Sprouting of Chayote Fruit as Influenced by Passive Modified Atmosphere Packaging and Different Postharvest Chemical Treatments

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Abstract

Chayote is one of the vegetable crops in the Philippines with inadequate local information on its sprouting inhibition or promotion upon application of some postharvest treatments. Newly harvested chayote fruit were applied with either passive modified atmosphere packaging (MAP) using cling wrap, 1-methylcyclopropene (1-MCP) (500 and 2500 $\mu L \cdot L^{-1}$), ethephon (100 and 500 $\mu L \cdot L^{-1}$) or gibberellic acid (GA_3) (100 and 500 $\mu L \cdot L^{-1}$) and stored at ambient conditions (26.51±1.38 °C and 81.11±7.03% relative humidity) to evaluate its sprouting and other postharvest characteristics. Results revealed that untreated chayote sprouted in 13.5 days while passive MAP delayed the onset of sprouting by eight days. Sprouts were longest when treated with 500 $\mu L \cdot L^{-1}$ ethephon and shortest when fumigated with 2500 $\mu L \cdot L^{-1}$ 1-MCP. 1-MCP promoted the occurrence of decay and higher weight loss resulting in faster deterioration of quality and shorter shelf life. Starch content did not vary. Cling-wrapped fruit maintained its quality longer because of delayed sprouting and lesser weight loss but also promoted an early onset of decay.

Keywords*:* chayote, 1-methylcyclopropene, cling wrap, ethephon, gibberellic acid

1. Introduction

Chayote (*Sechium edule* (Jacq.) Sw.) is a viviparous cucurbit, known locally as "*sayote*" in the Philippines. It is a high yielding but low input requiring vegetable crop that is usually harvested at an immature stage. It has been identified as an underutilized crop by Lira-Saade (1996) with many potential uses.

Sprouting is common in chayote. It occurs during transit, marketing, and storage. Sprout growth in chayote starts with the opening of the basal region of fruit and the emergence of the cotyledon. This is followed by the emergence of roots and shoot and subsequent elongation of the shoot and the emergence of leaves (Aung *et al*., 2004). This crop is propagated through mature sprouted fruit (Lira-Saade, 1996). In commercial chayote farms, sprout growth is regulated by using controlled humidity chambers and some chemicals (Lira-Saade, 1996). Sprouting in chayote is undesirable after harvest since it reduces the quality of the produce. Application of different postharvest treatments can regulate sprouting in chayote fruit which may be used to further understand the nature of sprouting in this crop or maintain its quality as a fruit vegetable.

For many produce, modified atmosphere packaging (MAP) maintains quality better than holding it unpacked. In general, MAP decreases the respiration and transpiration rates and maintains the high relative humidity (RH) that can reduce weight loss in fresh produce (Kader *et al*., 1989). A type of MAP is passive MAP, which results once a desired atmosphere develops within a film package from a naturally respiring produce and gases diffusing through the film. Aung *et al*. (1996) reported a reduction in weight loss of the chayote fruit wrapped in polyvinyl chloride, a kind of film package, prior to storage at low temperatures.

Sprouting of chayote may be inhibited by 1-methycyclopropene (1-MCP), an ethylene inhibitor. Cadena-Iñiguez *et al*. (2006) reported a delay in sprout growth in chayote up to 28 days after harvest when applied with 600 $nL \cdot L^{-1}$ 1-MCP and stored in 10 °C. A better quality of chayote fruit was maintained by 1-MCP at varying concentrations up to 15 days of storage in which 900 $nL \cdot L^{-1}$ 1-MCP treatment was found to be the most effective in maintaining fruit quality (Li *et al*., 2015a). The respiratory climacteric peak of chayote treated with 1-MCP was exhibited at 15 days while the control showed sharp decline indicating deterioration (Li *et al*., 2015b).

On the other hand, ethylene can be a key factor in regulating germination (Corbineau *et al*., 2014). An ethylene source, ethephon (2-chloroethyl phosphonic acid) is a plant growth regulator that promotes fruit ripening. It is also used as a foliar spray during the production of chayote (Baruah *et al*., 2013). There is, however, no adequate information on the postharvest use of ethephon in chayote fruit.

