 respectively. The amount expressed on the graph was the actual AA, DHA and TAA amounts for 250 g initial weight of mango and 1000 g initial weight of OS.

AA, DHA, and TAA content in fresh mango (0h) sample was, on average, 68.6 mg per 250 g mango (27.5 mg/100 g mango), 10.8 mg per 250 g mango (4 mg/100 g mango), and 79.5 mg per 250 g mango (31.8 mg/100 g mango) respectively. The AA content of fresh Kent mango was in the same range as reported by Muiruri (2013). The DHA content was similar to DHA content of fresh Tommy Atkins mango, which varied from 1.3 to 10.9 mg/100g (Oliveira et al. 2010). The AA content for all samples were higher than DHA content, which observed through AA/DHA ratios that were higher than 1. The amount of AA and TAA continually decreased with increasing immersion time; this confirms the findings of previous studies (Kong 2017, Super 2014). The changes in TAA showed a similar trend with the changes in AA, due to low level of DHA. The same result was also reported by Rybarczyk-Plonska et al. (2014).

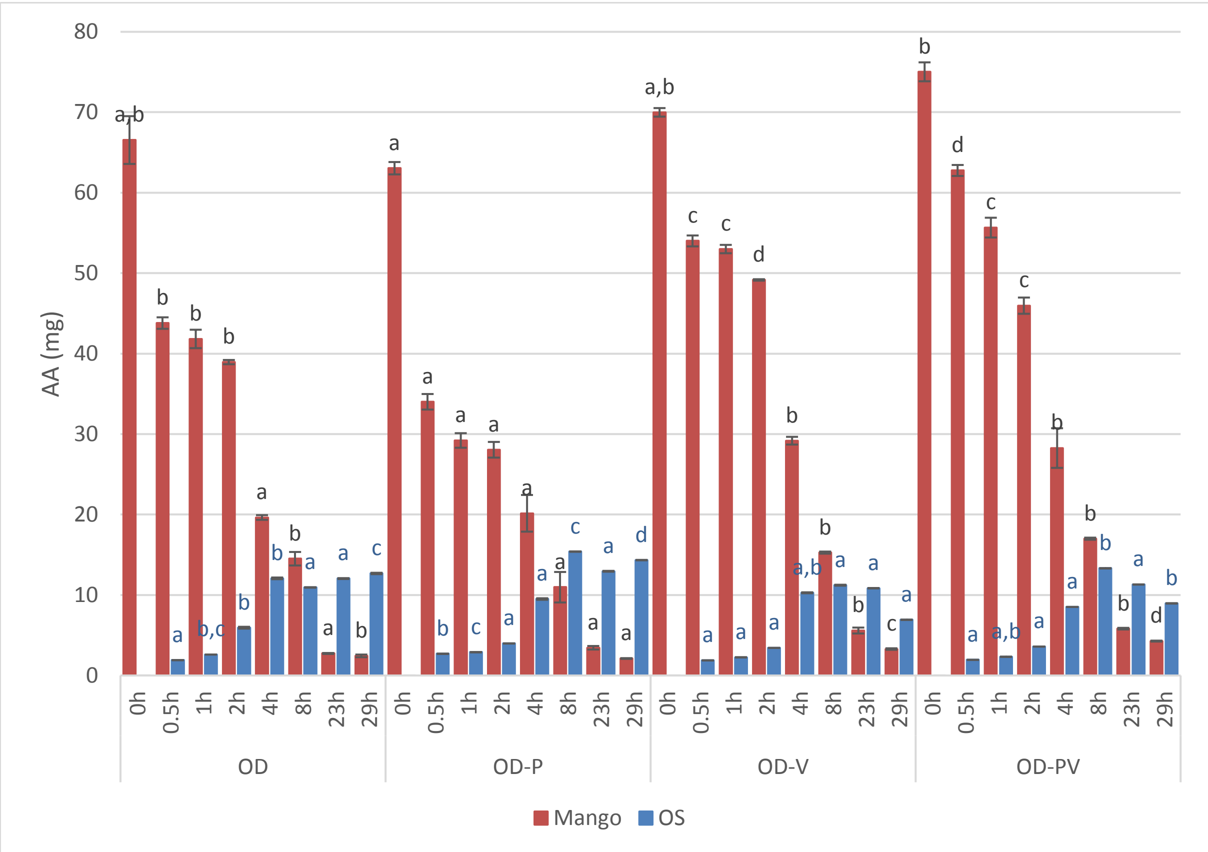

Figure 19. Ascorbic acid content (mg) of mango and OS with different treatment and time Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

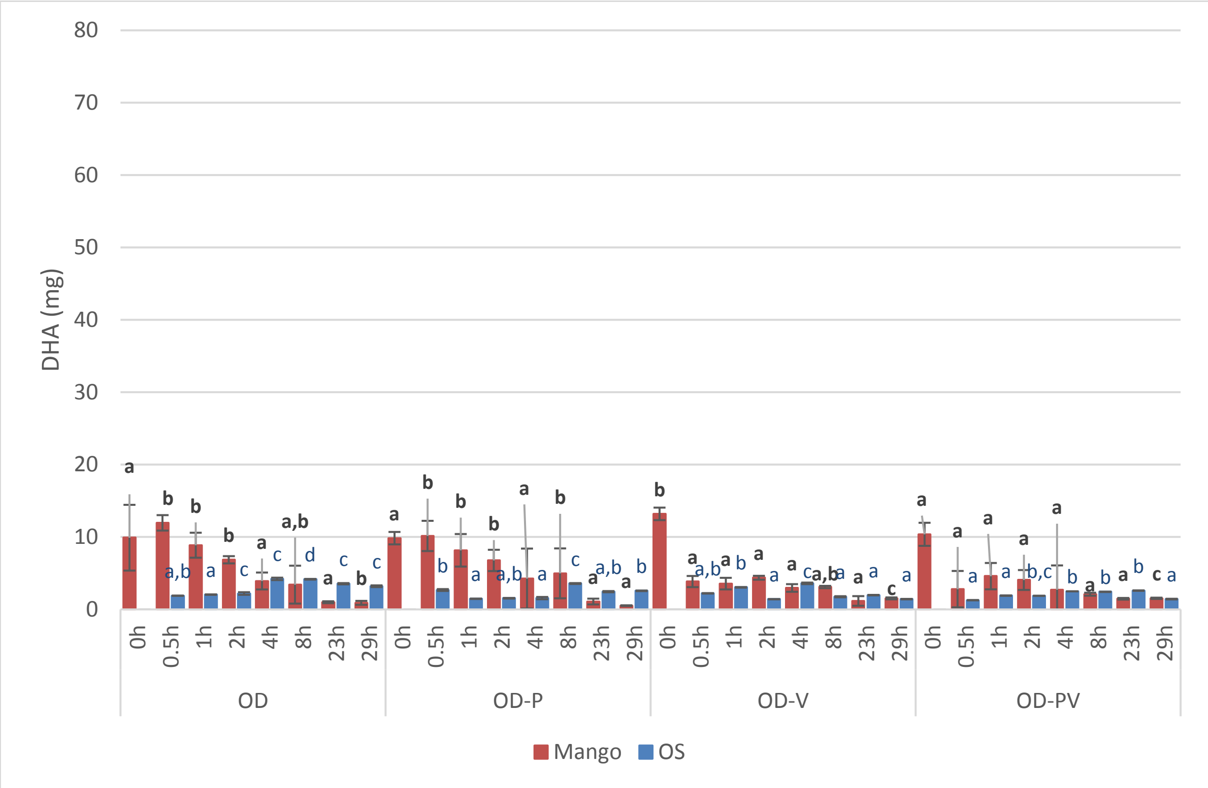

Figure 20. Dehydroascorbic acid content (mg) of mango and OS with different treatment and time Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

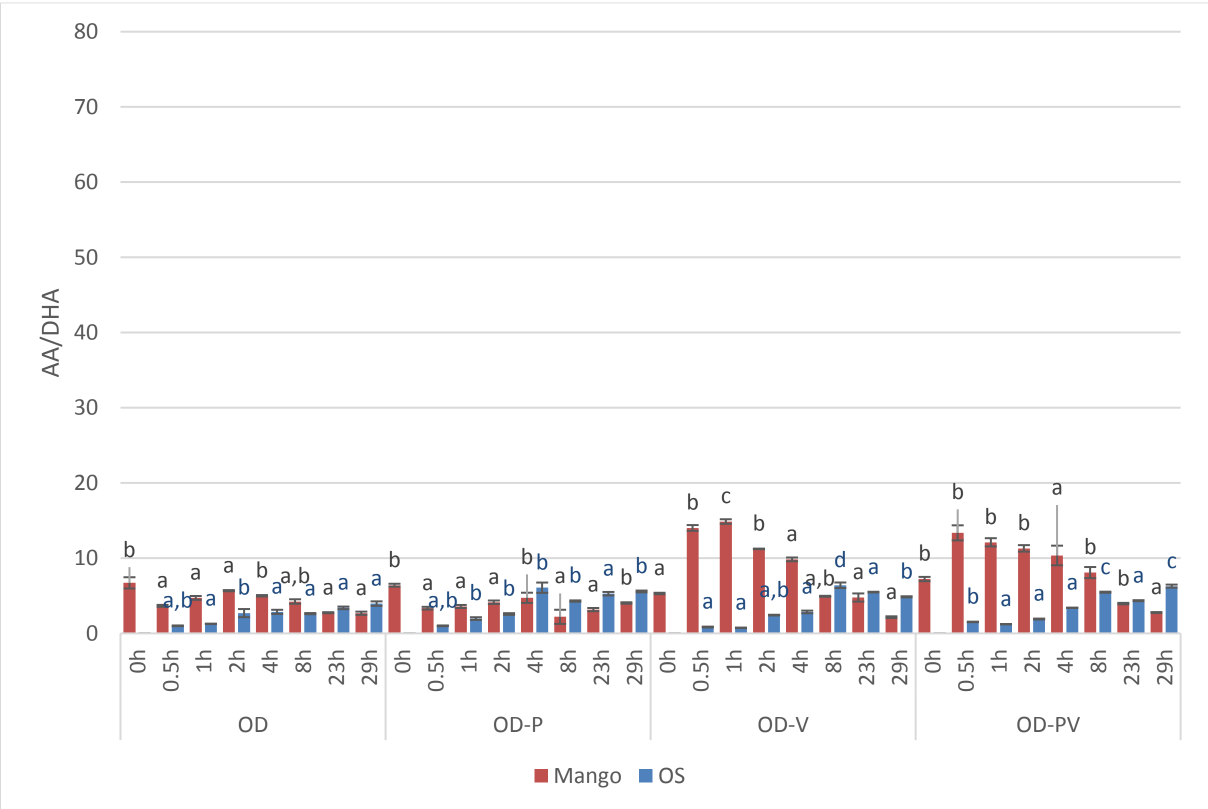

Figure 21. AA/DHA ratio of mango and OS with different treatment and time Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

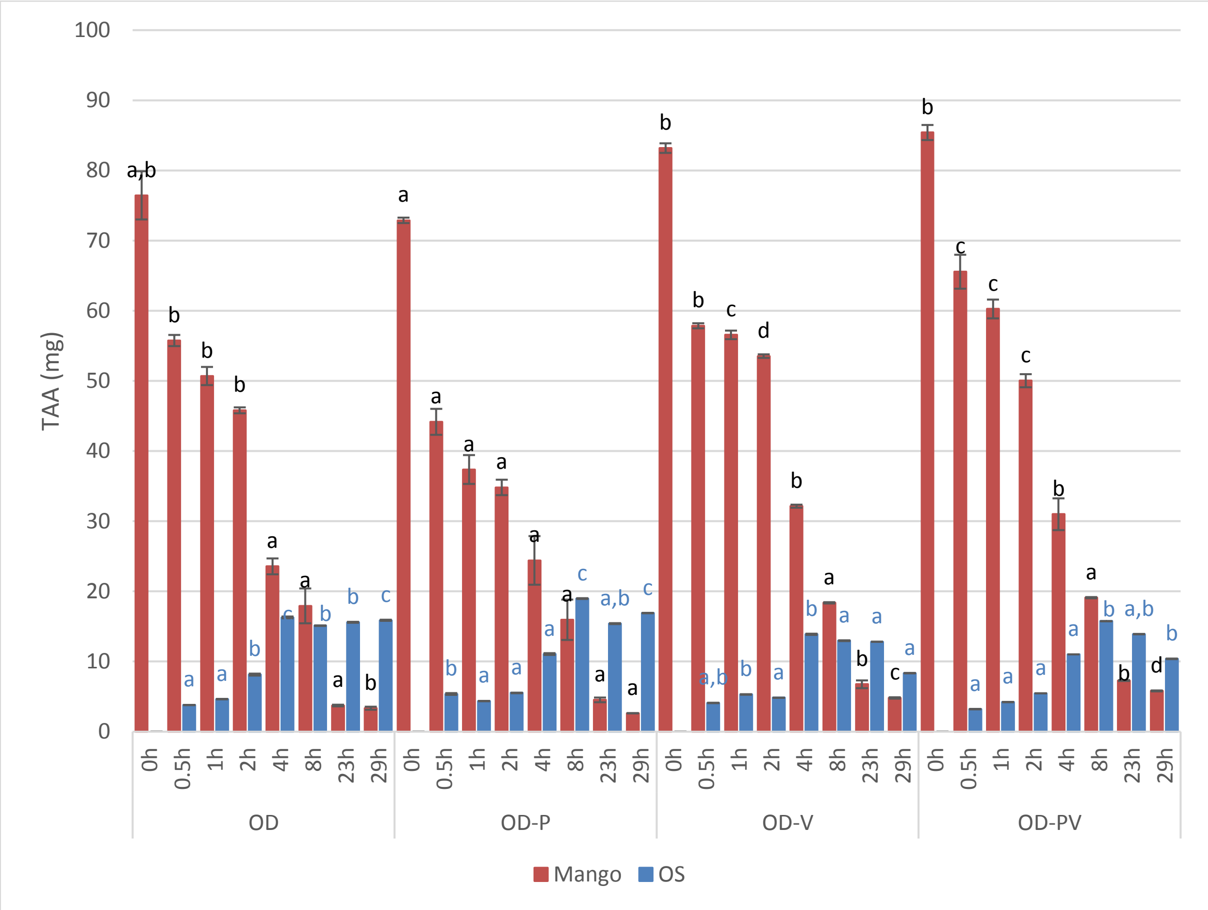

Figure 22. Total ascorbic acid content (mg) in mango and OS with different treatment and time Mean values with different small letters are significantly different (P≤0.05) among different treatment at the same time point.

Since 2h was considered as sufficient immersion time for OD process (Raoult-Wack 1994, Silva et al. 2014), the AA and DHA content between samples at first 2h was compared. Mango sample with VI pre-treatment showed significantly higher (P≤0.05) AA retention at first 2h immersion time compared to untreated OD sample. AA loss in OD-V sample and OD sample after 2h immersion time were 29,8% and 41,5% respectively. Study of cherry tomatoes (An et al. 2013) has shown similar result, with 2.26 times higher retention of vitamin C in samples exposed to pulsed vacuum process. It was also reported that the application of pulsed vacuum could increase the infusion of sugar solute and drive off the gas inside food tissue, which made the food product isolated from air, reducing the oxidation of vitamin C (An et al. 2013). However, according to water loss and solid gain data, there were no significance differences (P>0.05) between water loss and solid gain of OD sample with VI pre-treatment and those of untreated OD sample at first 2h. It showed a possibility that the AA content was mainly affected by degradation process rather than leaching process. The DHA content in OD-V sample was significantly lower (P≤0.05) than in OD sample. It gave significantly higher AA/DHA ratio in OD-V sample rather than OD sample. An increase in immersion time was followed by decrease in AA/DHA ratio in OD-V sample.

Compared to untreated OD sample, sample with added PME indicated significantly lower (P≤0.05) AA retention at the first 2h. Higher AA loss in OD-P mango at 2h was in line with its higher water loss. AA loss at first 2h in OD-P sample was 55.5%, higher than AA loss in OD sample (41.5%). The other study by Kong (2017), found a higher amount of TAA loss for mango with PME addition at 2h, which was 60%. The difference might due to difference in maturity stage of mango. Nevertheless, the addition of PME had no significant effects (P>0.05) on DHA content and AA/DHA ratio at first 2h compared to untreated OD sample. This result was in contrast with the expected result, which was the addition of PME would contribute in better retention of AA. It might be due to the insufficient amount of PME added into the OS.

Furthermore, the mango sample with combination of VI and PME treatment gave significantly higher (P≤0.05) AA retention than OD sample at the first 2h. This result was correlated with lower water loss and pH of OD-PV samples than OD sample at 2h. However, OD-V sample showed significantly higher vitamin C retention than OD-PV sample at 2h. Besides that, the DHA content and AA/DHA ratio of OD-PV samples did not have any significant differences (P>0.05) with those of OD-V samples. Therefore, it could be implied that applying only pretreatment of VI was already sufficient for reducing TAA loss at 2h OD time.

In whole process, the average of AA loss from mango was approximately 65.6 mg, whereas the average of highest AA content found in OS was 12.9 mg. It means the rest of it (approximately 80% of AA loss) was lost due to degradation. Longer immersion time to 4h caused AA loss to 65% of the initial content, as much as 95% of AA was lost at 29h immersion time. Due to relatively low amount and scattered data of DHA, it was not considered for vitamin C model. The same decision was also made by other authors (Santos and Silva 2008, Lee and Kader 2000).

5.5.2 Kinetic modelling

Multiresponse modelling was conducted to develop a functional tool to predict the TAA and AA degradation as well as leaching kinetics in mango sample and OS exposed to four different treatments (OD, OD-P, OD-V, OD-PV). Changes of TAA and AA concentration over time were monitored at 50°C. Time versus concentration plots of TAA and AA in mango and OS were given in Figure 22. It was observed that the TAA and AA data points were close to predictive value. The residuals appeared to behave randomly, which suggested that the model fits the data well. It was also supported by the R-squared values which were close to 1.

