

## POTENTIAL OF AQUEOUS GINGER EXTRACT AS FRUIT COATING ON TOMATO

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**Abstract:** Soft fleshed tomatoes are easily damaged due to mechanical injuries. Later, the wounded tissue will be exposed to fungal infection thus fasten the deterioration rate and reduce the quality of tomato. The aim of this study was to evaluate the potential aqueous ginger extract to inhibit fungal pathogen that causes tomato wilt and its potential in delaying the weight loss of tomato fruits. For this purpose, *in vitro* antifungal assay using poison plate technique was used to observe the inhibition of fungal pathogen. Then, healthy tomato fruits were dipped in aqueous ginger extract before evaluated for the post-harvest quality such as weight loss and firmness. The results of this study show that 10% aqueous ginger extract can inhibit the fungal pathogen (*Fusarium oxysporum*) that causes tomato wilt with 13.57% inhibition. Through *in vivo* antifungal assay, tomato fruits dipped in this plant extract showed lower weight loss (14.44%) and higher firmness (1.7 N) as compared to untreated fruit, but the data were not significantly different. Therefore, manipulation of this extract was suggested to increase its antifungal properties or as eco-friendly coating to lengthen the shelf life of agricultural produces.

Keywords: Aqueous ginger extract, antifungal, *Fusarium oxysporum*, postharvest quality, tomato

### Introduction

Tomato (*Solanum lycopersicum*) is a popular vegetable fruit that can be found in most of the supermarkets in Malaysia. The fruit is highly perishable and has a short shelf life. Tomatoes are climacteric fruits with a high respiration rate that fastens the ripening process (Tripathi et al., 2016). Generally, tomato fruits are harvested at different ripening stages depending on customer and market preferences. Since tomatoes have a very short shelf life, the fruits, if harvested at matured green or breaker stage, will have a longer shelf life, better appearance, firmer texture, less weight loss, less decay, and more red colour if stored at 15- 20°C (Cantwell, 2010 not in reference list). According to Steven and Celso (2005), good quality

tomato fruits should be firm, have turgid appearance and shiny colour without any signs of mechanical injuries, shrivelling or decaying.

In tropical countries, storage of tomato fruits at ambient temperature has become a big challenge due to the warm and humid climate that favours decay caused by fungal infection. Ofor *et al.* (2009) reported that by eating raw tomato or minimally processed tomato may be a serious threat to consumers due to food safety. As a result, many studies have been done on natural plant products to develop an effective coating for treating fungal disease on tomato fruits prior to enhancing quality. For example, tomato fruits have been coated with extracts from several plants such as from neem seeds, moringa seeds and garlic bulbs to

maintain quality and inhibit the growth of fungi (Tijjani *et al.*, 2014). Although many plant extracts have been widely utilised as treatments, many more types of plant extracts need to be explored to be used in extending the shelf life of tomatoes. Application of natural plant extracts will encourage an eco-friendly management of agricultural produce, reduce the exposure of chemical residue to humans and animals and reduce the profit loss to many farmers. Therefore, the objective of this study was to evaluate the potential of aqueous ginger extract to inhibit fungal pathogen and its potential in delaying the weight loss of tomato fruits. The data from this study will provide information on the ability of plant extract in maintaining the postharvest quality of tomato fruits.

## Materials and Methods

### *Aqueous ginger extract*

Ginger rhizomes were washed under tap water and air-dried at room temperature. The ginger was cut into small pieces and an electrical grinder was used to grind 10g of ginger mixed with 100ml distilled water (Balamurugan, 2014). The plant extracts were prepared as described in Kekuda *et al.* (2010) with some modifications. Then, plant extract solution was filtered through 3-fold muslin cloth and kept overnight at room temperature and filtered again by Whatman No. 1 filter paper prior to use.

### *Pathogenic Fungal Isolate*

Pathogenic fungal isolate namely *Fusarium oxysporum* isolated from a diseased tomato was obtained from the culture collection at the Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu. The isolate was subcultured onto potato dextrose agar (PDA) for 7 days before used in *in vitro* antifungal assay.

### *In vitro antifungal assay*

For *in vitro* antifungal assay, poison food technique was applied by impregnating the PDA with aqueous ginger extract and adjusted to 10% concentration at temperature range of 45 to 50°C following Mohana and Raveesha (2007) with some modifications. Then, the pathogenic fungal disc was placed at the center of the plate and incubated for 7 days at room temperature  $27 \pm 2^\circ\text{C}$ . Negative control plate used PDA plate without any plant extract. The percentage of fungal inhibition was calculated based on the following formula:

$$\text{Percentage of inhibition (\%)} = (C - T) / C \times 100$$

Where;

C= Average increase in mycelial growth in control plate

T= Average increase in mycelial growth in treatment plate

### *In vivo antifungal assay*

Washed healthy tomato fruits were dipped 2-3 minutes in aqueous ginger extract and air-dried. The control fruits were dipped in sterile distilled water only. The fruits were then air-dried before arranging them in a container. All the fruits were incubated at room temperature,  $27 \pm 2^\circ\text{C}$  for 8 days and the data on weight loss and fruit firmness were evaluated at a 2- day interval.