Others have linked sprout growth to gibberellic acid (GA_3). According to Lorenzi and Ceccarelli (1983), the immature fruit of chayote contained very high levels of GA_3. Gibberellin plays an important role in the development of chayote seed and fruit (Albone *et al*., 1984). The effect of gibberellin was demonstrated in chayote by enhancing sprout growth while GA antagonists inhibited sprouting (Aung *et al*., 2004). This was proved by injecting 1.0 mM GA_3 (138 µg/fruit) to the fruit which resulted in earlier sprouting relative to the control.

The viviparous chayote fruit has no dormant period and readily sprouts which significantly limits fruit marketability and utilization (Aung *et al*., 2004). Thus, it is necessary to understand the sprouting and other postharvest characteristics of chayote to reduce losses during postharvest handling of fruit. In addition, few studies have been conducted on the postharvest characteristics of *S. edule* grown in the Philippines. The sprouting of chayote was evaluated in this study using different postharvest treatments such as MAP via cling wrap, 1-MCP, ethephon, and GA_3.

2. Methodology

Chayote fruit (344 pieces) were harvested and procured from a local farm in Pamuhatan, Marilog District, Davao City, in Southern Philippines. Fruit were carefully transported to the Postharvest Biology Laboratory of the University of the Philippines Mindanao. From the total number of procured chayote fruit, 140 pieces of uniform quality were used in the study. Chayote fruit were given various postharvest treatments, namely cling wrap, 1-methylcyclopropene (1-MCP) (500 and 2500 $\mu L \cdot L^{-1}$), ethephon (100 and 500 $\mu L \cdot L^{-1}$), and GA_3 (100 or 500 $\mu L \cdot L^{-1}$). Untreated fruit served as the control. Fruit were sanitized with 200 $\mu L \cdot L^{-1}$ sodium hypochlorite (Winrox® liquid bleach, a.i.: 5.2% NaClO) before treatment. The 1-MCP concentrations in this study were arrived at after

an earlier study on various concentrations of 1-MCP on chayote fruit. The samples were stored at ambient conditions of 26±1.38 °C, 81.11±7.03% RH.

For passive MAP treatment, each fruit was wrapped with one layer of cling wrap (polyvinyl chloride). For 1-MCP treatment, fruit were placed in an airtight fiber glass chamber along with the required amount of 1-MCP powder (500 or 2500 $\mu L \cdot L^{-1}$) contained in a small beaker. Distilled water was added to the beaker with 1-MCP powder through a tube in the chamber. The tube was immediately sealed with clay after the delivery of water to the 1-MCP container. A fan was oscillating in each chamber to help the circulation of gas inside the chamber. Fruit were exposed to 1-MCP for 24 h.

For ethephon treatment, fruit were dipped in an ethephon solution (Zagro: Xtragro 480 Plant Growth Regulator, a.i.: 48% 2-chloroethyl phosphonic acid). Fruit were soaked in ethephon (100 or 500 $\mu L \cdot L^{-1}$) for 5 min and then air-dried.

Samples were soaked in GA_3 (a.i.: 90%) solutions (100 or 500 $\mu L \cdot L^{-1}$) for 5 min and air-dried. The GA_3 solution was prepared by mixing the GA_3 powder with a small amount of 95% ethanol. The solution was slightly warmed until the GA_3 was fully dissolved. The dissolved GA_3 was then mixed with distilled water to prepare the treatment solutions.

Thirty fruit per treatment (three replications at 10 fruit per replication) were assessed at an interval of five days until 15 days after treatment. Non-destructive data gathered were the degree of sprout growth, percentage sprouting, days to sprouting, sprout length, weight loss, visual quality, shelf life, degree of decay, and days to onset of decay. The visual quality rating was assessed using a scale of 1 to 5, where 1 = excellent, field fresh; 2 = very good, with slight defects; 3 = good, moderate defects; 4 = fair, the limit of saleability; and 5 = poor, unusable (Ekman *et al.*, 2019). The degree of decay was evaluated using a scale of 1-5, where 1 = no decay, 2 = 1-5% of surface area with decay, 3 = 6-10%, 4 = 11-25%, 5 = > 26%. The degree of sprout growth was assessed using a scale of 1-5, where: 1 = no sprouting, 2 = the opening of the basal region of fruit and emergence of cotyledon, 3 = roots emerging from basal region of fruit, 4 = emergence of shoot, 5 = shoot elongation, and emergence of leaves. The end of shelf life was noted when fruit showed one or more of the following: visual quality rating of 3, decay rating of 3 and sprout growth rating of 2.