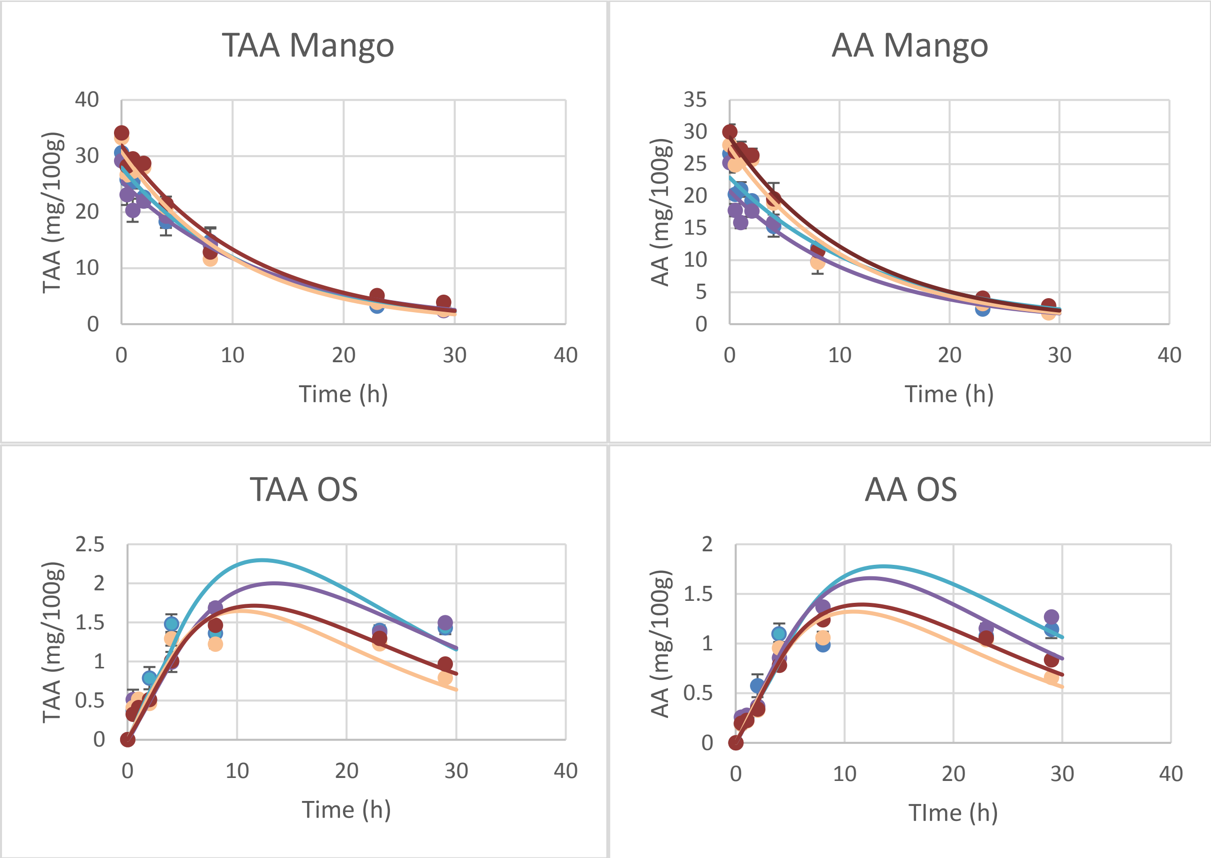

Figure 23. Model fit (lines) to experimental data (symbols) of TAA and AA in mango and OS for OD (● ; —), OD-P (● ; —), OD-V (● ; —), and OD-PV (● ; —)

The leaching and degradation rate constants was summarized in Table 4. The degradation rate of TAA and AA were much higher than the leaching rate. It was supported by the data of TAA and AA loss given before, in which approximately 75% of TAA and 80% AA loss were due to degradation and the rest were due to leaching. It could be implied that the vitamin C loss was mostly caused by degradation.

Based on the chart presented in Figure 24, it was observed that there were no significant effects of different treatment to the leaching and degradation rate of TAA and AA due to high standard deviation on each parameter. The average leaching rate constant and degradation rate constant were 0.002/h and 0.082/h respectively. Hiwilepo-van Hal et al. (2012) reported degradation rate of ascorbic acid in mango at 100°C was 0.13/min. Other study on strawberry showed degradation rate constant of vitamin C at 50°C was 0.00024/min (Gamboa-Santos et al. 2014).

Table 4. Leaching and degradation rate constants of TAA and AA

	TAA				AA			
	k ($h^{-1}x10^{-3}$)				k ($h^{-1}x10^{-3}$)			
Mechanism	**OD**	**OD-P**	**OD-V**	**OD-PV**	**OD**	**OD-P**	**OD-V**	**OD-PV**
Leaching	2.59 ± 1.22	2.02 ± 1.65	2.27 ± 1.99	1.92 ± 1.42	2.16 ± 1.91	2.26 ± 1.93	1.94 ± 1.76	1.70 ± 1.11
Degradation	80.99 ± 7.47	74.06 ± 11.57	91.73 ± 11.81	83.35 ± 8.98	73.15 ± 12.12	80.53 ± 13.32	88.22 ± 1.64	84.16 ± 7.20

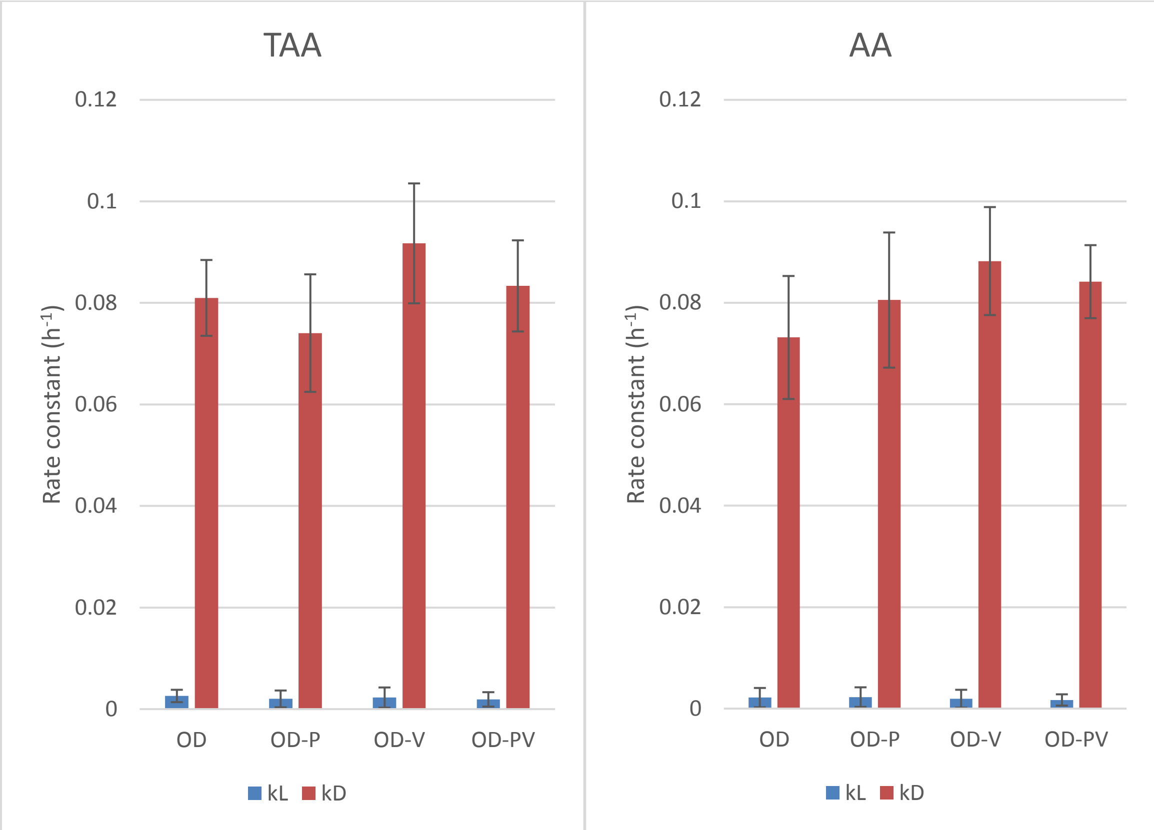

Figure 24. Leaching and degradation rate constants of TAA and AA

Degradation mechanism of vitamin C was specific to a certain system, as it depended on several factors (Tannenbaum 1976). According to the study of Gamboa-Santos et al. (2014), a higher degradation rate constant of vitamin C in strawberry at 50°C was observed compared to degradation rate constant at 40°C. Study by Eison-Perchonok and Downes (1982) reported that ascorbic acid autoxidation was influenced by dissolved oxygen concentration. Research on jujube fruit found that AA degradation might be favored by continuous fluorescence light condition even if at low temperatures (15-35°C) (Jiang et al. 2014). In addition, a decrease in ascorbic acid content with increasing heating time (30-240 min) at 80°C was also found (Hiwilepo-van Hal et al. 2012). In this study, temperature, time, dissolved oxygen concentration, and light might affect vitamin C degradation. Further research is needed to investigate this effect in more details.

6. Conclusion

In this research, the leaching and degradation kinetics of vitamin C in mango and its osmotic solution during OD was studied. The effect of PME addition and VI pre-treatment were also analysed. AA, DHA, and TAA content in fresh mango (0h) sample was, on average, 27.5 mg/100 g mango, 4 mg/100 g mango, and 31.8 mg/100 g mango, respectively. The amount of AA and TAA continually decreased with increasing immersion time. The changes in TAA showed a similar trend with the changes in AA, due to low level of DHA.

Compared to untreated OD sample at 2h, mango sample with VI pre-treatment gave significantly higher (P≤0.05) AA retention, lower DHA content, and higher AA/DHA ratio. AA

loss in OD-V sample and OD sample after 2h immersion time were 29,8% and 41,5% respectively. As there were no significance differences (P>0.05) between water loss and solid gain of OD sample with VI pre-treatment and those of untreated OD sample at first 2h, there was a possibility that the AA content was mainly affected by degradation process rather than leaching process.
Sample with added PME indicated significantly lower (P≤0.05) AA retention at the first 2h. AA loss at first 2h in OD-P sample was 55.5%, higher than AA loss in OD sample (41.5%). The addition of PME had no significant effects (P>0.05) on DHA content and AA/DHA ratio at first 2h compared to untreated OD sample.
OD-V sample showed significantly higher vitamin C retention than OD-PV sample at 2h. Besides that, the DHA content and AA/DHA ratio of OD-PV samples did not have any significant differences (P>0.05) with those of OD-V samples. Therefore, it could be implied that applying only pretreatment of VI was already sufficient for reducing TAA loss at 2h OD time.
The model proposed fits the TAA and AA data well. The residuals appeared to behave randomly and the R-squared values which were close to 1. Due to relatively low amount of DHA, it was not considered for vitamin C model. The degradation rate of TAA and AA were much higher than the leaching rate, supported by the data that described 75% of TAA and 80% AA loss were due to degradation. There were no significant effects (P>0.05) of different treatment to the leaching and degradation rate of TAA and AA due to high standard deviation on each parameters. The average leaching rate constant and degradation rate constant were 0.002/h and 0.082/h respectively.

7. Recommendation

- Other materials could be used to replace metal plates used in OD experiment. Some mango cubes could stick to the metal plates during process and more shrinkage was observed.
- Additional peaks were detected near ascorbic acid peak in chromatogram along with increase in weight of OD mango sample used for HPLC analysis. It is suggested to find out the cause of the unknown peaks and eliminate it for more accurate result.
- Optimization of PME dosage and VI pre-treatment might be carried out to obtain significant effect on result.
- Since vitamin C loss was mainly caused by degradation, further investigation might be performed to find out the factors that cause degradation of vitamin C. Subsequently, treatments for reducing degradation rate of vitamin C during osmotic dehydration could be applied.

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APPENDICES

Appendix 1. Firmness of mangoes

Firmness of mango for OD treatment

		Firmness (lb)					
No.	Weight (g)	1	2	3	4	Average	SD
1	687,40	9,00	7,50	6,00	5,50	7,00	1,58
2	777,40	5,50	6,00	6,50	4,00	5,50	1,08
3	789,10	5,00	6,00	5,50	5,50	5,50	0,41
4	652,30	4,00	4,00	5,50	8,00	5,38	1,89
5	591,75	7,00	6,00	7,00	7,20	6,80	0,54
6	823,60	6,00	7,00	6,00	9,00	7,00	1,41
7	672,90	8,00	8,00	8,00	8,00	8,00	0,00
8	646,00	5,50	5,00	8,00	7,00	6,38	1,38
9	653,30	5,00	6,00	7,00	7,00	6,25	0,96
10	673,30	7,50	6,00	6,00	6,50	6,50	0,71
11	673,20	9,50	10,00	9,00	9,00	9,38	0,48
12	796,20	5,00	5,50	6,50	6,50	5,88	0,75
13	620,70	7,00	8,50	9,00	10,00	8,63	1,25
14	734,30	6,00	9,00	6,50	7,50	7,25	1,32
15	626,00	8,00	9,00	9,00	8,00	8,50	0,58
16	653,80	7,50	7,50	8,50	7,00	7,63	0,63
17	625,90	6,00	6,50	7,00	5,00	6,13	0,85
18	584,60	8,50	7,50	6,50	8,50	7,75	0,96
19	638,20	9,00	9,50	9,00	8,00	8,88	0,63
20	748,90	10,00	9,00	8,00	9,00	9,00	0,82
21	649,10	6,00	6,00	8,00	8,50	7,13	1,31

Firmness of mango for OD with PME treatment

		Firmness (lb)					
No.	Weight (g)	1	2	3	4	Average	SD
1	686,10	9,00	9,00	9,50	10,50	9,50	0,71
2	605,50	12,00	9,00	8,00	9,50	9,63	1,70
3	666,10	7,00	6,50	5,00	5,00	5,88	1,03
4	690,80	9,00	10,00	9,00	9,50	9,38	0,48
5	620,10	4,50	5,00	7,00	8,00	6,13	1,65
6	624,30	9,00	8,50	8,00	8,00	8,38	0,48
7	671,20	9,00	11,00	9,00	8,00	9,25	1,26
8	658,70	8,00	6,00	8,00	5,50	6,88	1,31
9	653,50	7,00	8,00	7,50	5,50	7,00	1,08
10	716,20	7,00	6,00	6,00	6,00	6,25	0,50
11	626,40	9,00	8,00	6,50	6,00	7,38	1,38
12	854,20	9,00	10,00	8,50	10,00	9,38	0,75
13	657,60	5,00	4,00	4,50	5,00	4,63	0,48
14	642,60	4,50	5,50	6,00	8,00	6,00	1,47
15	601,70	6,00	5,50	6,00	8,00	6,38	1,11
16	716,10	5,00	6,00	7,00	6,00	6,00	0,82
17	524,10	5,00	6,00	7,00	6,50	6,13	0,85
18	675,50	8,50	6,00	7,00	6,50	7,00	1,08
19	751,90	5,00	6,00	6,50	6,00	5,88	0,63
20	806,20	5,50	6,50	7,00	8,50	6,88	1,25
21	790,40	6,00	4,50	5,00	7,00	5,63	1,11

Firmness of mango for OD with VI pre-treatment

		Firmness (lb)					
No.	Weight (g)	1	2	3	4	Average	SD
1	742,80	8,00	8,00	8,00	7,50	7,88	0,25
2	602,70	4,50	6,00	5,50	6,50	5,63	0,85
3	633,60	7,00	8,00	7,00	9,00	7,75	0,96
4	652,80	6,00	7,00	6,50	7,00	6,63	0,48
5	794,40	4,50	5,50	6,00	6,00	5,50	0,71
6	634,50	4,50	7,00	6,50	7,00	6,25	1,19
7	589,60	6,50	7,00	7,00	7,00	6,88	0,25
8	673,30	5,50	4,00	4,00	5,50	4,75	0,87
9	789,00	5,50	6,00	5,50	5,50	5,63	0,25
10	648,50	6,50	6,00	5,00	6,00	5,88	0,63
11	617,60	3,00	4,50	5,50	4,00	4,25	1,04
12	640,70	6,00	6,50	6,50	6,00	6,25	0,29
13	642,70	6,50	5,50	5,50	6,00	5,88	0,48
14	777,90	5,50	5,50	5,00	6,00	5,50	0,41
15	600,50	5,50	7,00	5,00	7,00	6,13	1,03
16	757,60	5,00	6,00	5,00	5,00	5,25	0,50
17	621,40	5,50	6,00	5,00	7,00	5,88	0,85
18	600,00	5,50	5,50	6,00	6,00	5,75	0,29
19	723,10	5,00	6,50	6,50	7,00	6,25	0,87
20	634,20	4,50	6,00	5,50	4,50	5,13	0,75
21	604,40	5,00	6,00	6,00	6,50	5,88	0,63
22	700,20	7,50	6,00	6,50	7,50	6,88	0,75

Firmness of mango for OD with VI and PME treatment

		Firmness (lb)					
No.	Weight (g)	1	2	3	4	Average	SD
1	823,70	6,00	7,50	7,50	7,00	7,00	0,71
2	642,60	8,00	9,00	7,50	7,00	7,88	0,85
3	643,50	5,50	6,00	6,00	5,00	5,63	0,48
4	774,00	5,50	5,00	5,00	6,50	5,50	0,71
5	692,90	4,00	4,50	2,00	3,00	3,38	1,11
6	755,80	5,00	6,00	5,50	5,00	5,38	0,48
7	599,04	5,00	5,50	4,00	4,00	4,63	0,75
8	713,70	5,00	5,50	6,50	5,00	5,50	0,71
9	837,70	4,50	4,50	3,00	2,50	3,63	1,03
10	577,33	5,00	5,50	6,00	5,50	5,50	0,41
11	665,30	6,00	8,00	5,00	6,50	6,38	1,25
12	720,90	5,00	5,50	6,50	5,50	5,63	0,63
13	763,20	5,00	5,50	6,00	5,00	5,38	0,48
14	687,90	5,50	5,00	4,50	4,50	4,88	0,48
15	652,80	5,50	4,50	6,00	5,00	5,25	0,65
16	586,65	6,00	7,50	5,50	6,00	6,25	0,87
17	653,70	7,00	7,00	6,50	6,50	6,75	0,29
18	760,70	7,00	7,00	5,50	6,50	6,50	0,71
19	642,60	6,00	5,00	5,00	6,50	5,63	0,75
20	768,00	6,50	7,00	7,00	6,50	6,75	0,29
21	669,80	4,50	4,00	3,00	3,50	3,75	0,65
22	612,60	7,00	6,50	9,00	7,50	7,50	1,08
23	615,80	6,00	5,50	5,00	5,00	5,38	0,48
24	582,15	5,00	6,50	5,00	7,50	6,00	1,22