### *Determination of weight loss*

Treated and untreated fruits were weighed individually at every two-day interval. Percentage of weight loss was calculated using the following formula:

$$\% \text{ (WL)} = \frac{\text{IW} - \text{FW}}{\text{IW}} \times 100$$

Where;

WL= The percentage weight loss of the sample

IW= Initial weight of the sample

FW= Final weight of the sample

### ***Determination of firmness***

The firmness of tomato fruits was determined by using Texture Analyzer (TA-TX) Plus Texture Analyzer (Texture Technologies Corp, USA). The texture analyzer was equipped with P/2N needle probe that interfaced with a computer with speed of 1.0 mm/s and 5 kg load cell. The data obtained was expressed in force, Newton (N).

### ***Statistical analysis***

For *in vitro* study, 3 replicates were used for each treatment with 3 plates in each replicate. For *in vivo* study, each treatment had 3 replicates with 4 fruits in each replicate. The treatments were conducted in a completely randomized design (CRD) throughout the experiment. Both of data were analysed using t-test using Statistical Package for the Social Sciences (SPSS) software version 23.

### **Results and Discussion**

Tomato fruits are frequently infected by many pathogens including *Fusarium oxysporum*. Occurrence of this tomato disease during storage not only causes profit loss to the producer but will increase mycotoxin contamination in the fruits which may be unfit for human consumption. Therefore, disease management of this fungus is very important to avoid any profit loss and reduce the risk to health problem. Numerous chemical controls have been established as fruit treatment, however application of these chemicals needs to be controlled to reduce bad impact on human health as well as the environment.

In this study, ginger aqueous extract at 10% concentration has been used as a dipping agent to reduce the weight loss of tomato fruits. Through *in vitro* study, PDA ameliorated with ginger aqueous extract can significantly inhibit the *F. oxysporum* isolate with a percentage of inhibition, 13.57% (Figure 1). Inhibition of this fungus was suggested due to the presence of antimicrobial properties in the plant extract. Studies conducted by Asgar *et al.* (2016 not in reference list) and Nychas *et al.* (2003) reported that ginger extract contained antimicrobial compound such as  $\alpha$ -pinene, borneol, camphene and linalool. In addition, ginger extract also contains several biologically active compounds that have medicinal properties such as phenolic compounds, flavonoids, essential oils, carbohydrates, proteins, alkaloids, glycosides, saponins, steroids, terpenoids and tannin (Dhanik *et al.*, 2017). According to Aldi (2017), ginger extract at 100% concentration can inhibit *F. oxysporum* with a percentage of inhibition, 100%. Surekha *et al.* (2010) reported that tomato fruits treated with 10% ginger extract can reduce the fungal spoilage and physiological loss on the fruits. The growth of fungi such as *Fusarium* sp., *Aspergillus*, and *Alternaria* sp. were also inhibited by using 5% and 10% of ginger extracts. A study conducted by Kappor (1997) reported that ginger extract effectively inhibits the growth of *Aspergillus niger* and *Penicillium digitatum*. Low percentage of fungal inhibition in this study was attributed to low concentration of ginger extract used and the different preparation methods which only used aqueous extract. Besides that, different ability of ginger extracts to inhibit fungal species was attributed to the cultivar and its source, solvent used, extraction process, the environmental conditions for growing and harvesting the fruit (Sivasothy *et al.*, 2011; Bautista-Banos *et al.*, 2003).

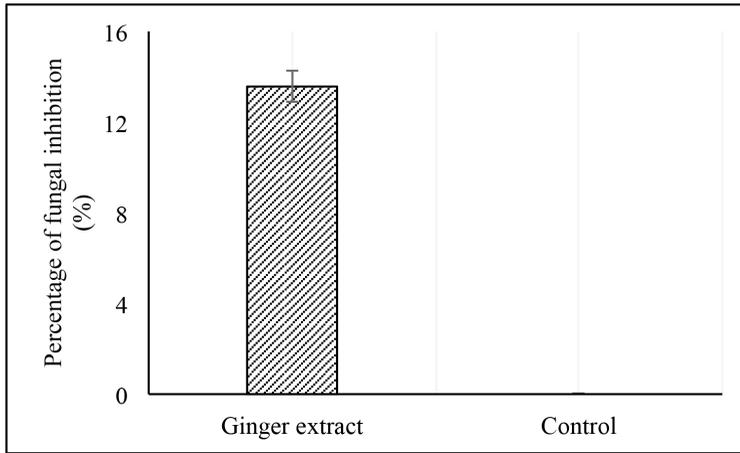


Figure 1: Percentage of fungal inhibition in PDA mixed with 10% ginger extract and only PDA inoculated with *F. oxysporum*

Nowadays, plant-derived compounds have become a major interest for many producers as natural alternatives to synthetic compounds. Application of aqueous ginger extract in this study can inhibit the growth of *F. oxysporum* on the PDA plate. Based on *in vivo* study, fresh tomatoes were dipped into this similar extract, but the results did not show any significant difference with the

untreated fruit (control) in terms of weight loss and firmness with p-value= 0.84 and 0.98, respectively (Figure 2 and Figure 3). Tomato fruits treated with 10% aqueous ginger extract showed lower weight loss and higher firmness after eight days of incubation as compared to untreated tomato fruits. However, these values were not significantly different with the control.