Four fruit per treatment at five days interval for 15 days were used for starch content determination following the method of Cagampang and Rodriguez (1980) using anthrone reagent. Crosswise samples from equidistant sections of each fruit were obtained, chopped finely and a consolidated sample of 25 g was dried at 105 ℃. In preparing the 0.2% anthrone reagent, 2 g anthrone was dissolved in 1 L 95% H_2SO_4. To measure the starch content of chayote fruit, 50 mg of dried and ground chayote sample was used and analyzed using a UV/VIS spectrophotometer (model 83059-15, Cole-Parmer®, United States).

The experiment followed a completely randomized design (CRD) with three and four replications for the non-destructive and starch analyses, respectively. Data were analyzed using analysis of variance (ANOVA) test at 5% level of significance. Tukey's Honestly Significant Difference (HSD) was used for mean comparison while data on percentage sprouting were transformed using the arc sine transformation method before performing the ANOVA and Tukey's HSD tests. Means for visual quality, degree of decay and degree of sprouting were analyzed using the Kruskal-Wallis test at 5% level of significance.

3. Results and Discussion

3.1 Lesser Sprout Growth and Sprouting in Chayote Fruit Treated with 1-MCP

No sprouting was observed at five days after treatment (DAT). Using the higher concentration of 1-MCP at 2500 $\mu L \cdot L^{-1}$, sprouting was suppressed up to 10 DAT (Table 1, Figure 1). At 10 DAT, chayote fruit treated with 500 $\mu L \cdot L^{-1}$ ethephon had more advanced sprouting (i.e., root emerging from the basal region of fruit) compared to cling wrap, 1-MCP and 500 $\mu L \cdot L^{-1}$ GA_3 (Table 1). Fruit treated with 1-MCP exhibited a lower rating of sprout growth compared to the control, ethephon and 500 $\mu L \cdot L^{-1}$ GA_3 at 15 DAT. Likewise, cling-wrapped fruit had lower sprout growth compared to 500 $\mu L \cdot L^{-1}$ ethephon but it did not vary with the control and 1-MCP at 15 DAT. Except for 1-MCP, the sprout growth in all treatments was similar with the control.

Table 1. Sprout growth and percentage of sprouting of chayote fruit after exposure to various postharvest treatments and holding at ambient conditions (26.51±1.38 °C, 81.11±7.03% RH)

Treatment	Concentration ($\mu L \cdot L^{-1}$)	Degree of Sprout Growth[xy]		Sprouting[z] (%)	
		10 DAT	15 DAT	10 DAT	15 DAT[NS]
Control		1.30[ab]	2.67[ab]	23.33[ab]	76.67
Cling wrap		1.13[b]	1.80[bc]	13.33[abc]	40.00
1-MCP	500	1.07[b]	1.43[c]	3.33[bc]	33.00
	2500	1.00[b]	1.33[c]	0.00[c]	33.00
Ethephon	100	1.50[ab]	2.80[ab]	26.67[ab]	76.67
	500	1.70[a]	3.03[a]	50.00[a]	80.00
GA_3	100	1.30[ab]	2.53[ab]	23.33[ab]	70.00
	500	1.03[b]	1.93[abc]	3.33[bc]	66.67

[x]Degree of sprout growth: 1 = no sprouting, 2 = the opening of the basal region of fruit and emergence of cotyledon, 3 = roots emerging from basal region of fruit, 4 = the emergence of the shoot, 5 = shoot elongation, and emergence of leaves; [y]Means in a column with common letter/s are not significantly different using Kruskal-Wallis test at 5% level of significance; [z]Means in a column with common letter/s are not significantly different using Tukey's HSD at 5% level of significance; DAT – days after treatment; [NS] – not significant