Appendix 2. Weight change of mango cubes (MC) and OS

Weight change of mango and OS in OD treatment

	MC		OS	
Sample (h)	Weight in (g)	Weight out (g)	Weight in (g)	Weight out (g)
0,5	251,18	217,25	1004,70	1022,40
1	251,13	199,87	1004,65	1043,40
2	251,10	202,89	1004,35	1037,40
4	250,51	128,99	1002,05	1104,40
8	250,81	121,65	1003,24	1113,80
23	250,73	116,04	1002,90	1119,70
29	251,67	119,55	1006,68	1118,40

Weight change of mango and OS in OD with PME treatment

	MC		OS	
Sample (h)	Weight in (g)	Weight out (g)	Weight in (g)	Weight out (g)
0,5	250,61	191,57	1002,44	1050,40
1	250,67	184,53	1002,68	1047,05
2	250,77	158,99	1003,08	1083,10
4	250,67	126,88	1002,68	1115,55
8	257,28	115,74	1029,12	1158,80
23	255,89	109,95	1023,56	1152,40
29	260,07	112,28	1040,28	1176,50

Weight change of mango and OS in OD with VI pre-treatment

	MC		OS	
Sample (h)	Weight in (g)	Weight out (g)	Weight in (g)	Weight out (g)
0,5	251,78	218,55	1007,12	1004,10
1	250,41	207,52	1001,64	1024,85
2	250,86	191,86	1003,44	1041,50
4	251,51	155,21	1006,04	1081,60
8	250,24	157,83	1000,96	1060,90
23	251,87	173,71	1007,48	1053,75
29	253,09	188,93	1012,36	1067,40

Weight change of mango and OS in OD with VI and PME treatment

	MC		OS	
Sample (h)	Weight in (g)	Weight out (g)	Weight in (g)	Weight out (g)
0,5	251,80	234,22	1007,20	995,70
1	250,57	204,66	1002,28	1033,80
2	250,32	174,36	1001,28	1064,90
4	251,44	145,23	1005,76	1097,10
8	251,85	149,40	1007,28	1082,85
23	250,79	142,83	1003,16	1075,10
29	253,38	150,47	1013,52	1087,80

Appendix 3. Total soluble solid (TSS) and water activity (Aw) of mango cubes (MC) and OS

TSS and Aw of mango and OS in OD treatment

	TSS Mango						TSS OS							
	°Brix						°Brix				Aw Mango			
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD	1	2	Average	SD
0	12,9	13,2	13,9	13,5	13,4	0,4	60,2	60,5	60,4	0,2	0,988	0,998	0,993	0,007
0,5	22,0	22,0	22,0	22,0	22,0	0,0	57	57,3	57,2	0,2	0,981	0,991	0,986	0,007
1	25,0	25,0	21,0	24,0	23,8	1,9	55,7	55,9	55,8	0,1	0,992	0,991	0,992	0,001
2	25,0	24,0	20,0	21,0	22,5	2,4	56,2	56,1	56,2	0,1	0,982	0,991	0,987	0,006
4	41,0	39,0	40,0	41,0	40,3	1,0	52,9	52,1	52,5	0,6	0,957	0,958	0,958	0,001
8	46,0	46,0	44,0	45,0	45,3	1,0	51,5	51,8	51,7	0,2	0,964	0,964	0,964	0,000
23	44,0	44,0	46,0	46,0	45,0	1,2	51,0	51,0	51,0	0,0	0,942	0,947	0,945	0,004
29	48,0	47,0	48,0	48,0	47,8	0,5	51,4	51,2	51,3	0,1	0,930	0,937	0,934	0,005

TSS and Aw of mango and OS in OD with PME treatment

	TSS Mango						TSS OS							
	°Brix						°Brix				Aw Mango			
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD	1	2	Average	SD
0	13,0	13,0	12,0	12,0	12,5	0,6	61,2	61	61,1	0,1	0,985	0,992	0,989	0,005
0,5	22,0	23,0	23,0	23,0	22,8	0,5	56,6	57,1	56,9	0,4	0,976	0,981	0,979	0,004
1	28,0	28,0	26,0	27,0	27,3	1,0	56,3	56,3	56,3	0,0	0,981	0,977	0,979	0,003
2	31,0	31,0	31,0	31,0	31,0	0,0	55,1	53,8	54,5	0,9	0,976	0,972	0,974	0,003
4	36,0	36,0	36,0	36,0	36,0	0,0	53,1	53,0	53,1	0,1	0,961	0,955	0,958	0,004
8	46,0	45,0	45,0	45,0	45,3	0,5	51,5	51,8	51,7	0,2	0,940	0,945	0,943	0,004
23	49,0	49,0	45,0	46,0	47,3	2,1	52,1	51,9	52,0	0,1	0,937	0,933	0,935	0,003
29	47,0	48,0	49,0	50,0	48,5	1,3	52,0	52,3	52,2	0,2	0,934	0,937	0,936	0,002

TSS and Aw of mango and OS in OD with VI pre-treatment

	TSS Mango						TSS OS							
	°Brix						°Brix				Aw Mango			
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD	1	2	Average	SD
0	13,0	13,0	15,0	14,0	13,8	1,0	61,3	60,9	61,1	0,3	0,986	0,993	0,990	0,005
0,5	17,0	17,0	20,0	20,0	18,5	1,7	58,6	58,1	58,4	0,4	0,982	0,984	0,983	0,001
1	22,0	22,0	24,0	24,0	23,0	1,2	57,5	57,1	57,3	0,3	0,982	0,980	0,981	0,001
2	26,0	26,0	25,0	25,0	25,5	0,6	56,1	55,9	56,0	0,1	0,975	0,977	0,976	0,001
4	39,0	39,0	39,0	38,0	38,8	0,5	53,4	52,8	53,1	0,4	0,963	0,959	0,961	0,003
8	43,0	43,0	44,0	43,0	43,3	0,5	51,1	51,8	51,5	0,5	0,938	0,938	0,938	0,000
23	47,0	47,0	45,0	44,0	45,8	1,5	52,2	52,1	52,2	0,1	0,930	0,939	0,935	0,006
29	46,0	45,0	44,0	44,0	44,8	1,0	51,9	52,0	52,0	0,1	0,944	0,934	0,939	0,007

TSS and Aw of mango and OS in OD with VI and PME treatment

	TSS Mango						TSS OS				Aw Mango			
	°Brix						°Brix							
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD	1	2	Average	SD
0	12,0	13,0	12,0	12,0	12,3	0,5	61,2	61,2	61,2	0,0	0,997	0,990	0,994	0,005
0,5	21,0	20,0	20,0	20,0	20,3	0,5	58,1	57,9	58,0	0,1	0,995	0,984	0,990	0,008
1	25,0	25,0	23,0	22,0	23,8	1,5	57,4	57,4	57,4	0,0	0,989	0,980	0,985	0,006
2	29,0	31,0	30,0	29,0	29,8	1,0	55,0	55,5	55,3	0,4	0,977	0,977	0,977	0,000
4	41,0	40,0	42,0	42,0	41,3	1,0	53,1	53,4	53,3	0,2	0,969	0,955	0,962	0,010
8	49,0	48,0	48,0	48,0	48,3	0,5	52,1	52,3	52,2	0,1	0,942	0,936	0,939	0,004
23	46,0	46,0	47,0	47,0	46,5	0,6	52,5	52,4	52,5	0,1	0,943	0,930	0,937	0,009
29	45,0	44,0	44,0	44,0	44,3	0,5	51,8	51,9	51,9	0,1	0,924	0,930	0,927	0,004

Appendix 4. pH of mango cubes (MC) and OS

pH of mango and OS in OD treatment

	pH Mango						pH OS			
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD
0	3,850	3,890	3,930	3,945	3,904	0,043	6,811	6,895	6,853	0,059
0,5	4,061	4,049	4,092	4,074	4,069	0,018	5,183	5,195	5,189	0,008
1	4,036	4,022	3,962	3,902	3,981	0,061	5,028	5,036	5,032	0,006
2	4,042	4,067	4,056	4,081	4,062	0,017	4,885	4,882	4,884	0,002
4	4,251	4,249	4,250	4,252	4,251	0,001	4,513	4,529	4,521	0,011
8	4,374	4,369	4,376	4,378	4,374	0,004	4,424	4,430	4,427	0,004
23	4,868	4,840	4,860	4,932	4,875	0,040	4,223	4,240	4,232	0,012
29	4,931	4,935	4,883	4,877	4,907	0,031	4,261	4,267	4,264	0,004

pH of mango and OS in OD with PME treatment

	pH Mango						pH OS			
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD
0	5,529	5,422	5,353	5,006	5,328	0,226	6,744	6,786	6,765	0,030
0,5	5,057	5,023	5,049	4,977	5,027	0,036	4,890	4,892	4,891	0,001
1	4,989	4,937	4,843	4,894	4,916	0,062	4,967	4,968	4,968	0,001
2	4,920	4,928	4,894	4,909	4,913	0,015	4,756	4,755	4,756	0,001
4	4,844	4,889	4,819	4,830	4,846	0,031	4,548	4,549	4,549	0,001
8	4,781	4,833	4,778	4,783	4,794	0,026	4,350	4,360	4,355	0,007
23	4,780	4,791	4,779	4,779	4,782	0,006	4,257	4,246	4,252	0,008
29	4,816	4,792	4,783	4,792	4,796	0,014	4,250	4,254	4,252	0,003

pH of mango and OS in OD with VI pre-treatment

	pH Mango						pH OS			
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD
0	4,128	4,105	4,060	4,076	4,092	0,030	6,857	6,818	6,838	0,028
0,5	4,116	4,124	4,213	4,237	4,173	0,061	5,253	5,253	5,253	0,000
1	4,216	4,208	4,210	4,213	4,212	0,004	5,085	5,074	5,080	0,008
2	4,168	4,161	4,186	4,190	4,176	0,014	4,937	4,937	4,937	0,000
4	4,266	4,254	4,174	4,170	4,216	0,051	4,564	4,567	4,566	0,002
8	4,423	4,423	4,543	4,560	4,487	0,075	4,367	4,364	4,366	0,002
23	4,901	4,937	4,973	4,973	4,946	0,034	4,276	4,290	4,283	0,010
29	5,128	5,126	5,199	5,213	5,167	0,046	4,244	4,233	4,239	0,008

pH of mango and OS in OD with VI and PME treatment

	pH Mango						pH OS			
Sample (h)	1A	1B	2A	2B	Average	SD	1	2	Average	SD
0	4,039	3,933	3,838	3,845	3,914	0,094	6,935	6,937	6,936	0,001
0,5	3,852	3,844	3,896	3,892	3,871	0,027	5,265	5,271	5,268	0,004
1	3,962	3,987	3,830	3,816	3,899	0,088	4,992	5,000	4,996	0,006
2	3,995	3,985	4,039	4,034	4,013	0,027	4,801	4,788	4,795	0,009
4	3,999	3,986	4,282	4,295	4,141	0,171	4,490	4,489	4,490	0,001
8	4,530	4,525	4,526	4,522	4,526	0,003	4,322	4,323	4,323	0,001
23	4,720	4,716	4,670	4,662	4,692	0,030	4,144	4,143	4,144	0,001
29	5,060	4,999	5,017	5,013	5,022	0,026	4,149	4,139	4,144	0,007

Appendix 5. Total titratable acidity (TTA) of mango cubes (MC)

TTA of fresh mango for OD treatment

	TTA		Citric acid				Sugar/Acid Ratio			
	mL		%				(Brix/% CA)			
Sample (h)	1	2	1	2	Average	SD	1	2	Average	SD
0	9,52	10,40	0,61	0,67	0,64	0,04	21,95	20,09	21,02	1,31

TTA of fresh mango for OD with PME treatment

	TTA		Citric acid				Sugar/Acid Ratio			
	mL		%				(Brix/% CA)			
Sample (h)	1	2	1	2	Average	SD	1	2	Average	SD
0	12,58	12,08	0,81	0,77	0,79	0,02	15,53	16,17	15,85	0,45

TTA of fresh mango for OD with VI pre-treatment

	TTA		Citric acid				Sugar/Acid Ratio			
	mL		%				(Brix/% CA)			
Sample (h)	1	2	1	2	Average	SD	1	2	Average	SD
0	9,41	9,61	0,60	0,62	0,61	0,01	22,83	22,36	22,59	0,34

TTA of fresh mango for OD with VI and PME treatment

	TTA		Citric acid				Sugar/Acid Ratio			
	mL		%				(Brix/% CA)			
Sample (h)	1	2	1	2	Average	SD	1	2	Average	SD
0	10,70	11,68	0,68	0,75	0,72	0,04	17,89	16,39	17,14	1,06

Appendix 6. Pectin esterase unit (PEU) of mango cubes (MC)

PEU of mango in OD treatment

	PEU Mango											
	N NaOH		mL NaOH		mL sample		minutes		PEU			
Sample (h)	1	2	1	2	1	2	1	2	1	2	Average	SD
0	0,05	0,05	0,1	0,1	4	4	19,55	19,05	6,39386E-05	6,5617E-05	**6,4778E-05**	**1,1867E-06**
0,5	0,05	0,05	0,2	0,1	4	4	45,43	20,50	5,50257E-05	6,0976E-05	**5,8001E-05**	**4,2072E-06**
1												
2												
4												
8												
23												
29	0,05	0,05	0,1	0,1	4	4	9,40	9,07	0,000132979	0,00013787	**0,00013542**	**3,457E-06**

PEU of mango in OD with PME treatment

	PEU Mango											
	N NaOH		mL NaOH		mL sample		minutes		PEU			
Sample (h)	1	2	1	2	1	2	1	2	1	2	Average	SD
0	0,05	0,05	0,1	0,1	4	4	21,92	24,55	5,70342E-05	5,092E-05	**5,398E-05**	**4,326E-06**
0,5	0,05	0,05	0,1	0,1	4	4	0,43	0,28	0,002884615	0,0044118	**0,0036482**	**0,0010799**
1												
2												
4												
8												
23												
29	0,05	0,05	0,2	0,1	4	4	1,12	0,40	0,002238806	0,003125	**0,0026819**	**0,0006266**

PEU of mango in OD with VI pre-treatment

	PEU Mango											
	N NaOH		mL NaOH		mL sample		minutes		PEU			
Sample (h)	1	2	1	2	1	2	1	2	1	2	Average	SD
0	0,05	0,05	0,1	0,1	4	4	21,18	21,53	5,90087E-05	5,805E-05	**5,853E-05**	**6,782E-07**
0,5	0,05	0,05	0,1	0,1	4	4	11,15	10,72	0,000112108	0,0001166	**0,0001144**	**3,205E-06**
1												
2												
4												
8												
23												
29	0,05	0,05	0,1	0,1	4	4	13,63	12,63	9,1687E-05	9,894E-05	**9,532E-05**	**5,132E-06**

PEU of mango in OD with VI and PME treatment

	PEU Mango											
	N NaOH		mL NaOH		mL sample		minutes		PEU			
Sample (h)	1	2	1	2	1	2	1	2	1	2	Average	SD
0	0,05	0,05	0,1	0,1	4	4	18,57	18,37	6,732E-05	6,806E-05	**6,769E-05**	**5,184E-07**
0,5	0,05	0,05	0,1	0,1	4	4	0,70	0,88	0,0017857	0,0014151	**0,0016004**	**0,0002621**
1												
2												
4												
8												
23												
29	0,05	0,05	0,2	0,2	4	4	1,18	1,08	0,0021127	0,0023077	**0,0022102**	**0,0001379**

Appendix 7. Dry matter content of mango cubes (MC) and OS

Dry matter content of mango in OD treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminiun (g		Weight sample (g)		Final Weight (g)		Fresh		Dry		Water content	
Sample (h	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2940	1,2940	1,1290	0,9850	1,4412	1,4155	1,1290	0,9850	0,1472	0,1215	0,9818	0,8635
0,5	1,2980	1,3030	1,1280	1,2590	1,5542	1,5750	1,1280	1,2590	0,2562	0,2720	0,8718	0,9870
1	1,3036	1,3050	0,9880	1,0550	1,5749	1,6198	0,9880	1,0550	0,2713	0,3148	0,7167	0,7402
2	1,2939	1,3127	1,0708	1,1016	1,5822	1,6188	1,0708	1,1016	0,2883	0,3061	0,7825	0,7955
4	1,3250	1,2946	0,9139	1,0146	1,7700	1,7787	0,9139	1,0146	0,4450	0,4841	0,4689	0,5305
8	1,3052	1,3130	1,0871	0,9719	1,8537	1,8123	1,0871	0,9719	0,5485	0,4993	0,5386	0,4726
23	1,2809	1,2831	1,3582	0,9476	2,0283	1,8068	1,3582	0,9476	0,7474	0,5237	0,6108	0,4239
29	1,2827	1,2820	1,1009	1,1817	1,9004	1,9521	1,1009	1,1817	0,6177	0,6701	0,4832	0,5116

Dry matter content of mango in OD treatment (2)

	Water/Fruit weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,870	0,877	86,96	87,66	13,04	12,34
0,5	0,773	0,784	77,29	78,40	22,71	21,60
1	0,725	0,702	72,54	70,16	27,46	29,84
2	0,731	0,722	73,08	72,21	26,92	27,79
4	0,513	0,523	51,31	52,29	48,69	47,71
8	0,495	0,486	49,54	48,63	50,46	51,37
23	0,450	0,447	44,97	44,73	55,03	55,27
29	0,439	0,433	43,89	43,29	56,11	56,71

Dry matter content of mango in OD with PME treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminium (g)		Weight sample (g)		Final Weight (g)		Fresh		Dry		Water content	
Sample (h)	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2877	1,2866	1,1074	1,1560	1,4310	1,4514	1,1074	1,1560	0,1433	0,1648	0,9641	0,9912
0,5	1,2867	1,2814	1,1000	1,2087	1,5644	1,5597	1,1000	1,2087	0,2777	0,2783	0,8223	0,9304
1	1,2789	1,2838	0,9672	1,0109	1,5606	1,5613	0,9672	1,0109	0,2817	0,2775	0,6855	0,7334
2	1,2855	1,2819	1,1322	0,9059	1,6272	1,5713	1,1322	0,9059	0,3417	0,2894	0,7905	0,6165
4	1,2836	1,2848	1,0320	0,8251	1,7480	1,6575	1,0320	0,8251	0,4644	0,3727	0,5676	0,4524
8	1,2730	1,2694	0,9480	0,9929	1,8032	1,7725	0,9480	0,9929	0,5302	0,5031	0,4178	0,4898
23	1,2757	1,2869	0,9803	1,1031	1,8287	1,9055	0,9803	1,1031	0,5530	0,6186	0,4273	0,4845
29	1,2772	1,2890	1,0436	0,9411	1,8644	1,8177	1,0436	0,9411	0,5872	0,5287	0,4564	0,4124