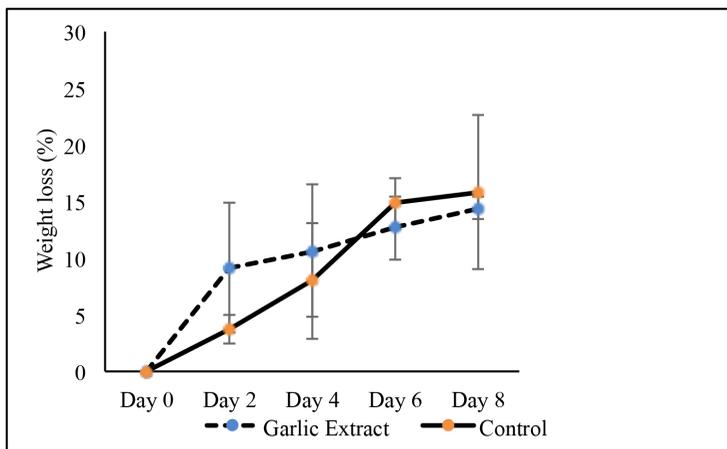


Figure 2: Weight loss of treated (ginger extract) and untreated (control) tomato fruits.

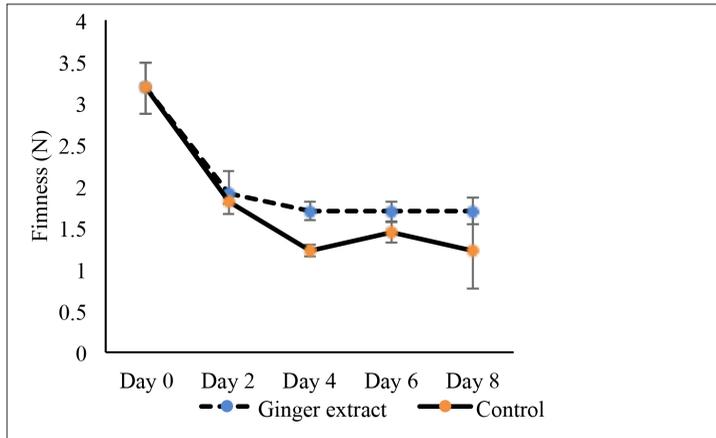


Figure 3: Firmness of treated (ginger extract) and untreated (control) tomato fruits.

Tomato is a climacteric fruit thus it has very high moisture content and respiration rate. The loss of weight in treated and untreated tomato fruits were attributes to water loss via the transpiration process that leads to wilting and shriveling (Ball, 1997). As a result, the fruit will shrink and may affect the market value and consumer acceptability. Findings by Javanmardi and Kubota (2006) show that tomatoes stored at ambient temperature will experience higher weight loss as compared to tomatoes stored at a low temperature. Therefore, higher weight loss in this study was also attributed to the ambient temperature at  $27 \pm 2^\circ\text{C}$  during incubation.

Changes in weight loss will directly impact the firmness of the fruits. In this study, changes in firmness occurred due to the loss of moisture through transpiration process as well as enzymatic changes (Znidarcic *et al.*, 2010). The pericarp flesh becomes soft during the ripening process which is a major contribution to the loss of texture. Jawadul *et al.* (2014) agreed that texture of firmness was a critical quality for consumer acceptability for many fresh fruits and vegetables. The reduction rate of firmness during storage will determine the quality and postharvest shelf life of tomato fruits. The continuous loss of the firmness of the fruits will increase the susceptibility of tomatoes

toward bruising (Khan & Vincent, 1993). The results of this study showed that dipping of tomato fruits in 10% aqueous ginger extract can reduce the deterioration rate and slow down the tomato's senescent process. As a result, the fruits undergo lower percentage of weight loss and at the same time maintain firmness. However, Tijjani *et al.* (2014) stated that the effectiveness of ginger extract to reduce the weight loss in tomato fruits is depends on the nature and amount of biologically active ingredients in the extracts. Therefore, this study concluded that dipping the tomato fruits in 10% aqueous ginger extract was not enough to prolong the shelf life of tomatoes. Further studies using higher concentrations of aqueous ginger extract was suggested to increase its ability as a dipping agent.

### Conclusion

As a conclusion, 10% aqueous ginger extract can inhibit the growth of *F. oxysporum* isolates through *in vitro* study. The ability of the solution to inhibit the fungal growth was suggested due to the presence of antifungal compound in the plant extract. Although this concentration of plant extract showed reduction in the weight loss and increase in the firmness of tomato fruits incubated for eight days at  $27 \pm 2^\circ\text{C}$ , the results were

not significantly different with untreated tomato fruits. Thus, a higher concentration of aqueous ginger extract is recommended to increase its ability in maintain quality of postharvest tomato fruits.

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