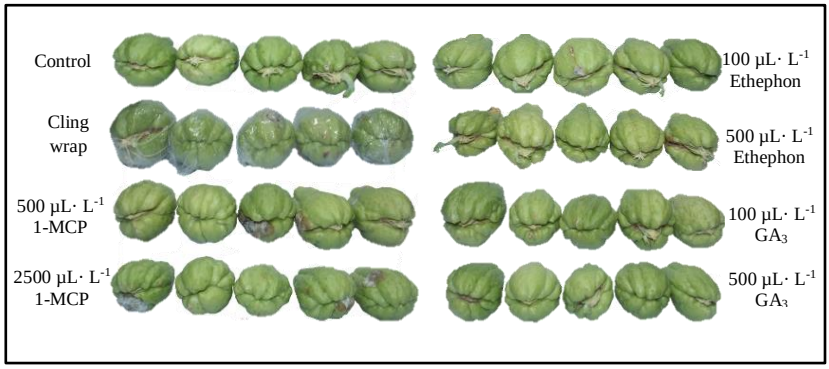

Figure 1. Sprout growth in chayote fruit at 15 days after exposure to various postharvest treatments and holding at ambient conditions (26.51±1.38 °C, 81.11±7.03% RH)

3.2 Cling Wrap Delayed the Sprouting of Chayote Fruit

Considering all the treatments, the mean number of days to onset of sprouting in chayote ranged from 12.2 to 21.6 DAT (Table 2). Chayote treated with ethephon at the higher concentration of 500 $\mu L \cdot L^{-1}$ sprouted earlier compared to those treated with 100 $\mu L \cdot L^{-1}$ ethephon, 500 $\mu L \cdot L^{-1}$ GA_3 and cling wrap

(Table 2). The onset of sprouting among the treatments was, however, similar to the control, except in cling wrap. Cling wrap delayed the sprouting of chayote for eight days compared to the control but had similar sprout lengths at 15 DAT (Table 2). 1-MCP (2500 $\mu L \cdot L^{-1}$) produced the shortest sprout while ethephon (500 $\mu L \cdot L^{-1}$) produced the longest sprout at 15 DAT (Table 2).

Table 2. Onset of sprouting and sprout length in chayote fruit after exposure to various postharvest treatments and holding at ambient conditions (26.51±1.38 °C, 81.11±7.03% RH)

Treatment	Concentration ($\mu L \cdot L^{-1}$)	No. of Days to Onset of Sprouting[z]	Sprout Length[z] (mm) at 15 DAT
Control		13.54^{bc}	30.96^{b}
Cling wrap		21.58^{a}	31.03^{b}
1-MCP	500	14.38^{bc}	28.01^{d}
	2500	16.21^{bc}	20.11^{f}
Ethephon	100	14.39^{b}	28.95^{cd}
	500	12.22^{c}	36.51^{a}
GA_3	100	14.29^{bc}	29.82^{c}
	500	17.33^{ab}	24.84^{e}

[z]Means in a column with common letter/s are not significantly different using Tukey's HSD at a 5% level of significance; DAT – days after treatment

At a temperature higher by about 1.5 °C, sprouts emerged in 10 days in the chayote used in the present study while it only took six to seven days in the chayote studied by Aung (1992) at a slightly lower temperature of 25 °C. This could be due to varietal difference. Sprouts in chayote emerged from the cleft at the apex part of the fruit once the seed has germinated (Lira-Saade, 1996). Sprouting in chayote is characterized by fruit showing opening of the base and appearance of embryo (Cadena-Iñiguez *et al*., 2006) in which the growing shoot and roots appear (Aung *et al*., 2004).

Cling wrap creates a barrier against exogenous ethylene which could have delayed the onset of sprouting. In contrast to the present study, shrink wrapping and plastic packaging increased the sprouting of 'Beauregard' sweet potatoes (Kilili, 1999) and potato (Nyankanga *et al*., 2018), respectively. The retention of moisture in plastic packaging possibly contributed to the early sprouting of potato (Nyankanga *et al*., 2018). However, the plastic wrap used in this study, cling wrap (polyvinyl chloride [PVC]), provides a moderate barrier to water vapor permeability (Mangaraj *et al*., 2009) such that moisture retention may not be high enough to induce sprouting in all the sample chayote fruit. The PVC has relatively high permeability which may result in low O_2

concentration – a level that is suitable for a low respiration rate produce like chayote (Exama *et al*., 1993). Moreover, the low oxygen microenvironment in cling wrap could have contributed to the delay of sprouting as ethylene production is suppressed in low oxygen conditions (Jayas and Jeyamkondan, 2002).