Dry matter content of mango in OD with PME treatment (2)

	Water/Fruit weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,871	0,857	87,06	85,74	12,94	14,26
0,5	0,748	0,770	74,75	76,98	25,25	23,02
1	0,709	0,725	70,87	72,55	29,13	27,45
2	0,698	0,681	69,82	68,05	30,18	31,95
4	0,550	0,548	55,00	54,83	45,00	45,17
8	0,441	0,493	44,07	49,33	55,93	50,67
23	0,436	0,439	43,59	43,92	56,41	56,08
29	0,437	0,438	43,73	43,82	56,27	56,18

Dry matter content of mango in OD with VI pre-treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminium (g)		Weight sample (g		Final Weight (g)		Fresh		Dry		Water content	
Sample (h)	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2774	1,2807	1,1920	1,3527	1,4627	1,4503	1,1920	1,3527	0,1853	0,1696	1,0067	1,1831
0,5	1,2765	1,2781	1,0543	0,9568	1,4889	1,4820	1,0543	0,9568	0,2124	0,2039	0,8419	0,7529
1	1,2849	1,2710	1,0682	1,2904	1,5731	1,6177	1,0682	1,2904	0,2882	0,3467	0,7800	0,9437
2	1,2835	1,2893	1,4560	1,3789	1,7364	1,6839	1,4560	1,3789	0,4529	0,3946	1,0031	0,9843
4	1,2894	1,2828	1,3179	1,2217	1,8345	1,7870	1,3179	1,2217	0,5451	0,5042	0,7728	0,7175
8	1,2759	1,2796	1,4263	1,3446	2,0490	2,0105	1,4263	1,3446	0,7731	0,7309	0,6532	0,6137
23	1,2703	1,2807	0,9990	0,8750	1,7067	1,6515	0,9990	0,8750	0,4364	0,3708	0,5626	0,5042
29	1,2857	1,2792	1,1650	1,2456	1,9596	1,9979	1,1650	1,2456	0,6739	0,7187	0,4911	0,5269

Dry matter content of mango in OD with VI pre-treatment (2)

	Water/Fruit weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,845	0,875	84,45	87,46	15,55	12,54
0,5	0,799	0,787	79,85	78,69	20,15	21,31
1	0,730	0,731	73,02	73,13	26,98	26,87
2	0,689	0,714	68,89	71,38	31,11	28,62
4	0,586	0,587	58,64	58,73	41,36	41,27
8	0,458	0,456	45,80	45,64	54,20	54,36
23	0,563	0,576	56,32	57,62	43,68	42,38
29	0,422	0,423	42,15	42,30	57,85	57,70

Dry matter content of mango in OD with VI and PME treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminiun (g)		Weight sample (g		Final Weight (g)		Fresh		Dry		Water content	
Sample (h)	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2800	1,2791	1,0987	1,5061	1,4543	1,5380	1,0987	1,5061	0,1743	0,2589	0,9244	1,2472
0,5	1,2885	1,2767	1,0268	1,1843	1,5658	1,5703	1,0268	1,1843	0,2773	0,2936	0,7495	0,8907
1	1,2858	1,2837	1,0819	0,9551	1,5323	1,5116	1,0819	0,9551	0,2465	0,2279	0,8354	0,7272
2	1,2866	1,2819	1,0641	1,1685	1,5970	1,6616	1,0641	1,1685	0,3104	0,3797	0,7537	0,7888
4	1,2912	1,2825	1,0119	1,2123	1,8587	1,9634	1,0119	1,2123	0,5675	0,6809	0,4444	0,5314
8	1,2836	1,2869	1,1008	1,0756	1,8667	1,8534	1,1008	1,0756	0,5831	0,5665	0,5177	0,5091
23	1,2876	1,2880	1,0070	1,1848	1,8503	1,9476	1,0070	1,1848	0,5627	0,6596	0,4443	0,5252
29	1,2766	1,2807	1,0691	1,2060	1,8797	1,9633	1,0691	1,2060	0,6031	0,6826	0,4660	0,5234

Dry matter content of mango in OD with VI and PME treatment (2)

	Water/Fruit weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,841	0,828	84,14	82,81	15,86	17,19
0,5	0,730	0,752	72,99	75,21	27,01	24,79
1	0,772	0,761	77,22	76,14	22,78	23,86
2	0,708	0,675	70,83	67,51	29,17	32,49
4	0,439	0,438	43,92	43,83	56,08	56,17
8	0,470	0,473	47,03	47,33	52,97	52,67
23	0,441	0,443	44,12	44,33	55,88	55,67
29	0,436	0,434	43,59	43,40	56,41	56,60

Dry matter content of OS in OD treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminiun (g		Weight sample (g)		Final Weight (g)		Fresh		Dry		Water content	
Sample (h	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2993	1,3126	2,0990	2,0939	2,6118	2,5863	2,0990	2,0939	1,3125	1,2737	0,7865	0,8202
0,5	1,2928	1,2902	2,0863	2,0849	2,5344	2,5347	2,0863	2,0849	1,2416	1,2445	0,8447	0,8404
1	1,3487	1,3044	2,0751	2,0255	2,5293	2,4698	2,0751	2,0255	1,1806	1,1654	0,8945	0,8601
2	1,3102	1,2899	2,0068	2,1344	2,4772	2,5286	2,0068	2,1344	1,1670	1,2387	0,8398	0,8957
4	1,3065	1,2937	2,0080	2,0200	2,3960	2,3887	2,0080	2,0200	1,0895	1,0950	0,9185	0,9250
8	1,2901	1,3119	2,0233	2,0242	2,3757	2,4063	2,0233	2,0242	1,0856	1,0944	0,9377	0,9298
23	1,2858	1,2881	1,9698	2,0052	2,3284	2,3475	1,9698	2,0052	1,0426	1,0594	0,9272	0,9458
29	1,2830	1,2868	2,0576	1,9892	2,3697	2,3434	2,0576	1,9892	1,0867	1,0566	0,9709	0,9326

Dry matter content of OS in OD treatment (2)

	Water/OS weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,375	0,392	37,47	39,17	62,53	60,83
0,5	0,405	0,403	40,49	40,31	59,51	59,69
1	0,431	0,425	43,11	42,46	56,89	57,54
2	0,418	0,420	41,85	41,96	58,15	58,04
4	0,457	0,458	45,74	45,79	54,26	54,21
8	0,463	0,459	46,35	45,93	53,65	54,07
23	0,471	0,472	47,07	47,17	52,93	52,83
29	0,472	0,469	47,19	46,88	52,81	53,12

Dry matter content of OS in OD with PME treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminium (g)		Weight sample (g)		Final Weight (g)		Fresh		Dry		Water content	
Sample (h)	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2818	1,2862	2,2011	2,0926	2,6324	2,5838	2,2011	2,0926	1,3506	1,2976	0,8505	0,7950
0,5	1,2792	1,2822	2,0763	2,0406	2,4747	2,4861	2,0763	2,0406	1,1955	1,2039	0,8808	0,8367
1	1,2785	1,2872	2,0094	2,1590	2,4466	2,5405	2,0094	2,1590	1,1681	1,2533	0,8413	0,9057
2	1,2828	1,2878	2,0480	2,1367	2,4492	2,5056	2,0480	2,1367	1,1664	1,2178	0,8816	0,9189
4	1,2785	1,2778	2,1674	2,0927	2,4621	2,4166	2,1674	2,0927	1,1836	1,1388	0,9838	0,9539
8	1,2815	1,2814	1,9018	1,8858	2,3064	2,3044	1,9018	1,8858	1,0249	1,0230	0,8769	0,8628
23	1,2850	1,2893	1,8746	1,9166	2,2884	2,3183	1,8746	1,9166	1,0034	1,0290	0,8712	0,8876
29	1,2856	1,2898	1,8515	1,8649	2,2754	2,2862	1,8515	1,8649	0,9898	0,9964	0,8617	0,8685

Dry matter content of OS in OD with PME treatment (2)

	Water/OS weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,386	0,380	38,64	37,99	61,36	62,01
0,5	0,424	0,410	42,42	41,00	57,58	59,00
1	0,419	0,419	41,87	41,95	58,13	58,05
2	0,430	0,430	43,05	43,01	56,95	56,99
4	0,454	0,456	45,39	45,58	54,61	54,42
8	0,461	0,458	46,11	45,75	53,89	54,25
23	0,465	0,463	46,47	46,31	53,53	53,69
29	0,465	0,466	46,54	46,57	53,46	53,43

Dry matter content of OS in OD with VI pre-treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminiun (g)		Weight sample (g		Final Weight (g)		Fresh		Dry		Water content	
Sample (h)	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2901	1,2824	1,9273	1,7526	2,5170	2,3744	1,9273	1,7526	1,2269	1,0920	0,7004	0,6606
0,5	1,2784	1,2806	1,8009	1,8661	2,4146	2,4266	1,8009	1,8661	1,1362	1,1460	0,6647	0,7201
1	1,2830	1,2746	1,8747	1,8218	2,3889	2,3437	1,8747	1,8218	1,1059	1,0691	0,7688	0,7527
2	1,2830	1,2784	2,0871	1,8405	2,4815	2,3490	2,0871	1,8405	1,1985	1,0706	0,8886	0,7699
4	1,2799	1,2791	2,0749	1,8978	2,4225	2,3241	2,0749	1,8978	1,1426	1,0450	0,9323	0,8528
8	1,2811	1,2820	1,8791	1,9070	2,2970	2,3150	1,8791	1,9070	1,0159	1,0330	0,8632	0,8740
23	1,2839	1,2822	1,8730	1,8792	2,2897	2,2912	1,8730	1,8792	1,0058	1,0090	0,8672	0,8702
29	1,2801	1,2777	1,9694	2,0085	2,3366	2,3529	1,9694	2,0085	1,0565	1,0752	0,9129	0,9333

Dry matter content of OS in OD with VI pre-treatment (2)

	Water/OS weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,363	0,377	36,34	37,69	63,66	62,31
0,5	0,369	0,386	36,91	38,59	63,09	61,41
1	0,410	0,413	41,01	41,32	58,99	58,68
2	0,426	0,418	42,58	41,83	57,42	58,17
4	0,449	0,449	44,93	44,94	55,07	55,06
8	0,459	0,458	45,94	45,83	54,06	54,17
23	0,463	0,463	46,30	46,31	53,70	53,69
29	0,464	0,465	46,35	46,47	53,65	53,53

Dry matter content of OS in OD with VI and PME treatment (1)

	Dry Matter						Weight (g)					
	Weight aluminiun (g)		Weight sample (g		Final Weight (g)		Fresh		Dry		Water content	
Sample (h)	1	2	1	2	1	2	1	2	1	2	1	2
0	1,2884	1,2780	1,8834	2,0406	2,4903	2,5843	1,8834	2,0406	1,2019	1,3063	0,6815	0,7343
0,5	1,2920	1,2754	2,0660	1,9774	2,5232	2,4936	2,0660	1,9774	1,2312	1,2182	0,8348	0,7592
1	1,2819	1,2648	1,7942	1,8550	2,3415	2,3658	1,7942	1,8550	1,0596	1,1010	0,7346	0,7540
2	1,2876	1,2841	1,9992	1,8601	2,4327	2,3408	1,9992	1,8601	1,1451	1,0567	0,8541	0,8034
4	1,2885	1,2856	1,9005	1,8964	2,3373	2,3258	1,9005	1,8964	1,0488	1,0402	0,8517	0,8562
8	1,2788	1,2818	1,9013	2,0940	2,2910	2,3997	1,9013	2,0940	1,0122	1,1179	0,8891	0,9761
23	1,2795	1,2762	2,1118	2,0671	2,4121	2,3854	2,1118	2,0671	1,1326	1,1092	0,9792	0,9579
29	1,2903	1,2940	1,9157	1,8616	2,3153	2,2751	1,9157	1,8616	1,0250	0,9811	0,8907	0,8805

Dry matter content of OS in OD with VI and PME treatment (2)

	Water/OS weight Ratio		Water Content (%)		Dry Matter (%)	
Sample (h)	1	2	1	2	1	2
0	0,362	0,360	36,18	35,98	63,82	64,02
0,5	0,404	0,384	40,41	38,39	59,59	61,61
1	0,409	0,406	40,94	40,65	59,06	59,35
2	0,427	0,432	42,72	43,19	57,28	56,81
4	0,448	0,451	44,81	45,15	55,19	54,85
8	0,468	0,466	46,76	46,61	53,24	53,39
23	0,464	0,463	46,37	46,34	53,63	53,66
29	0,465	0,473	46,49	47,30	53,51	52,70

Appendix 8. Water loss, solid gain, OD performance index of mango cubes and OS

Water loss, solid gain, OD performance index of mango cubes in OD treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	0,201	0,199	0,200	0,002	0,069	0,062	0,065	0,005	2,910	3,224	3,067	0,222
1	0,242	0,270	0,256	0,020	0,099	0,067	0,083	0,023	2,444	4,051	3,247	1,137
2	0,238	0,252	0,245	0,010	0,094	0,047	0,070	0,034	2,524	5,409	3,966	2,040
4	0,426	0,424	0,425	0,001	0,249	0,247	0,248	0,002	1,709	1,721	1,715	0,008
8	0,441	0,456	0,449	0,011	0,309	0,287	0,298	0,016	1,427	1,591	1,509	0,116
23	0,481	0,490	0,485	0,006	0,289	0,302	0,295	0,009	1,662	1,624	1,643	0,027
29	0,490	0,502	0,496	0,009	0,324	0,322	0,323	0,002	1,512	1,562	1,537	0,035

Water loss, solid gain, OD performance index of mango cubes in OD with PME treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	0,299	0,269	0,284	0,021	0,055	0,073	0,064	0,013	5,446	3,684	4,565	1,245
1	0,329	0,303	0,316	0,018	0,110	0,108	0,109	0,001	2,991	2,804	2,897	0,132
2	0,337	0,337	0,337	0,000	0,140	0,153	0,146	0,009	2,407	2,204	2,306	0,144
4	0,450	0,438	0,444	0,008	0,190	0,203	0,196	0,009	2,370	2,159	2,265	0,149
8	0,534	0,480	0,507	0,038	0,285	0,293	0,289	0,006	1,873	1,639	1,756	0,165
23	0,537	0,522	0,530	0,011	0,320	0,298	0,309	0,015	1,680	1,751	1,715	0,050
29	0,536	0,522	0,529	0,010	0,305	0,338	0,321	0,023	1,759	1,546	1,652	0,151

Water loss, solid gain, OD performance index of mango cubes in OD with VI pre-treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	0,151	0,192	0,171	0,028	0,020	0,033	0,027	0,009	7,482	5,814	6,648	1,180
1	0,211	0,240	0,225	0,021	0,070	0,073	0,072	0,002	3,000	3,287	3,144	0,203
2	0,247	0,255	0,251	0,006	0,110	0,083	0,097	0,019	2,236	3,074	2,655	0,592
4	0,336	0,365	0,350	0,021	0,240	0,218	0,229	0,016	1,397	1,674	1,535	0,196
8	0,447	0,478	0,463	0,022	0,280	0,268	0,274	0,009	1,595	1,786	1,690	0,135
23	0,356	0,374	0,365	0,013	0,320	0,278	0,299	0,030	1,111	1,347	1,229	0,167
29	0,479	0,507	0,493	0,020	0,305	0,273	0,289	0,023	1,568	1,859	1,714	0,206

Water loss, solid gain, OD performance index of mango cubes in OD with VI and PME treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	0,162	0,129	0,145	0,024	0,071	0,071	0,071	0,000	2,299	1,810	2,055	0,346
1	0,123	0,120	0,121	0,002	0,116	0,096	0,106	0,014	1,065	1,249	1,157	0,130
2	0,183	0,200	0,191	0,012	0,166	0,166	0,166	0,000	1,102	1,206	1,154	0,073
4	0,433	0,420	0,427	0,009	0,271	0,291	0,281	0,014	1,599	1,445	1,522	0,110
8	0,404	0,388	0,396	0,011	0,351	0,351	0,351	0,000	1,152	1,105	1,128	0,033
23	0,431	0,416	0,423	0,011	0,326	0,341	0,333	0,011	1,323	1,219	1,271	0,074
29	0,436	0,424	0,430	0,008	0,311	0,311	0,311	0,000	1,403	1,365	1,384	0,027

Water loss, solid gain, OD performance index of OS in OD treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	-0,092	-0,017	-0,055	0,053	-0,171	-0,171	-0,171	0,000	0,538	0,100	0,319	0,310
1	-0,195	-0,102	-0,148	0,066	-0,223	-0,227	-0,225	0,003	0,874	0,448	0,661	0,302
2	-0,146	-0,082	-0,114	0,045	-0,203	-0,219	-0,211	0,011	0,717	0,375	0,546	0,242
4	-0,299	-0,233	-0,266	0,047	-0,335	-0,379	-0,357	0,031	0,891	0,613	0,752	0,197
8	-0,322	-0,238	-0,280	0,060	-0,391	-0,391	-0,391	0,000	0,824	0,608	0,716	0,152
23	-0,351	-0,287	-0,319	0,045	-0,411	-0,423	-0,417	0,009	0,853	0,677	0,765	0,125
29	-0,355	-0,275	-0,315	0,057	-0,395	-0,415	-0,405	0,014	0,899	0,663	0,781	0,167

Water loss, solid gain, OD performance index of OS in OD with PME treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	-0,070	-0,042	-0,056	0,020	-0,307	-0,279	-0,293	0,020	0,228	0,151	0,190	0,055
1	-0,049	-0,078	-0,064	0,021	-0,319	-0,311	-0,315	0,006	0,154	0,251	0,203	0,069
2	-0,094	-0,118	-0,106	0,017	-0,367	-0,411	-0,389	0,031	0,256	0,288	0,272	0,023
4	-0,183	-0,216	-0,200	0,024	-0,447	-0,443	-0,445	0,003	0,410	0,489	0,449	0,056
8	-0,211	-0,223	-0,217	0,009	-0,511	-0,491	-0,501	0,014	0,412	0,454	0,433	0,030
23	-0,224	-0,244	-0,234	0,014	-0,487	-0,487	-0,487	0,000	0,461	0,502	0,481	0,029
29	-0,227	-0,254	-0,241	0,019	-0,491	-0,471	-0,481	0,014	0,462	0,540	0,501	0,055