Ethylene has been reported to regulate germination and seed dormancy (Corbineau *et al*., 2014). This is indicated by the longest sprouts of chayote treated with the higher concentration of ethephon, a liquid formulation of ethylene, as shown in the present study. In contrast, ethephon application in potato minitubers resulted in a lower percentage of sprouting with shorter sprouts (Secretaria *et al*., 2018). In potato tubers, Rylski *et al*. (1974) reported a dual effect of ethylene on potato tubers which shorten the dormancy period but inhibits elongation of the sprouts during extended treatment. Cadena-Iñiguez *et al*. (2006) found that the associated action of CO_2 and ethylene mediate the fruit base opening and germination in chayote fruit.

The external application of hormonal compounds influence the endogenous substances in the produce. GA_3 is essential in promoting sprout development in chayote (Aung *et al*., 2004). However, in this study, the exogenous application of ethephon or GA_3 resulted in a similar response as untreated fruit in terms of the number of days to sprouting. The fruit used in the study were uniform in size and harvested at the same time but the different sprouting responses could have also depended on other developmental stage factors in the fruit tissues not usually easily observed with fruit size as well as the presence and concentration of the substances used (Aung *et al.*, 2004).

3.3 Other Postharvest Characteristics

3.3.1 1-MCP Resulted in Poor Quality and Shorter Shelf Life of Treated Chayote Fruit due to Decay

Apart from the price, the consumer's preferences are mainly affected by the visual appearance of the fruit. The visual quality of variously treated chayote at 10 to 15 DAT showed the development of blemishes and decay. All treatments had good quality, except for fruit treated with 1-MCP. Fruit treated with 1-MCP exhibited the poorest quality due to earlier onset of decay accompanied by a high decay incidence at 10 to15 DAT (Tables 3 and 4). The shelf life of all treatments did not vary from the control fruit. Cling-wrapped fruit had longer shelf life, but this only varied with fruit treated with 1-MCP. Cling-wrapped fruit were acceptable until 19 days while fruit exposed to the

1-MCP treatment exhibited a shorter shelf life of 12 days (Table 3). Although cling-wrapped fruit exhibited the longer shelf life, a few samples showed early onset of decay (Table 4).

Table 3. Visual quality and shelf life of chayote fruit after exposure to various postharvest treatments and holding at ambient conditions (26.51±1.38 °C, 81.11±7.03% RH)

Treatment	Concentration ($\mu L \cdot L^{-1}$)	Visual Quality[xy]			Shelf Life[z] (d)
		5 DAT[NS]	10 DAT	15 DAT	
Control		1.53	2.13[b]	2.50[b]	14.32[ab]
Cling wrap		1.67	2.13[b]	2.37[b]	19.29[a]
1-MCP	500	1.93	3.67[a]	4.27[a]	12.00[b]
	2500	1.67	3.27[a]	3.80[a]	12.97[ab]
Ethephon	100	1.53	2.20[b]	2.63[b]	16.73[ab]
	500	1.47	2.43[b]	3.00[b]	14.03[ab]
GA_3	100	1.60	2.17[b]	2.47[b]	16.90[ab]
	500	1.73	2.27[b]	2.43[b]	17.33[ab]

[x]Visual quality: 1 = excellent, field fresh, 2 = very good, with slight defects, 3 = good, moderate defects, 4 = fair, the limit of saleability and 5 = poor, unusable; [y]Means in a column with common letter/s are not significantly different using Kruskal-Wallis test at 5 % level of significance; [z]Means in a column with same letter/s are not significantly different using Tukey's HSD at 5% level of significance; [NS] – not significant; DAT – days after treatment

A better retention of moisture in cling-wrapped fruit may have accelerated the growth of pathogens that caused the early onset of decay (Risse, 1989). This observation was similar in wrapped cucumber showing high incidence of decay compared to unwrapped fruit (Dhall *et al*., 2012). In pomegranate, Moradinezhad *et al*. (2020) reported that high concentration of O_2 or CO_2 (active MAP) and ascorbic acid effectively controlled microbial growth in pomegranate relative to the passive MAP treatment. In the present study on chayote in passive MAP, the moisture inside the cling wrap along with the changed O_2 and CO_2 levels relative to that in air may have contributed to the development of decay.

Meanwhile, the blockage of ethylene in 1-MCP treatments on chayote may have influenced the development of decay, which suggests that small amounts of ethylene may be required to maintain basic levels of resistance against postharvest pathogens (Ku *et al*., 1999; Lurie, 2007). In other produce, the negative effect of 1-MCP on decay was also observed in walnut (Jiang *et al*., 2015); 'Shamouti' oranges (Porat *et al*., 1999); avocado, mango, custard apple and papaya (Hofman *et al*., 2001). This is in contrast with other fruits (i.e., apples, stone fruit, plum) wherein 1-MCP reduced decay severity (Saftner *et al*., 2003).

Table 4. Degree of decay and onset of decay in chayote fruit after exposure to various postharvest treatments and holding at ambient conditions (26.51±1.38 °C, 81.11±7.03% RH)

Treatment	Concentration ($\mu L \cdot L^{-1}$)	Degree of Decay[xy]			Onset of Decay[z] (d)
		5 DAT	10 DAT	15 DAT	
Control		1.07^{c}	1.17^{d}	1.50^{d}	24.25^{ab}
Cling wrap		1.47^{ab}	1.67^{bc}	2.17^{bc}	14.00^{cd}
1-MCP	500	1.70^{a}	2.93^{a}	3.80^{a}	10.93^{cd}
	2500	1.63^{abc}	2.43^{ab}	2.93^{ab}	9.04^{d}
Ethephon	100	1.37^{abc}	1.33^{cd}	1.77^{cd}	22.76^{ab}
	500	1.23^{bc}	1.63^{cd}	2.33^{bcd}	18.50^{bc}
GA_3	100	1.17^{c}	1.20^{d}	1.60^{cd}	23.85^{ab}
	500	1.33^{bc}	1.43^{cd}	1.67^{d}	27.87^{a}

[x]Degree of decay: 1 = no decay, 2 = 1 to 5% of surface area with decay, 3 = 6-10%, 4 =11-25%, 5 = > 26%; [y]Means in a column with common letter/s are not significantly different using Kruskal-Wallis test at 5 % level of significance; [z]Means in a column with common letter/s are not significantly different using Tukey's HSD at 5% level of significance; DAT – days after treatment

3.3.2 Cling-Wrapped Chayote Fruit Exhibited Lower Weight Loss

Higher weight loss in chayote was observed in 1-MCP treatment but this did not vary with 500 $\mu L \cdot L^{-1}$ ethephon-treated fruit at 10 days of storage. High weight loss in fruit treated with 1-MCP could be due to decay that increased water loss and sprout growth albeit rather slow. Weight loss at 15 DAT was similar among treatments. The least weight loss was observed in cling-wrapped fruit from 5 to 10 DAT (Table 5).

Table 5. Percentage weight loss of chayote fruit after exposure to various postharvest treatments and holding at ambient conditions (26.51±1.38 °C, 81.11±7.03% RH)

Treatment	Concentration ($\mu L \cdot L^{-1}$)	Weight loss[z] (%)		
		5 DAT	10 DAT	15 DAT[NS]
Control		2.62^{bc}	5.70^{bcd}	9.38
Cling wrap		0.82^{d}	2.07^{e}	5.10
1-MCP	500	4.13^{a}	6.41^{abc}	11.36
	2500	3.75^{a}	6.88^{a}	11.93
Ethephon	100	2.51^{bc}	5.42^{bcd}	8.85
	500	2.99^{b}	6.54^{ab}	10.66
GA_3	100	2.40^{bc}	5.29^{cd}	9.29
	500	2.29^{c}	5.14^{d}	17.06

[z]Means in a column with a common letter are not significantly different using Tukey's HSD at 5% level of significance; DAT – days after treatment; [NS] – not significant