Water loss, solid gain, OD performance index of OS in OD with VI pre-treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	-0,027	-0,040	-0,034	0,009	-0,101	-0,105	-0,103	0,003	0,270	0,386	0,328	0,082
1	-0,192	-0,150	-0,171	0,030	-0,145	-0,145	-0,145	0,000	1,325	1,036	1,180	0,204
2	-0,254	-0,171	-0,213	0,059	-0,201	-0,193	-0,197	0,006	1,268	0,885	1,077	0,271
4	-0,349	-0,295	-0,322	0,038	-0,309	-0,317	-0,313	0,006	1,131	0,932	1,031	0,141
8	-0,389	-0,331	-0,360	0,041	-0,401	-0,357	-0,379	0,031	0,972	0,928	0,950	0,031
23	-0,404	-0,350	-0,377	0,038	-0,357	-0,345	-0,351	0,008	1,132	1,016	1,074	0,083
29	-0,406	-0,357	-0,381	0,035	-0,369	-0,349	-0,359	0,014	1,101	1,023	1,062	0,056

Water loss, solid gain, OD performance index of OS in OD with VI and PME treatment

	Water Loss				Sucrose Gain				OD Performance Index			
Sample (h)	1	2	Average	SD	1	2	Average	SD	1	2	Average	SD
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
0,5	-0,187	-0,114	-0,151	0,052	-0,096	-0,104	-0,100	0,006	1,944	1,091	1,518	0,603
1	-0,209	-0,205	-0,207	0,003	-0,124	-0,124	-0,124	0,000	1,681	1,649	1,665	0,023
2	-0,281	-0,308	-0,295	0,019	-0,220	-0,200	-0,210	0,014	1,275	1,537	1,406	0,185
4	-0,366	-0,387	-0,376	0,015	-0,296	-0,284	-0,290	0,008	1,234	1,362	1,298	0,090
8	-0,444	-0,446	-0,445	0,001	-0,336	-0,328	-0,332	0,006	1,321	1,360	1,341	0,027
23	-0,429	-0,435	-0,432	0,005	-0,320	-0,324	-0,322	0,003	1,338	1,342	1,340	0,003
29	-0,434	-0,474	-0,454	0,029	-0,348	-0,344	-0,346	0,003	1,245	1,377	1,311	0,093

Appendix 9. Vitamin C of mango cubes (MC) and OS

Weight of supernatant for OD sample

	Code	Sample dry weight	Fresh weight (g)	Empty tube weight (g)	Tube+supernatant weight (g)	Supernatant weight (g)
MC	REF A	0,5007	2,5035	6,6919	15,3757	8,6838
	REF B	0,5023	2,5115	6,6694	15,2995	8,6301
	0A	0,5092	1,9451	6,6681	16,6489	9,9808
	0B	0,5016	1,9161	6,6478	16,3313	9,6835
	0.5A	0,5077	1,3956	6,6666	16,9894	10,3228
	0.5B	0,5052	1,3887	6,6634	16,9227	10,2593
	1A	0,5028	1,2669	6,6633	17,4157	10,7524
	1B	0,5091	1,2828	6,6955	16,7520	10,0565
	2A	0,5020	1,3043	6,6451	17,1160	10,4709
	2B	0,5018	1,3038	6,6689	16,8132	10,1443
	4A	0,5015	0,8730	6,6649	16,8149	10,1500
	4B	0,5049	0,8790	6,6673	17,0504	10,3831
	8A	0,5032	0,8377	6,6491	17,1938	10,5447
	8B	0,5041	0,8392	6,6876	16,9998	10,3122
	23A	0,7058	1,0606	6,6846	17,2262	10,5416
	23B	0,7041	1,0683	6,6882	17,0757	10,3875
	29A	0,8072	1,2247	6,6804	16,9245	10,2441
	29B	0,8075	1,2252	6,6425	17,1222	10,4797
OS	0A	5,0297	6,8851	13,1676	27,9406	14,7730
	0B	5,0936	6,9726	13,1015	28,3190	15,2175
	0.5A	5,0260	7,5065	13,1973	27,9430	14,7457
	0.5B	5,0395	7,5267	13,1370	28,1561	15,0191
	1A	5,0900	7,7429	13,1192	28,0930	14,9738
	1B	5,0600	7,6972	13,1944	28,3312	15,1368
	2A	5,0176	7,6270	13,2168	27,9883	14,7715
	2B	5,0289	7,6442	12,9757	27,8586	14,8829
	4A	5,0745	8,1826	13,1592	28,0170	14,8578
	4B	5,0611	8,1610	13,2514	28,0254	14,7740
	8A	5,0219	8,2317	13,0627	28,0003	14,9376
	8B	5,0855	8,3360	13,4192	28,3423	14,9231
	23A	5,0066	8,1981	13,1106	28,0089	14,8983
	23B	5,0731	8,3070	13,0343	27,4718	14,4375
	29A	5,0440	8,2887	13,0986	27,7953	14,6967
	29B	5,0085	8,2304	13,1402	27,2685	14,1283

Weight of supernatant for OD sample with PME treatment

	Code	Sample dry weight (g)	Fresh weight (g)	Empty tube weight (g)	Tube+supernatant weight (g)	Supernatant weight (g)
MC	REF A	0,5030	2,5150	6,7240	15,8075	9,0835
	REF B	0,5029	2,5145	6,6767	15,5575	8,8808
	0A	0,5051	1,9406	6,6486	16,6774	10,0288
	0B	0,5059	1,9437	6,6751	16,7137	10,0386
	0.5A	0,5066	1,3241	6,6632	17,4432	10,7800
	0.5B	0,5039	1,3170	6,6297	17,2365	10,6068
	1A	0,5079	1,2922	6,6909	17,2740	10,5831
	1B	0,5060	1,2874	6,6581	17,3092	10,6511
	2A	0,5047	1,1441	6,7296	17,2194	10,4898
	2B	0,5038	1,1421	6,7275	17,4744	10,7469
	4A	0,5029	0,9056	6,6575	17,0924	10,4349
	4B	0,5055	0,9103	6,6497	16,9432	10,2935
	8A	0,5044	0,7808	6,6603	17,1389	10,4786
	8B	0,5040	0,7802	6,6766	17,0344	10,3578
	23A	0,7016	1,0533	6,6558	17,3705	10,7147
	23B	0,7038	1,0712	6,6553	17,0707	10,4154
	29A	0,8059	1,2266	6,6624	17,1742	10,5118
	29B	0,8033	1,2226	6,7326	17,5599	10,8273
OS	0A	5,0122	7,2348	13,1865	28,4617	15,2752
	0B	5,0881	7,3443	13,1590	28,2604	15,1014
	0.5A	5,0668	7,6155	13,1646	28,1513	14,9867
	0.5B	5,0762	7,6296	13,1453	27,8567	14,7114
	1A	2,5025	3,8252	6,6980	19,3391	12,6411
	1B	2,5064	3,8312	6,6831	19,1981	12,5150
	2A	2,5040	3,8664	6,6737	19,1723	12,4986
	2B	2,5030	3,8648	6,6587	18,7146	12,0559
	4A	2,5097	4,0449	6,6564	19,1651	12,5087
	4B	2,5067	4,0400	6,6719	19,2185	12,5466
	8A	2,5027	4,1035	6,6655	19,3545	12,6890
	8B	2,5060	4,1089	6,7295	19,1989	12,4694
	23A	2,5067	4,0838	6,6990	19,4395	12,7405
	23B	2,5082	4,0862	6,6482	19,2659	12,6177
	29A	2,5098	4,0451	6,7067	19,3951	12,6884
	29B	2,5165	4,0559	6,6612	19,4388	12,7776

Weight of supernatant for OD sample with VI pre-treatment

	Code	Sample dry weight (g)	Fresh weight (g)	Empty tube weight (g)	Tube+supernatant weight (g)	Supernatant weight (g)
MC	REF A	0,5037	2,5185	6,6413	15,3445	8,7032
	REF B	0,5049	2,5245	6,6704	15,1700	8,4996
	0A	0,5037	1,9980	6,6440	16,6181	9,9741
	0B	0,5053	2,0044	6,6790	16,4990	9,8200
	0.5A	0,5058	1,5227	6,6643	16,7656	10,1013
	0.5B	0,5075	1,5278	6,6624	17,1434	10,4810
	1A	0,5035	1,3809	6,6459	16,4119	9,7660
	1B	0,5080	1,3932	6,6437	16,7596	10,1159
	2A	0,5082	1,1510	6,6651	16,7160	10,0509
	2B	0,5071	1,1485	6,6476	16,6331	9,9855
	4A	0,5062	0,8859	6,6701	16,9076	10,2375
	4B	0,5023	0,8790	6,6592	17,3013	10,6421
	8A	0,5026	0,8052	6,6715	17,2276	10,5561
	8B	0,5040	0,8075	6,6636	17,4234	10,7598
	23A	0,5059	0,7536	6,6581	17,2257	10,5676
	23B	0,5060	0,7498	6,6767	17,2463	10,5696
	29A	0,5060	0,7498	6,6556	17,4804	10,8248
	29B	0,5025	0,7446	6,6742	17,1755	10,5013
OS	0A	5,0974	7,2122	13,2392	28,1646	14,9254
	0B	5,0219	7,1054	13,0644	28,0876	15,0232
	0.5A	5,0158	7,2899	13,2307	27,7252	14,4945
	0.5B	5,0096	7,2809	13,1527	27,1300	13,9773
	1A	5,0353	7,3759	13,1356	27,9993	14,8637
	1B	5,0396	7,3822	13,0750	27,0486	13,9736
	2A	2,5092	3,8103	6,6765	19,2993	12,6228
	2B	2,5067	3,8065	6,6866	19,5412	12,8546
	4A	5,0261	7,9519	13,1660	27,7569	14,5909
	4B	5,0208	7,9435	13,2069	28,1039	14,8970
	8A	2,5032	4,0762	6,6800	19,1379	12,4579
	8B	2,5041	4,0776	6,6810	19,2686	12,5876
	23A	2,5079	4,0822	6,6710	19,3825	12,7115
	23B	2,5072	4,0810	6,6701	19,4020	12,7319
	29A	2,5071	4,0472	6,6777	19,2714	12,5937
	29B	2,5027	4,0401	6,6649	19,6069	12,9420

Weight of supernatant for OD sample with VI and PME treatment

	Code	Sample dry weight (g)	Fresh weight (g)	Empty tube weight (g)	Tube+supernatant weight (g)	Supernatant weight (g)
MC	REF A	0,5022	2,5110	6,6597	15,1766	8,5169
	REF B	0,5051	2,5255	6,6704	15,5235	8,8531
	0A	0,5037	1,8501	6,6787	16,6846	10,0059
	0B	0,5027	1,8464	6,6519	16,2860	9,6341
	0.5A	0,5027	1,4074	6,6580	17,0454	10,3874
	0.5B	0,5078	1,4217	6,6901	16,6110	9,9209
	1A	0,5084	1,3366	6,6656	16,6655	9,9999
	1B	0,5096	1,3397	6,6803	16,8262	10,1459
	2A	0,5083	1,0978	6,6757	17,2704	10,5947
	2B	0,5037	1,0878	6,6391	16,8759	10,2368
	4A	0,5069	0,8863	6,6810	17,1047	10,4237
	4B	0,5071	0,8866	6,6600	17,5680	10,9080
	8A	0,5026	0,7581	6,6481	17,3076	10,6595
	8B	0,5040	0,7602	6,6806	17,2546	10,5740
	23A	0,5039	0,7612	6,6729	17,1776	10,5047
	23B	0,5046	0,7616	6,6577	17,0850	10,4273
	29A	0,5020	0,7577	6,6661	17,2707	10,6046
	29B	0,5023	0,7581	6,6655	17,0044	10,3389
OS	0A	2,5076	3,5602	6,6835	19,2732	12,5897
	0B	2,5095	3,5629	6,7010	19,3325	12,6315
	0.5A	2,5104	3,7317	6,6333	19,3144	12,6811
	0.5B	2,5093	3,7301	6,7020	18,9589	12,2569
	1A	2,5034	3,7797	6,6573	19,3416	12,6843
	1B	2,5099	3,7896	6,6639	19,3323	12,6684
	2A	2,5023	3,8329	6,6607	19,5601	12,8994
	2B	2,5049	3,8369	6,6645	19,2953	12,6308
	4A	2,5017	3,9638	6,6572	19,3692	12,7120
	4B	2,5081	3,9739	6,6458	19,2081	12,5623
	8A	2,5037	4,1104	6,6746	19,2977	12,6231
	8B	2,5045	4,1118	6,6810	19,3736	12,6926
	23A	2,5022	3,8972	6,6667	19,3451	12,6784
	23B	2,5045	3,9007	6,6858	19,0150	12,3292
	29A	2,5043	4,0781	6,6370	19,0768	12,4398
	29B	2,5078	4,0838	6,6621	19,1466	12,4845

Ascorbic acid content of mango cubes in OD treatment

MC	Area	Vit.C	Vit.C Total	Vit.C Total	Vit.C Total		
Code	mV*min	µg/ml	µg	µg/g	mg/100 g	mean	stdev.
REF A1 AA	70,9861	88,7837	770,9800	307,9609	30,7961	33,1487	2,7630
REF A2 AA	70,8081	88,5604	769,0409	307,1863	30,7186		
REF B1 AA	82,9216	103,7574	895,4365	356,5345	35,6535		
REF B2 AA	82,3957	103,0976	889,7426	354,2674	35,4267		
0 A1 AA	39,9714	49,8743	497,7854	255,9118	25,5912	26,6188	2,9688
0 A2 AA	42,6574	53,2440	531,4178	273,2023	27,3202		
0 B1 AA	36,8999	46,0210	445,6439	232,5772	23,2577		
0 B2 AA	48,0169	59,9678	580,6978	303,0605	30,3060		
0,5 A1 AA	21,4654	26,6576	275,1814	197,1833	19,7183	20,2567	0,7137
0,5 A2 AA	21,3929	26,5667	274,2425	196,5105	19,6510		
0,5 B1 AA	22,3345	27,7480	284,6747	204,9951	20,4995		
0,5 B2 AA	23,0450	28,6393	293,8194	211,5803	21,1580		
1 A1 AA	18,8038	23,3185	250,7302	197,9115	19,7911	21,0230	1,1449
1 A2 AA	19,3152	23,9601	257,6286	203,3567	20,3357		
1 B1 AA	22,3384	27,7529	279,0966	217,5760	21,7576		
1 B2 AA	22,7958	28,3267	284,8673	222,0747	22,2075		
2 A1 AA	19,6901	24,4304	255,8086	196,1297	19,6130	19,2820	0,2650
2 A2 AA	19,4573	24,1384	252,7505	193,7850	19,3785		
2 B1 AA	19,7663	24,5260	248,7994	190,8317	19,0832		
2 B2 AA	19,7358	24,4878	248,4113	190,5340	19,0534		
4 A1 AA	10,5346	12,9444	131,3859	150,4927	15,0493	15,2563	0,2916
4 A2 AA	10,4770	12,8722	130,6524	149,6526	14,9653		
4 B1 AA	10,6506	13,0900	135,9143	154,6313	15,4631		
4 B2 AA	10,7075	13,1613	136,6555	155,4746	15,5475		
8 A1 AA	7,3036	8,8910	93,7527	111,9161	11,1916	11,9690	0,8400
8 A2 AA	7,3682	8,9720	94,6073	112,9362	11,2936		
8 B1 AA	8,4366	10,3124	106,3433	126,7193	12,6719		
8 B2 AA	8,4670	10,3505	106,7366	127,1880	12,7188		
23 A1 AA	1,8231	2,3179	24,4340	23,0384	2,3038	2,3654	0,0611
23 A2 AA	1,8382	2,3362	24,6269	23,2203	2,3220		
23 B1 AA	1,9613	2,4853	25,8164	24,1663	2,4166		
23 B2 AA	1,9635	2,4880	25,8441	24,1922	2,4192		
29 A1 AA	1,7924	2,2807	23,3633	19,0766	1,9077	2,0520	0,1649
29 A2 AA	1,7995	2,2893	23,4514	19,1485	1,9149		
29 B1 AA	2,0585	2,6031	27,2800	22,2663	2,2266		
29 B2 AA	1,9933	2,5241	26,4520	21,5905	2,1591		

Total ascorbic acid content of mango cubes in OD treatment

MC Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
REF A1 TAA	73,2013	91,5628	795,1130	317,6005	31,7601	34,0816	2,4939
REF A2 TAA	74,1901	92,8033	805,8852	321,9034	32,1903		
REF B1 TAA	82,6774	103,4510	892,7926	355,4818	35,5482		
REF B2 TAA	85,6457	107,1749	924,9300	368,2779	36,8278		
0 A1 TAA	46,1219	57,5904	574,7982	295,5042	29,5504	30,5817	3,4360
0 A2 TAA	48,8061	60,9578	608,4081	312,7831	31,2783		
0 B1 TAA	42,2302	52,7081	510,3986	266,3720	26,6372		
0 B2 TAA	55,2010	68,9806	667,9732	348,6086	34,8609		
0,5 A1 TAA	27,6029	34,3574	354,6648	254,1376	25,4138	25,7880	0,7939
0,5 A2 TAA	27,0917	33,7161	348,0445	249,3938	24,9394		
0,5 B1 TAA	28,2944	35,2249	361,3832	260,2332	26,0233		
0,5 B2 TAA	29,1060	36,2431	371,8292	267,7554	26,7755		
1 A1 TAA	22,9719	28,5476	306,9553	242,2923	24,2292	25,4822	1,2915
1 A2 TAA	23,2441	28,8891	310,6271	245,1906	24,5191		
1 B1 TAA	27,0908	33,7150	339,0546	264,3177	26,4318		
1 B2 TAA	27,4132	34,1194	343,1221	267,4886	26,7489		
2 A1 TAA	23,1018	28,7106	300,6256	230,4910	23,0491	22,6775	0,4255
2 A2 TAA	23,0946	28,7015	300,5310	230,4185	23,0419		
2 B1 TAA	23,0973	28,7049	291,1914	223,3468	22,3347		
2 B2 TAA	23,0456	28,6401	290,5335	222,8422	22,2842		
4 A1 TAA	12,9655	15,9941	162,3402	185,9485	18,5949	18,3081	1,1312
4 A2 TAA	13,0097	16,0496	162,9030	186,5932	18,6593		
4 B1 TAA	13,2387	16,3368	169,6271	192,9868	19,2987		
4 B2 TAA	11,4714	14,1197	146,6061	166,7955	16,6796		
8 A1 TAA	8,2178	10,0379	105,8465	126,3529	12,6353	14,7930	2,4812
8 A2 TAA	8,2333	10,0573	106,0516	126,5977	12,6598		
8 B1 TAA	11,0946	13,6470	140,7303	167,6950	16,7695		
8 B2 TAA	11,3137	13,9218	143,5648	171,0727	17,1073		
23 A1 TAA	2,4946	3,1316	33,0121	31,1266	3,1127	3,2259	0,1178
23 A2 TAA	2,5152	3,1566	33,2753	31,3747	3,1375		
23 B1 TAA	2,7188	3,4033	35,3517	33,0921	3,3092		
23 B2 TAA	2,7486	3,4394	35,7269	33,4432	3,3443		
29 A1 TAA	2,5038	3,1428	32,1947	26,2876	2,6288	2,8186	0,2173
29 A2 TAA	2,5084	3,1483	32,2518	26,3342	2,6334		
29 B1 TAA	2,7892	3,4886	36,5596	29,8405	2,9840		
29 B2 TAA	2,8317	3,5401	37,0993	30,2810	3,0281		