Aung *et al*. (1996) reported that as weight loss increases due to water loss, sprout growth also increases in chayote. Water in a viviparous fruit like chayote is important in the seed germination process (Farnsworth, 2000). This is shown in the present study wherein fruit showing longer sprout and higher

percentage of sprouting had higher weight loss compared to cling-wrapped fruit. Likewise, in potato minitubers, longer sprouts and the greater number of sprouts per minituber contributed to the higher weight loss (Secretaria *et al*., 2018). At 10 DAT, cling wrap was able to reduce weight loss (64%) relative to the control in the present study. In accordance with the study of Aung *et al.* (1996), wrapped chayote fruit significantly resulted in reduced weight loss.

3.3.3 Starch Content did not vary among Treatments

At five to 15 DAT, in all treatments, starch content (i.e., samples from various parts of the fruit) were similar to the control. Overall, starch content during storage was lesser compared to the initial data (0 DAT) (Table 6). Starch reduction occurs over time since starch degrades into sugars to provide the substrate for the respiration process as observed in squash treated with exogenous ethylene (Araújo *et al*., 2017). The starch in the cotyledon of chayote is hydrolyzed and utilized in embryo growth during germination (Cadena-Iñiguez *et al.*, 2006). As the fruit matures, it becomes harder and fibrous which lessens the starch content as storage time progresses (Shiga *et al.*, 2015).

Table 6. Starch content of chayote after exposure to various postharvest treatments and holding at ambient conditions (26.51±1.38°C, 81.11±7.03 % RH)

Treatment	Concentration ($\mu L \cdot L^{-1}$)	Starch (%)	
		0 DAT ^{NS}	During storage period (5- 15 DAT)^{NS}
Control		8.12	6.05
Cling wrap		7.29	6.77
1-MCP	500	8.83	6.37
	2500	7.53	5.52
Ethephon	100	9.29	5.58
	500	7.17	6.08
GA_3	100	7.19	5.30
	500	7.48	5.28

^{NS} – not significant; DAT – days after treatment

In the present study, the starch content differed from previous studies on chayote grown in other countries like Mexico at 1.2 g/100 g (Modgil *et al*., 2004) and India at 10-11% (w/w; dry weight) which corresponds to 1-2% in the fresh weight (Shiga *et al.*, 2015). Aung *et al*. (1991) reported 17.7, 33.0 and 122.0 μg/mg dry weight starch content of skin (exocarp), flesh (mesocarp) and seed, respectively. Overmature chayote tuber can yield up to 10 to 25% starch (Coronel *et al*., 2017). Differences in starch content and other

characteristics may possibly be due to different types and growing conditions (Aung *et al*., 1991; Lira-Saade, 1996).

4. Conclusion and Recommendation

Different postharvest treatments were used to evaluate the sprouting and other postharvest characteristics of chayote fruit. These treatments included cling wrap (polyvinyl chloride, passive MAP), 500 and 2500 $\mu L \cdot L^{-1}$ 1-MCP, 100 and 500 $\mu L \cdot L^{-1}$ GA_3 and 100 and 500 $\mu L \cdot L^{-1}$ ethephon. Sprouting of chayote was delayed by using cling wrap and 1-MCP. However, these postharvest treatments also hastened the deterioration of the fruit due to the higher incidence and early occurrence of decay. Cling wrap retained moisture better than the other treatments as it reduced weight loss along with an eight days delay in the onset of sprouting compared to the control. Ethephon and GA_3 treatments showed similar results with untreated fruit in terms of visual quality, degree of decay, weight loss, onset of decay and shelf life. Although the ethephon treatment produced the longest sprouts, it did not enhance the early onset of sprouting. Cling wrap or 1-MCP may have suppressed ethylene action on sprouting as there was a delay in sprouting. On the other hand, the application of ethephon resulted in sprouting that was similar to the control. Starch content decreased with storage regardless of the treatment. To maintain the postharvest quality of chayote for marketing, sprouting must be reduced as it detracts the appearance of the fruit. Cling wrap treatment retained the quality of chayote longer by delaying the onset of sprouting and maintaining lower weight loss in fruit.

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