Ascorbic acid content of OS in OD treatment

OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 AA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B1 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B2 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0,5 A1 AA	0,8356	1,0061	14,8355	1,9764	0,1976	0,1875	0,0095
0,5 A2 AA	0,8185	0,9853	14,5283	1,9354	0,1935		
0,5 B1 AA	0,7472	0,8984	13,4927	1,7927	0,1793		
0,5 B2 AA	0,7489	0,9004	13,5238	1,7968	0,1797		
1 A1 AA	1,0951	1,3223	19,8002	2,5572	0,2557	0,2503	0,0058
1 A2 AA	1,0598	1,2793	19,1561	2,4740	0,2474		
1 B1 AA	1,0714	1,2934	19,5786	2,5436	0,2544		
1 B2 AA	1,0262	1,2384	18,7448	2,4353	0,2435		
2 A1 AA	2,0591	2,4971	36,8855	4,8362	0,4836	0,5751	0,1151
2 A2 AA	1,9933	2,4169	35,7011	4,6809	0,4681		
2 B1 AA	2,8062	3,4075	50,7136	6,6343	0,6634		
2 B2 AA	2,8980	3,5194	52,3785	6,8521	0,6852		
4 A1 AA	4,6094	5,6049	83,2768	10,1773	1,0177	1,0955	0,1068
4 A2 AA	4,4820	5,4497	80,9701	9,8954	0,9895		
4 B1 AA	5,3613	6,5212	96,3443	11,8054	1,1805		
4 B2 AA	5,4225	6,5958	97,4461	11,9404	1,1940		
8 A1 AA	4,4511	5,4120	80,8425	9,8208	0,9821	0,9857	0,0297
8 A2 AA	4,2869	5,2119	77,8535	9,4577	0,9458		
8 B1 AA	4,6605	5,6672	84,5721	10,1454	1,0145		
8 B2 AA	4,5948	5,5871	83,3773	10,0021	1,0002		
23 A1 AA	11,2636	13,7139	204,3133	24,9220	2,4922	1,0789	0,0556
23 A2 AA	11,4710	13,9666	208,0787	25,3813	2,5381		
23 B1 AA	5,2897	6,4340	92,8902	11,1822	1,1182		
23 B2 AA	4,9184	5,9815	86,3576	10,3958	1,0396		
29 A1 AA	4,9364	6,0034	88,2303	10,6447	1,0645	1,1414	0,0867
29 A2 AA	4,9558	6,0271	88,5778	10,6866	1,0687		
29 B1 AA	5,7892	7,0427	99,5007	12,0895	1,2089		
29 B2 AA	5,8597	7,1286	100,7145	12,2369	1,2237		

Total scorbic acid content of OS in OD treatment

OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0,5 A1 TAA	1,6139	1,9545	28,8211	3,8395	0,3839	0,3739	0,0114
0,5 A2 TAA	1,6122	1,9525	28,7906	3,8354	0,3835		
0,5 B1 TAA	1,5097	1,8276	27,4484	3,6468	0,3647		
0,5 B2 TAA	1,5038	1,8204	27,3404	3,6325	0,3632		
1 A1 TAA	1,8104	2,1940	32,8526	4,2430	0,4243	0,4473	0,0180
1 A2 TAA	1,8889	2,2897	34,2850	4,4280	0,4428		
1 B1 TAA	1,9524	2,3670	35,8295	4,6549	0,4655		
1 B2 TAA	1,9161	2,3228	35,1599	4,5679	0,4568		
2 A1 TAA	2,7725	3,3664	49,7274	6,5199	0,6520	0,7882	0,1423
2 A2 TAA	2,8867	3,5056	51,7831	6,7894	0,6789		
2 B1 TAA	3,8197	4,6426	69,0950	9,0389	0,9039		
2 B2 TAA	3,8789	4,7147	70,1687	9,1794	0,9179		
4 A1 TAA	6,1718	7,5089	111,5657	13,6345	1,3634	1,4786	0,1261
4 A2 TAA	6,2279	7,5773	112,5814	13,7586	1,3759		
4 B1 TAA	7,1681	8,7230	128,8737	15,7914	1,5791		
4 B2 TAA	7,2446	8,8162	130,2510	15,9601	1,5960		
8 A1 TAA	5,9647	7,2565	108,3950	13,1679	1,3168	1,3610	0,0364
8 A2 TAA	6,1056	7,4282	110,9598	13,4795	1,3480		
8 B1 TAA	6,3332	7,7056	114,9912	13,7945	1,3795		
8 B2 TAA	6,4272	7,8201	116,7006	13,9996	1,4000		
23 A1 TAA	12,5568	15,2898	227,7918	27,7859	2,7786	1,3970	0,0668
23 A2 TAA	13,1578	16,0222	238,7032	29,1169	2,9117		
23 B1 TAA	6,8291	8,3099	119,9741	14,4426	1,4443		
23 B2 TAA	6,3830	7,7663	112,1255	13,4977	1,3498		
29 A1 TAA	6,2910	7,6542	112,4908	13,5716	1,3572	1,4298	0,0793
29 A2 TAA	6,3296	7,7012	113,1821	13,6550	1,3655		
29 B1 TAA	7,1441	8,6938	122,8281	14,9238	1,4924		
29 B2 TAA	7,2010	8,7631	123,8077	15,0428	1,5043		

Ascorbic acid content of mango cubes in OD with PME treatment

MC Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g FW	Vit.C Total mg/100 g FW	mean	stdev.
REF A1 AA	56,0907	63,7153	578,7576	230,1223	23,0122	27,5726	5,5185
REF A2 AA	90,8923	103,3842	939,0908	373,3959	37,3396		
REF B1 AA	64,7731	73,6120	653,7334	259,9854	25,9985		
REF B2 AA	83,921	95,4379	847,5652	337,0711	33,7071		
0 A1 AA	42,1021	47,7702	479,0778	246,8650	24,6865	25,2184	0,7685
0 A2 AA	41,6792	47,2882	474,2435	244,3738	24,4374		
0 B1 AA	43,9907	49,9229	501,1565	257,8335	25,7834		
0 B2 AA	44,3019	50,2777	504,7174	259,6656	25,9666		
0,5 A1 AA	20,499	23,1457	249,5104	188,4422	18,8442	17,7996	0,9660
0,5 A2 AA	20,0071	22,5850	243,4660	183,8773	18,3877		
0,5 B1 AA	18,561	20,9366	222,0706	168,6171	16,8617		
0,5 B2 AA	18,8259	21,2386	225,2733	171,0489	17,1049		
1 A1 AA	17,8824	20,1631	213,3883	165,1326	16,5133	15,8720	0,9067
1 A2 AA	18,177	20,4989	216,9421	167,8828	16,7883		
1 B1 AA	16,2388	18,2896	194,8048	151,3177	15,1318		
1 B2 AA	16,1572	18,1966	193,8141	150,5481	15,0548		
2 A1 AA	17,8432	20,1184	211,0383	184,4546	18,4455	17,6995	0,9744
2 A2 AA	18,0109	20,3096	213,0435	186,2072	18,6207		
2 B1 AA	16,0701	18,0973	194,4903	170,2948	17,0295		
2 B2 AA	15,765	17,7496	190,7529	167,0223	16,7022		
4 A1 AA	10,6178	11,8825	123,9925	136,9188	13,6919	15,9286	2,2795
4 A2 AA	13,0332	14,6357	152,7221	168,6435	16,8644		
4 B1 AA	11,4223	12,7995	131,7516	144,7386	14,4739		
4 B2 AA	14,6887	16,5227	170,0768	186,8415	18,6842		
8 A1 AA	5,5973	6,1598	64,5462	82,6655	8,2666	9,7547	1,8937
8 A2 AA	8,2315	9,1624	96,0094	122,9611	12,2961		
8 B1 AA	5,7134	6,2921	65,1728	83,5343	8,3534		
8 B2 AA	6,8693	7,6097	78,8199	101,0262	10,1026		
23 A1 AA	2,6452	3,3141	35,5096	33,7135	3,3713	3,2080	0,2200
23 A2 AA	2,6858	3,3633	36,0368	34,2140	3,4214		
23 B1 AA	2,5004	3,1386	32,6901	30,5174	3,0517		
23 B2 AA	2,446	3,0727	32,0035	29,8764	2,9876		
29 A1 AA	1,8323	2,3290	24,4821	19,9594	1,9959	1,9557	0,0462
29 A2 AA	1,7818	2,2678	23,8388	19,4350	1,9435		
29 B1 AA	1,7626	2,2445	24,3024	19,8770	1,9877		
29 B2 AA	1,6768	2,1406	23,1766	18,9563	1,8956		

Total ascorbic acid content of mango cubes in OD with PME treatment

MC Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g FW	Vit.C Total mg/100 g FW	mean	stdev.
REF A1 TAA	59,4018	67,4895	613,0405	243,7537	24,3754	31,7626	6,9741
REF A2 TAA	95,7738	108,9485	989,6335	393,4924	39,3492		
REF B1 TAA	68,6372	78,0165	692,8492	275,5415	27,5542		
REF B2 TAA	89,0494	101,2836	899,4794	357,7170	35,7717		
0 A1 TAA	49,7273	56,4619	566,2448	291,7814	29,1781	29,1565	0,3862
0 A2 TAA	48,7523	55,3505	555,0992	286,0381	28,6038		
0 B1 TAA	50,1431	56,9358	571,5560	294,0525	29,4052		
0 B2 TAA	50,2001	57,0008	572,2082	294,3880	29,4388		
0,5 A1 TAA	27,8144	31,4842	339,3998	256,3311	25,6331	23,1122	1,8516
0,5 A2 TAA	23,0216	26,0211	280,5073	211,8526	21,1853		
0,5 B1 TAA	24,8909	28,1518	298,6008	226,7261	22,6726		
0,5 B2 TAA	25,2017	28,5061	302,3585	229,5793	22,9579		
1 A1 TAA	23,2816	26,3175	278,5202	215,5356	21,5536	20,3091	2,0565
1 A2 TAA	23,8418	26,9560	285,2781	220,7653	22,0765		
1 B1 TAA	18,7332	21,1329	225,0887	174,8412	17,4841		
1 B2 TAA	21,5304	24,3213	259,0489	201,2203	20,1220		
2 A1 TAA	22,1228	24,9966	262,2091	229,1796	22,9180	21,9704	1,1007
2 A2 TAA	22,1294	25,0041	262,2880	229,2486	22,9249		
2 B1 TAA	19,8748	22,4342	241,0978	211,1040	21,1104		
2 B2 TAA	19,705	22,2406	239,0178	209,2828	20,9283		
4 A1 TAA	13,3552	15,0027	156,5520	172,8728	17,2873	19,2964	3,4642
4 A2 TAA	16,2611	18,3151	191,1158	211,0398	21,1040		
4 B1 TAA	12,3042	13,8047	142,0991	156,1060	15,6106		
4 B2 TAA	18,1796	20,5019	211,0361	231,8382	23,1838		
8 A1 TAA	7,7101	8,5681	89,7818	114,9852	11,4985	14,1869	2,8777
8 A2 TAA	11,2161	12,5645	131,6579	168,6169	16,8617		
8 B1 TAA	8,0613	8,9684	92,8932	119,0645	11,9064		
8 B2 TAA	11,0841	12,4140	128,5817	164,8078	16,4808		
23 A1 TAA	3,3939	4,2214	45,2310	42,9431	4,2943	4,2234	0,3334
23 A2 TAA	3,695	4,5863	49,1406	46,6550	4,6655		
23 B1 TAA	3,2558	4,0540	42,2245	39,4181	3,9418		
23 B2 TAA	3,2983	4,1056	42,7609	39,9189	3,9919		
29 A1 TAA	2,259	2,8461	29,9176	24,3908	2,4391	2,4398	0,0220
29 A2 TAA	2,2726	2,8626	30,0909	24,5320	2,4532		
29 B1 TAA	2,2008	2,7756	30,0519	24,5796	2,4580		
29 B2 TAA	2,1553	2,7204	29,4549	24,0913	2,4091		

Ascorbic acid content of OS in OD with PME treatment

OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 AA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B1 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B2 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0,5 A1 AA	1,1148	1,2154	18,2154	2,3919	0,2392	0,2574	0,0131
0,5 A2 AA	1,1835	1,3032	19,5310	2,5646	0,2565		
0,5 B1 AA	1,2397	1,3750	20,2286	2,6513	0,2651		
0,5 B2 AA	1,2539	1,3932	20,4956	2,6863	0,2686		
1 A1 AA	0,508	0,7242	9,1545	2,3932	0,2393	0,2773	0,0255
1 A2 AA	0,625	0,8660	10,9468	2,8618	0,2862		
1 B1 AA	0,649	0,8951	11,2016	2,9238	0,2924		
1 B2 AA	0,6467	0,8923	11,1667	2,9147	0,2915		
2 A1 AA	0,8852	1,1813	14,7645	3,8187	0,3819	0,3686	0,0158
2 A2 AA	0,8872	1,1837	14,7948	3,8265	0,3827		
2 B1 AA	0,8451	1,1327	13,6557	3,5333	0,3533		
2 B2 AA	0,8535	1,1429	13,7784	3,5651	0,3565		
4 A1 AA	2,4004	3,0175	37,7444	9,3314	0,9331	0,8544	0,0959
4 A2 AA	2,4228	3,0446	38,0839	9,4153	0,9415		
4 B1 AA	1,9729	2,4994	31,3589	7,7620	0,7762		
4 B2 AA	1,9478	2,4690	30,9773	7,6675	0,7668		
8 A1 AA	3,5405	4,3991	55,8196	13,6029	1,3603	1,3675	0,0269
8 A2 AA	3,6136	4,4876	56,9437	13,8768	1,3877		
8 B1 AA	3,5335	4,3906	54,7478	13,3241	1,3324		
8 B2 AA	3,689	4,5790	57,0975	13,8960	1,3896		
23 A1 AA	3,0669	3,8251	48,7341	11,9336	1,1934	1,1506	0,0509
23 A2 AA	3,0738	3,8335	48,8406	11,9597	1,1960		
23 B1 AA	2,8643	3,5796	45,1665	11,0534	1,1053		
23 B2 AA	2,8703	3,5869	45,2583	11,0759	1,1076		
29 A1 AA	3,2046	3,9920	50,6521	12,5218	1,2522	1,2680	0,0269
29 A2 AA	3,1697	3,9497	50,1155	12,3891	1,2389		
29 B1 AA	3,3068	4,1159	52,5907	12,9664	1,2966		
29 B2 AA	3,274	4,0761	52,0828	12,8412	1,2841		

Total scorbic acid content of OS in OD with PME treatment

OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0,5 A1 TAA	1,6573	1,9086	28,6042	3,7561	0,3756	0,5133	0,1276
0,5 A2 TAA	1,9032	2,2228	33,3131	4,3744	0,4374		
0,5 B1 TAA	2,7836	3,3478	49,2510	6,4553	0,6455		
0,5 B2 TAA	2,5777	3,0847	45,3805	5,9480	0,5948		
1 A1 TAA	0,9995	1,3198	16,6837	4,3615	0,4362	0,4182	0,0128
1 A2 TAA	0,9437	1,2522	15,8289	4,1381	0,4138		
1 B1 TAA	0,9365	1,2435	15,5619	4,0619	0,4062		
1 B2 TAA	0,9632	1,2758	15,9668	4,1676	0,4168		
2 A1 TAA	1,3233	1,7122	21,4000	5,5349	0,5535	0,5117	0,0388
2 A2 TAA	1,2709	1,6487	20,6063	5,3296	0,5330		
2 B1 TAA	1,1472	1,4988	18,0692	4,6753	0,4675		
2 B2 TAA	1,2141	1,5799	19,0466	4,9282	0,4928		
4 A1 TAA	2,9177	3,6443	45,5858	11,2700	1,1270	0,9950	0,1283
4 A2 TAA	2,7987	3,5001	43,7820	10,8240	1,0824		
4 B1 TAA	2,2912	2,8851	36,1984	8,9599	0,8960		
4 B2 TAA	2,2345	2,8164	35,3363	8,7465	0,8747		
8 A1 TAA	4,4208	5,4658	69,3559	16,9016	1,6902	1,6853	0,0567
8 A2 TAA	4,484	5,5424	70,3277	17,1384	1,7138		
8 B1 TAA	4,273	5,2867	65,9222	16,0437	1,6044		
8 B2 TAA	4,6224	5,7101	71,2019	17,3286	1,7329		
23 A1 TAA	3,6483	4,5297	57,7105	14,1317	1,4132	1,3686	0,0670
23 A2 TAA	3,7132	4,6083	58,7125	14,3771	1,4377		
23 B1 TAA	3,445	4,2833	54,0457	13,2264	1,3226		
23 B2 TAA	3,387	4,2130	53,1589	13,0093	1,3009		
29 A1 TAA	3,8127	4,7289	60,0024	14,8333	1,4833	1,4954	0,0265
29 A2 TAA	3,7613	4,6666	59,2120	14,6379	1,4638		
29 B1 TAA	3,878	4,8080	61,4353	15,1471	1,5147		
29 B2 TAA	3,8912	4,8240	61,6397	15,1975	1,5197		

Ascorbic acid content of mango cubes in OD with VI pre-treatment

MC	Area	Vit.C	Vit.C Total	Vit.C Total	Vit.C Total		
Code	**mV*min**	**µg/ml**	**µg**	**µg/g FW**	**mg/100 g FW**	**mean**	**stdev.**
REF A1 AA	66,8515	85,0494	740,2022	293,9060	29,3906	32,4740	2,6856
REF A2 AA	78,3584	99,7472	868,1200	344,6972	34,4697		
REF B1 AA	78,699	100,1823	851,5092	337,2982	33,7298		
REF B2 AA	80,0287	101,8807	865,9452	343,0165	34,3017		
0 A1 AA	43,5808	55,3257	551,8242	276,1869	27,6187	27,9945	0,5321
0 A2 AA	43,3374	55,0148	548,7233	274,6349	27,4635		
0 B1 AA	45,587	57,8882	568,4625	283,6134	28,3613		
0 B2 AA	45,8635	58,2414	571,9306	285,3437	28,5344		
0,5 A1 AA	30,3149	38,3811	387,6995	254,6184	25,4618	24,8886	0,6775
0,5 A2 AA	30,2809	38,3377	387,2608	254,3303	25,4330		
0,5 B1 AA	28,3196	35,8325	375,5609	245,8203	24,5820		
0,5 B2 AA	27,7436	35,0968	367,8498	240,7730	24,0773		
1 A1 AA	28,0653	35,5077	346,7685	251,1238	25,1124	25,5815	0,5186
1 A2 AA	28,1183	35,5754	347,4296	251,6026	25,1603		
1 B1 AA	28,2428	35,7344	361,4861	259,4631	25,9463		
1 B2 AA	28,4161	35,9558	363,7253	261,0704	26,1070		
2 A1 AA	23,3762	29,5183	296,6858	257,7674	25,7767	25,7121	0,0907
2 A2 AA	23,2006	29,2940	294,4314	255,8087	25,5809		
2 B1 AA	23,47	29,6381	295,9516	257,6873	25,7687		
2 B2 AA	23,4278	29,5842	295,4134	257,2187	25,7219		
4 A1 AA	13,2049	16,5265	169,1901	190,9918	19,0992	18,9152	0,4808
4 A2 AA	13,4698	16,8649	172,6540	194,9021	19,4902		
4 B1 AA	12,16	15,1919	161,6732	183,9233	18,3923		
4 B2 AA	12,3455	15,4288	164,1947	186,7919	18,6792		
8 A1 AA	6,1621	7,5307	79,4950	98,7250	9,8725	9,6860	0,1284
8 A2 AA	6,0068	7,3324	77,4011	96,1245	9,6125		
8 B1 AA	5,9015	7,1979	77,4475	95,9150	9,5915		
8 B2 AA	5,9462	7,2549	78,0618	96,6758	9,6676		
23 A1 AA	1,7694	1,9199	20,2889	26,9223	2,6922	3,2403	0,3689
23 A2 AA	2,2058	2,4773	26,1794	34,7388	3,4739		
23 B1 AA	2,1778	2,4416	25,8063	34,4187	3,4419		
23 B2 AA	2,1285	2,3786	25,1408	33,5310	3,3531		
29 A1 AA	1,1667	1,1501	12,4494	16,6042	1,6604	1,7616	0,0930
29 A2 AA	1,2886	1,3058	14,1349	18,8521	1,8852		
29 B1 AA	1,2329	1,2346	12,9653	17,4127	1,7413		
29 B2 AA	1,243	1,2475	13,1008	17,5947	1,7595		

Total ascorbic acid content of mango cubes in OD with VI pre-treatment

MC	Area	Vit.C	Vit.C Total	Vit.C Total	Vit.C Total		
Code	**mV*min**	**µg/ml**	**µg**	**µg/g FW**	**mg/100 g FW**	**mean**	**stdev.**
REF A1 TAA	68,3576	86,9732	756,9450	300,5539	30,0554	34,0630	2,6778
REF A2 TAA	81,0228	103,1505	897,7391	356,4579	35,6458		
REF B1 TAA	82,4062	104,9175	891,7567	353,2409	35,3241		
REF B2 TAA	82,1801	104,6287	889,3020	352,2686	35,2269		
0 A1 TAA	51,7367	65,7433	655,7299	328,1915	32,8191	33,2752	0,6836
0 A2 TAA	51,3572	65,2585	650,8951	325,7717	32,5772		
0 B1 TAA	54,1332	68,8043	675,6584	337,0949	33,7095		
0 B2 TAA	54,5892	69,3868	681,3781	339,9485	33,9949		
0,5 A1 TAA	31,7696	40,2392	406,4686	266,9449	26,6945	26,6638	0,3609
0,5 A2 TAA	32,3218	40,9446	413,5933	271,6240	27,1624		
0,5 B1 TAA	30,3665	38,4471	402,9636	263,7565	26,3756		
0,5 B2 TAA	30,42	38,5154	403,6798	264,2253	26,4225		
1 A1 TAA	29,8141	37,7415	368,5832	266,9217	26,6922	27,3015	0,6113
1 A2 TAA	29,9983	37,9768	370,8810	268,5857	26,8586		
1 B1 TAA	30,2694	38,3230	387,6719	278,2585	27,8258		
1 B2 TAA	30,2732	38,3279	387,7210	278,2937	27,8294		
2 A1 TAA	25,1998	31,8476	320,0972	278,1078	27,8108	28,0009	0,2543
2 A2 TAA	25,1485	31,7821	319,4386	277,5356	27,7536		
2 B1 TAA	25,6979	32,4838	324,3674	282,4291	28,2429		
2 B2 TAA	25,6559	32,4302	323,8317	281,9627	28,1963		
4 A1 TAA	14,4753	18,1492	185,8023	209,7447	20,9745	20,8372	0,2151
4 A2 TAA	14,5368	18,2277	186,6065	210,6525	21,0653		
4 B1 TAA	13,6386	17,0805	181,7721	206,7883	20,6788		
4 B2 TAA	13,6071	17,0402	181,3439	206,3012	20,6301		
8 A1 TAA	7,1451	8,7863	92,7491	115,1853	11,5185	11,6506	0,0934
8 A2 TAA	7,2353	8,9015	93,9653	116,6957	11,6696		
8 B1 TAA	7,126	8,7619	94,2764	116,7568	11,6757		
8 B2 TAA	7,163	8,8092	94,7849	117,3866	11,7387		
23 A1 TAA	2,2795	2,5715	27,1742	36,0588	3,6059	3,9197	0,5551
23 A2 TAA	2,9102	3,3771	35,6874	47,3554	4,7355		
23 B1 TAA	2,3764	2,6952	28,4876	37,9948	3,7995		
23 B2 TAA	2,2311	2,5096	26,5259	35,3785	3,5378		
29 A1 TAA	1,7418	1,8847	20,4011	27,2095	2,7210	2,5788	0,1006
29 A2 TAA	1,6639	1,7852	19,3240	25,7730	2,5773		
29 B1 TAA	1,6654	1,7871	18,7666	25,2039	2,5204		
29 B2 TAA	1,6522	1,7702	18,5895	24,9661	2,4966		

Ascorbic acid content of OS in OD with VI pre-treatment

OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 AA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B1 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B2 AA	0,0000	0,0000	0,0000	0,0000	0,0000		
0,5 A1 AA	0,8428	0,8679	12,5794	1,7256	0,1726	0,1885	0,0120
0,5 A2 AA	0,8957	0,9355	13,5592	1,8600	0,1860		
0,5 B1 AA	0,9647	1,0236	14,3077	1,9651	0,1965		
0,5 B2 AA	0,9745	1,0362	14,4827	1,9891	0,1989		
1 A1 AA	1,067	1,1544	17,1580	2,3262	0,2326	0,2206	0,0096
1 A2 AA	1,034	1,1122	16,5313	2,2412	0,2241		
1 B1 AA	1,0408	1,1209	15,6627	2,1217	0,2122		
1 B2 AA	1,0467	1,1284	15,7681	2,1359	0,2136		
2 A1 AA	0,9738	1,0083	12,7275	3,3403	0,3340	0,3304	0,0064
2 A2 AA	0,9328	0,9688	12,2283	3,2093	0,3209		
2 B1 AA	0,9563	0,9914	12,7443	3,3480	0,3348		
2 B2 AA	0,947	0,9824	12,6290	3,3178	0,3318		
4 A1 AA	3,9786	4,8748	71,1274	8,9447	0,8945	0,9563	0,0594
4 A2 AA	4,0725	4,9948	72,8781	9,1649	0,9165		
4 B1 AA	4,3505	5,3500	79,6988	10,0332	1,0033		
4 B2 AA	4,3822	5,3905	80,3022	10,1092	1,0109		
8 A1 AA	3,7099	3,6473	45,4375	11,1471	1,1147	1,0587	0,0606
8 A2 AA	3,6847	3,6230	45,1347	11,0728	1,1073		
8 B1 AA	3,295	3,2471	40,8733	10,0238	1,0024		
8 B2 AA	3,3218	3,2730	41,1987	10,1036	1,0104		
23 A1 AA	3,3532	3,3032	41,9891	10,2860	1,0286	1,0373	0,0087
23 A2 AA	3,3683	3,3178	42,1743	10,3314	1,0331		
23 B1 AA	3,4139	3,3618	42,8019	10,4881	1,0488		
23 B2 AA	3,3798	3,3289	42,3832	10,3854	1,0385		
29 A1 AA	2,083	2,0781	26,1713	6,4665	0,6466	0,6566	0,0102
29 A2 AA	2,0915	2,0863	26,2745	6,4920	0,6492		
29 B1 AA	2,087	2,0820	26,9450	6,6694	0,6669		
29 B2 AA	2,0764	2,0718	26,8127	6,6366	0,6637		

Total ascorbic acid content of OS in OD with VI pre-treatment

OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0,5 A1 TAA	1,8322	2,1321	30,9041	4,2393	0,4239	0,4114	0,0306
0,5 A2 TAA	1,8313	2,1310	30,8874	4,2370	0,4237		
0,5 B1 TAA	1,9249	2,2506	31,4570	4,3205	0,4320		
0,5 B2 TAA	1,6553	1,9061	26,6419	3,6592	0,3659		
1 A1 TAA	2,3208	2,7565	40,9711	5,5547	0,5555	0,5188	0,0391
1 A2 TAA	2,296	2,7248	40,5001	5,4908	0,5491		
1 B1 TAA	2,1966	2,5978	36,2999	4,9172	0,4917		
1 B2 TAA	2,1441	2,5307	35,3625	4,7902	0,4790		
2 A1 TAA	1,3586	1,3794	17,4124	4,5698	0,4570	0,4663	0,0158
2 A2 TAA	1,3331	1,3548	17,1019	4,4884	0,4488		
2 B1 TAA	1,3985	1,4179	18,2268	4,7884	0,4788		
2 B2 TAA	1,4039	1,4231	18,2938	4,8060	0,4806		
4 A1 TAA	5,3686	6,6509	97,0427	12,2037	1,2204	1,2915	0,0878
4 A2 TAA	5,3278	6,5988	96,2820	12,1081	1,2108		
4 B1 TAA	5,8712	7,2931	108,6457	13,6773	1,3677		
4 B2 TAA	5,8688	7,2901	108,6000	13,6716	1,3672		
8 A1 TAA	4,2497	4,1679	51,9235	12,7384	1,2738	1,2241	0,0547
8 A2 TAA	4,2332	4,1520	51,7253	12,6897	1,2690		
8 B1 TAA	3,8763	3,8078	47,9307	11,7546	1,1755		
8 B2 TAA	3,8851	3,8163	48,0376	11,7808	1,1781		
23 A1 TAA	3,9404	3,8696	49,1884	12,0496	1,2050	1,2262	0,0166
23 A2 TAA	4	3,9271	49,9191	12,2286	1,2229		
23 B1 TAA	4,0261	3,9523	50,3197	12,3302	1,2330		
23 B2 TAA	4,0624	3,9873	50,7655	12,4394	1,2439		
29 A1 TAA	2,5298	2,5091	31,5984	7,8074	0,7807	0,7917	0,0175
29 A2 TAA	2,5054	2,4855	31,3020	7,7342	0,7734		
29 B1 TAA	2,5519	2,5304	32,7482	8,1058	0,8106		
29 B2 TAA	2,5239	2,5034	32,3987	8,0193	0,8019		

Ascorbic acid content of mango cubes in OD with VI and PME treatment

MC Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g FW	Vit.C Total mg/100 g FW	mean	stdev.
REF A1 AA	75,9976	95,3987	812,5009	323,5766	32,3577	34,7166	2,0439
REF A2 AA	77,4873	97,2727	828,4622	329,9332	32,9933		
REF B1 AA	81,4232	102,2242	905,0009	358,3452	35,8345		
REF B2 AA	81,7026	102,5757	908,1127	359,5774	35,9577		
0 A1 AA	46,2327	57,9538	579,8802	313,4373	31,3437	30,0116	1,1764
0 A2 AA	45,2257	56,6870	567,2045	306,5858	30,6586		
0 B1 AA	44,3707	55,6114	535,7658	290,1686	29,0169		
0 B2 AA	44,3864	55,6311	535,9560	290,2716	29,0272		
0,5 A1 AA	28,5258	35,6782	370,6037	263,3296	26,3330	26,9909	0,6839
0,5 A2 AA	28,6714	35,8614	372,5064	264,6816	26,4682		
0,5 B1 AA	31,5696	39,5074	391,9486	275,6990	27,5699		
0,5 B2 AA	31,5952	39,5396	392,2681	275,9238	27,5924		
1 A1 AA	27,9449	34,9474	349,4707	261,4697	26,1470	27,2598	1,2296
1 A2 AA	28,0567	35,0881	350,8771	262,5220	26,2522		
1 B1 AA	29,7539	37,2232	377,6626	281,8972	28,1897		
1 B2 AA	30,0273	37,5671	381,1522	284,5019	28,4502		
2 A1 AA	21,2584	26,5357	281,1374	256,0979	25,6098	26,3954	1,0076
2 A2 AA	21,1196	26,3611	279,2874	254,4126	25,4413		
2 B1 AA	23,1564	28,9234	296,0829	272,1754	27,2175		
2 B2 AA	23,2371	29,0249	297,1222	273,1307	27,3131		
4 A1 AA	14,8795	18,5109	192,9519	217,7055	21,7706	19,5766	2,4649
4 A2 AA	14,7987	18,4092	191,8923	216,5101	21,6510		
4 B1 AA	11,4545	14,2022	154,9172	174,7225	17,4722		
4 B2 AA	11,416	14,1537	154,3889	174,1266	17,4127		
8 A1 AA	6,5402	8,0199	85,4879	112,7672	11,2767	11,4642	0,1295
8 A2 AA	6,7074	8,2302	87,7300	115,7248	11,5725		
8 B1 AA	6,7327	8,2620	87,3629	114,9204	11,4920		
8 B2 AA	6,7462	8,2790	87,5425	115,1566	11,5157		
23 A1 AA	2,599	3,0618	32,1630	42,2555	4,2256	4,0879	0,1010
23 A2 AA	2,4658	2,8942	30,4027	39,9429	3,9943		
23 B1 AA	2,5437	2,9922	31,2006	40,9680	4,0968		
23 B2 AA	2,5077	2,9469	30,7283	40,3479	4,0348		
29 A1 AA	1,8248	2,0878	22,1404	29,2220	2,9222	2,8800	0,0585
29 A2 AA	1,8266	2,0901	22,1644	29,2537	2,9254		
29 B1 AA	1,8393	2,1061	21,7743	28,7216	2,8722		
29 B2 AA	1,7974	2,0533	21,2293	28,0028	2,8003		

Total ascorbic acid content of mango cubes in OD with VI and PME treatment

MC Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g FW	Vit.C Total mg/100 g FW	mean	stdev.
REF A1 TAA	77,8138	97,6835	831,9604	331,3263	33,1326	35,0390	1,7344
REF A2 TAA	79,8595	100,2570	853,8790	340,0553	34,0055		
REF B1 TAA	82,8907	104,0703	921,3450	364,8169	36,4817		
REF B2 TAA	83,0139	104,2253	922,7171	365,3602	36,5360		
0 A1 TAA	52,1953	65,4549	654,9352	354,0060	35,4006	34,1640	1,0737
0 A2 TAA	51,1991	64,2017	642,3954	347,2280	34,7228		
0 B1 TAA	50,7667	63,6577	613,2846	332,1524	33,2152		
0 B2 TAA	50,9222	63,8533	615,1692	333,1731	33,3173		
0,5 A1 TAA	26,7262	33,4143	347,0873	246,6203	24,6620	28,1951	2,4183
0,5 A2 TAA	30,9675	38,7499	402,5108	286,0010	28,6001		
0,5 B1 TAA	34,0065	42,5730	422,3628	297,0926	29,7093		
0,5 B2 TAA	34,1203	42,7162	423,7831	298,0916	29,8092		
1 A1 TAA	30,3378	37,9577	379,5735	283,9923	28,3992	29,5108	1,3402
1 A2 TAA	30,2356	37,8292	378,2878	283,0303	28,3030		
1 B1 TAA	32,4053	40,5587	411,5044	307,1575	30,7158		
1 B2 TAA	32,3103	40,4392	410,2918	306,2525	30,6252		
2 A1 TAA	23,3462	29,1622	308,9643	281,4464	28,1446	28,7307	0,9345
2 A2 TAA	23,0012	28,7281	304,3660	277,2576	27,7258		
2 B1 TAA	25,0893	31,3550	320,9750	295,0575	29,5058		
2 B2 TAA	25,124	31,3987	321,4219	295,4683	29,5468		
4 A1 TAA	16,0585	19,9941	208,4124	235,1494	23,5149	21,4664	2,2638
4 A2 TAA	15,938	19,8425	206,8322	233,3666	23,3367		
4 B1 TAA	12,7815	15,8716	173,1269	195,2602	19,5260		
4 B2 TAA	12,7568	15,8405	172,7880	194,8779	19,4878		
8 A1 TAA	7,3796	9,0759	96,7441	127,6153	12,7615	12,8822	0,0866
8 A2 TAA	7,4461	9,1595	97,6359	128,7917	12,8792		
8 B1 TAA	7,5562	9,2980	98,3173	129,3303	12,9330		
8 B2 TAA	7,5689	9,3140	98,4863	129,5525	12,9553		
23 A1 TAA	3,0934	3,6837	38,6965	50,8393	5,0839	5,1205	0,0578
23 A2 TAA	3,0837	3,6715	38,5683	50,6709	5,0671		
23 B1 TAA	3,1814	3,7944	39,5658	51,9519	5,1952		
23 B2 TAA	3,147	3,7512	39,1145	51,3594	5,1359		
29 A1 TAA	2,4396	2,8612	30,3423	40,0474	4,0047	3,9169	0,0674
29 A2 TAA	2,3796	2,7858	29,5419	38,9909	3,8991		
29 B1 TAA	2,4509	2,8755	29,7291	39,2145	3,9215		
29 B2 TAA	2,4047	2,8173	29,1282	38,4219	3,8422		

Ascorbic acid content of OS in OD with VI and PME treatment

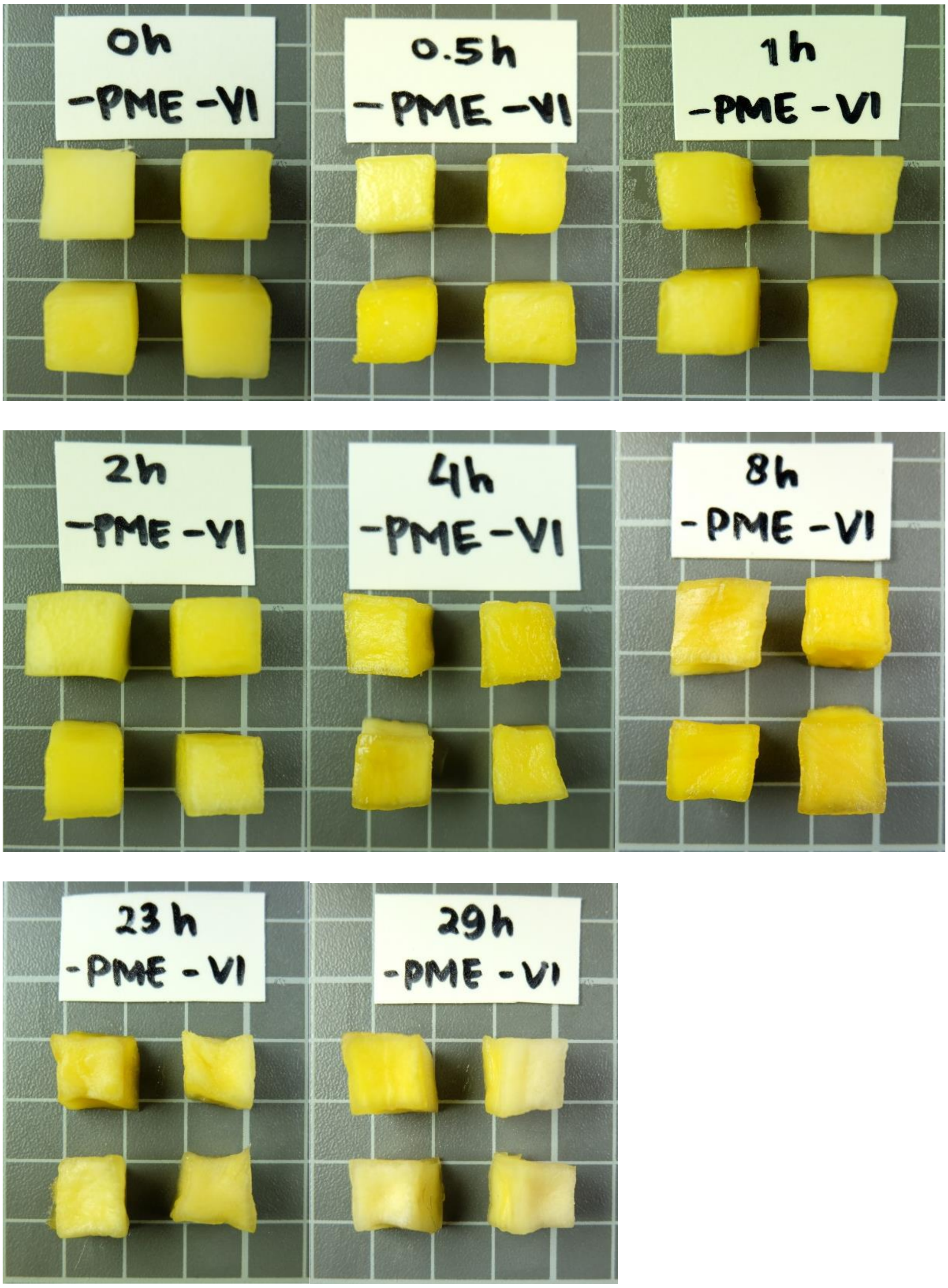
OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 AA	0	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 AA	0	0,0000	0,0000	0,0000	0,0000		
0 B1 AA	0	0,0000	0,0000	0,0000	0,0000		
0 B2 AA	0	0,0000	0,0000	0,0000	0,0000		
0,5 A1 AA	0,5475	0,5971	7,5722	2,0291	0,2029	0,1965	0,0048
0,5 A2 AA	0,5289	0,5792	7,3447	1,9682	0,1968		
0,5 B1 AA	0,5432	0,5930	7,2681	1,9485	0,1949		
0,5 B2 AA	0,5326	0,5828	7,1428	1,9149	0,1915		
1 A1 AA	0,6424	0,6887	8,7351	2,3110	0,2311	0,2253	0,0048
1 A2 AA	0,6089	0,6563	8,3253	2,2026	0,2203		
1 B1 AA	0,6193	0,6664	8,4419	2,2277	0,2228		
1 B2 AA	0,6323	0,6789	8,6008	2,2696	0,2270		
2 A1 AA	1,0014	1,0349	13,3498	3,4829	0,3483	0,3376	0,0107
2 A2 AA	0,9904	1,0243	13,2129	3,4472	0,3447		
2 B1 AA	0,9745	1,0090	12,7441	3,3214	0,3321		
2 B2 AA	0,9529	0,9881	12,4810	3,2529	0,3253		
4 A1 AA	2,4777	2,4588	31,2565	7,8855	0,7886	0,7810	0,0056
4 A2 AA	2,4505	2,4326	30,9230	7,8014	0,7801		
4 B1 AA	2,4876	2,4684	31,0083	7,8029	0,7803		
4 B2 AA	2,4706	2,4520	30,8024	7,7511	0,7751		
8 A1 AA	4,084	4,0081	50,5947	12,3088	1,2309	1,2391	0,0160
8 A2 AA	4,0512	3,9765	50,1953	12,2117	1,2212		
8 B1 AA	4,1476	4,0694	51,6518	12,5620	1,2562		
8 B2 AA	4,1212	4,0440	51,3286	12,4834	1,2483		
23 A1 AA	3,2167	3,1716	40,2106	10,3179	1,0318	1,0550	0,0167
23 A2 AA	3,29	3,2423	41,1070	10,5479	1,0548		
23 B1 AA	3,4173	3,3651	41,4886	10,6361	1,0636		
23 B2 AA	3,4379	3,3849	41,7335	10,6989	1,0699		
29 A1 AA	2,7053	2,6783	33,3180	8,1699	0,8170	0,8349	0,0274
29 A2 AA	2,6678	2,6422	32,8680	8,0596	0,8060		
29 B1 AA	2,8347	2,8031	34,9959	8,5694	0,8569		
29 B2 AA	2,8435	2,8116	35,1018	8,5953	0,8595		

Total ascorbic acid content of OS in OD with VI and PME treatment

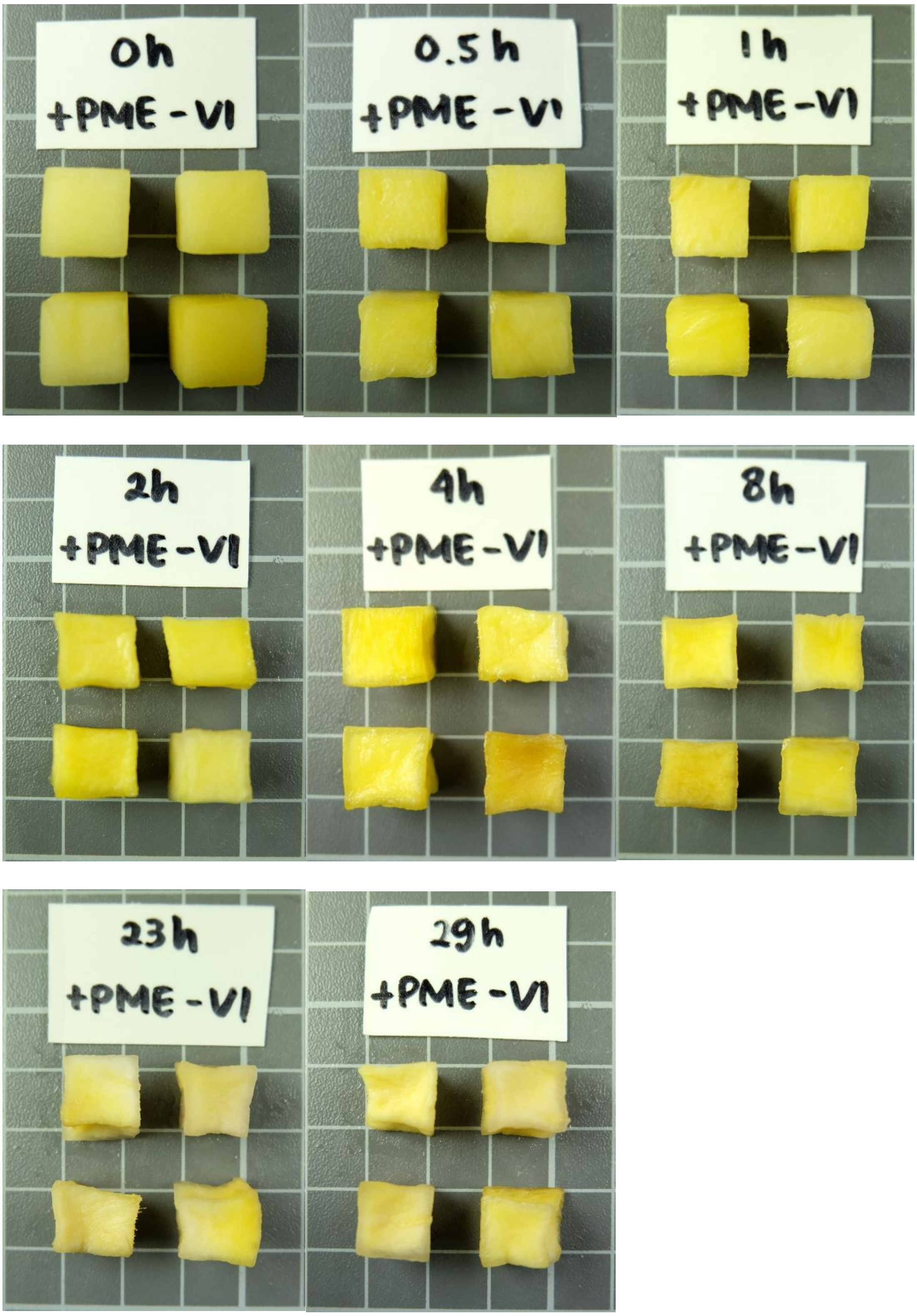
OS Code	Area mV*min	Vit.C µg/ml	Vit.C Total µg	Vit.C Total µg/g	Vit.C Total mg/100 g	mean	stdev.
0 A1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
0 A2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B1 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0 B2 TAA	0,0000	0,0000	0,0000	0,0000	0,0000		
0,5 A1 TAA	0,9289	0,9650	12,2371	3,2792	0,3279	0,3255	0,0054
0,5 A2 TAA	0,9372	0,9730	12,3386	3,3064	0,3306		
0,5 B1 TAA	0,9550	0,9902	12,1363	3,2536	0,3254		
0,5 B2 TAA	0,9322	0,9682	11,8668	3,1814	0,3181		
1 A1 TAA	1,1965	1,2231	15,5140	4,1045	0,4105	0,4098	0,0102
1 A2 TAA	1,1490	1,1773	14,9329	3,9508	0,3951		
1 B1 TAA	1,2191	1,2449	15,7707	4,1616	0,4162		
1 B2 TAA	1,2228	1,2485	15,8160	4,1736	0,4174		
2 A1 TAA	1,5477	1,5618	20,1466	5,2562	0,5256	0,5147	0,0114
2 A2 TAA	1,5312	1,5459	19,9413	5,2026	0,5203		
2 B1 TAA	1,5459	1,5601	19,7052	5,1357	0,5136		
2 B2 TAA	1,5009	1,5167	19,1570	4,9928	0,4993		
4 A1 TAA	3,1678	3,1244	39,7176	10,0201	1,0020	1,0105	0,0069
4 A2 TAA	3,2083	3,1635	40,2142	10,1454	1,0145		
4 B1 TAA	3,2346	3,1889	40,0593	10,0805	1,0081		
4 B2 TAA	3,2656	3,2188	40,4349	10,1751	1,0175		
8 A1 TAA	4,8026	4,7012	59,3437	14,4373	1,4437	1,4654	0,0194
8 A2 TAA	4,8403	4,7376	59,8027	14,5490	1,4549		
8 B1 TAA	4,9169	4,8114	61,0697	14,8525	1,4852		
8 B2 TAA	4,8921	4,7875	60,7661	14,7786	1,4779		
23 A1 TAA	3,9836	3,9113	49,5886	12,7243	1,2724	1,2978	0,0257
23 A2 TAA	4,0069	3,9337	49,8735	12,7974	1,2797		
23 B1 TAA	4,2759	4,1932	51,6987	13,2535	1,3254		
23 B2 TAA	4,2372	4,1559	51,2385	13,1356	1,3136		
29 A1 TAA	3,1079	3,0666	38,1485	9,3544	0,9354	0,9678	0,0385
29 A2 TAA	3,1014	3,0604	38,0705	9,3353	0,9335		
29 B1 TAA	3,3287	3,2796	40,9443	10,0260	1,0026		
29 B2 TAA	3,3188	3,2701	40,8251	9,9968	0,9997		

Appendix 10. Picture of mango cubes

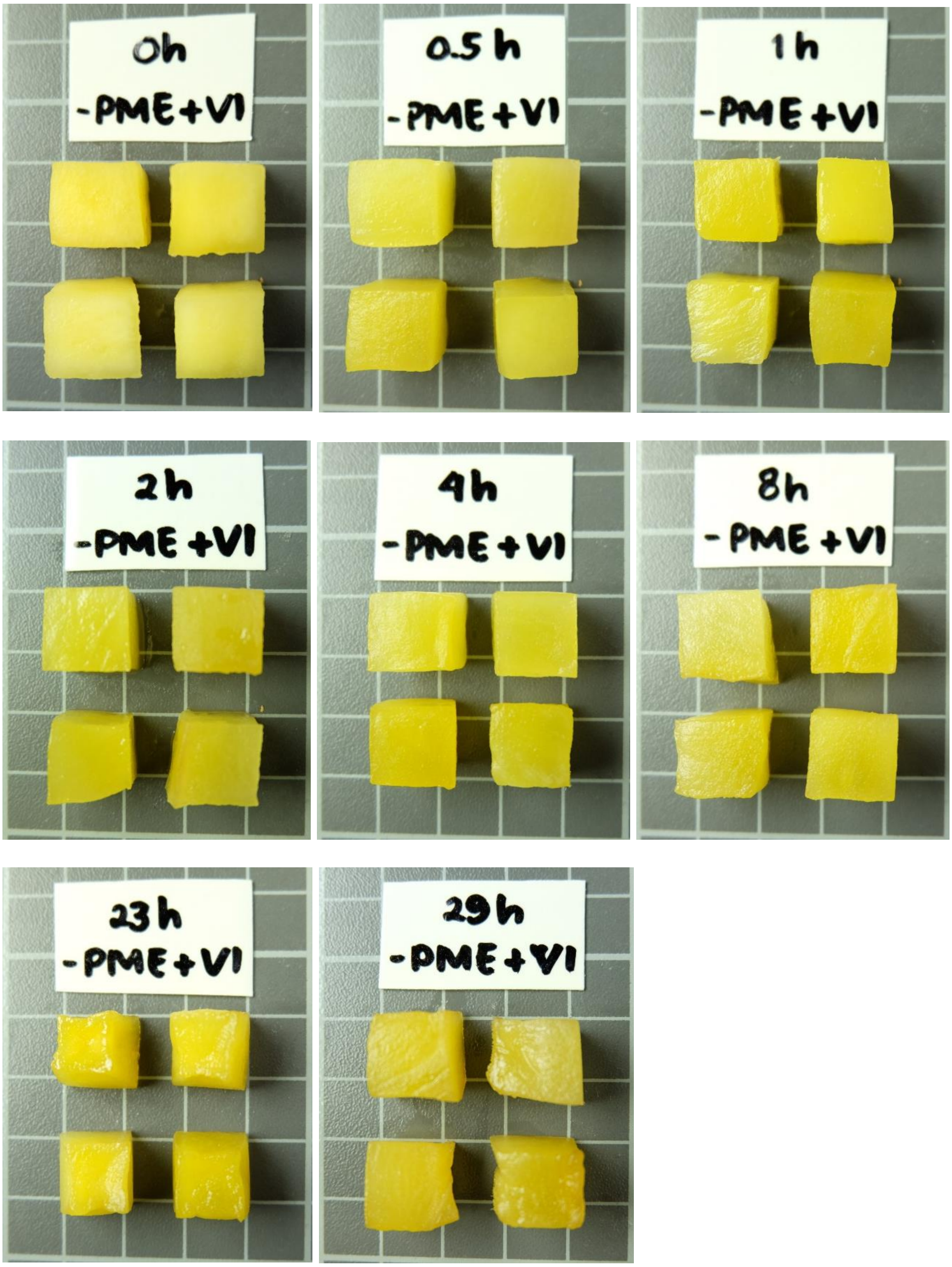
Picture of mango cubes with OD treatment



Picture of mango cubes in OD with PME treatment



Picture of mango cubes in OD with VI pre-treatment



Picture of mango cubes in OD with VI and PME treatment