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Efficacy of *Aloe vera* (*Aloe barbadensis* Miller) Gel Edible Coatings on Quality Characteristics of Tomato Fruit During Postharvest Storage

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Abstract. Tomato fruit is prone to perishability with a shorter shelf-life owing to higher moisture content. The technique of coating edible *Aloe vera* (*AV*) gel on tomato fruit proposes the prospect of adding an antioxidant rich un-conventional ingredient in culinary applications alongside an extension of the shelf life of fruit to minimize its commercial losses. The present study investigated the efficacy of *Aloe vera* (*Aloe barbadensis* Miller) gel coatings in extending the physiological shelf life of tomato fruit during twenty one days of storage at ambient temperature (24 °C ± 2). A total of three (03) *Aloe vera* gel concentrations *i.e.*, 3, 6 and 9% were prepared and assessed for coating quality characteristics *i.e.*, pH, total solids %, viscosity (cp), drying time (min) and coating weight (g). Moreover, *AV* gel concentrations were coated on tomato fruits to examine postharvest quality characteristics *i.e.*, decay %, pH value, total soluble solids (TSS), titratable acidity %, sugar-acid (SA) ratio, weight loss %, moisture %, ash %, fibre %, carbohydrate % and vitamin C mg/100g after an interval of every 07 days during the storage period however uncoated tomato fruits were served as control. The results revealed that *AV* gel concentrations showed significant differences ($P < 0.05$) in coating quality characteristics. Results further revealed that tomato fruits coated with 6% *AV* gel maintained postharvest quality characteristics followed by 9% and 3% *AV* gel. It was further noticed that tomato fruits coated with *AV* gel notably maintained postharvest quality characteristics during the storage period in comparison to uncoated (control) fruits. The overall findings suggest that using 6% *AV* gel as edible coatings at ambient temperature (24 °C ± 2) may delay fruit ripening and extend the storage life of tomato fruit.

Keywords: tomato fruit, *Aloe vera* gel, edible coating, postharvest storage

Introduction

Tomato (*Lycopersicon esculentum* L.) is a culinarily important, widely cultivated and nutritionally rich climacteric fruit that is loaded with dietary fibres, sugars, pectin, protein, minerals (K, P, Mg), vitamins (ascorbic acid, niacin), carotenoids (lycopene, β-carotene, lutein), and polyphenols (chlorogenic acid, quercetin, naringenin) etc. (Collins *et al*., 2022; Chaudhary *et al*., 2018; Wang and Seymour, 2017). Tomato fruit has wide culinary uses and great significance in everyday life due to its high nutritional value, characteristic taste and flavor. This fruit is globally popular as a versatile culinary ingredient. Its consumption has been associated with health promoting effects against cardiac disease, cancer etc. (Brown and White, 2019). Tomato fruit is highly perishable owing to its higher moisture content. In the summer season, the postharvest life of tomato fruit is relatively shorter which significantly reduces its nutritional value and economic efficiency. Alongside, postharvest damages, poor postharvest storage practices and pathogenic microbes are also responsible for its losses. Therefore, it is immensely essential to control its postharvest losses, ensure its nutritional and sensorial quality characteristics, maintain aesthetic attributes and enhance its shelf life using efficient, cost-effective and reliable techniques (Cao *et al*., 2023; Peralta-Ruiz *et al*., 2020). Certain factors such as fruit harvest at the right maturity time, adequate temperature, humidity control and ethylene supply are some factors that limit the fruit losses, while on the other side edible film or coating treatments on fruit surfaces are also receiving potential attention in enhancing fruit's postharvest shelf

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life. Edible coatings (ECs) are thin layers of edible materials (liquid/semi-solid etc.) applied on fruit surfaces to enhance shelf life (Maringgal *et al*., 2021; Nor and Ding, 2020) and are gaining research interest due to their versatile applications. ECs are safer to consume together with fruit (Summo and De Angelis, 2022). Plant-based ECs provide a barrier against moisture, gases, growth of micro-organisms and colour changes, and are involved in limiting the transfer of lipids and flavour compounds (Victor *et al*., 2011; Ali and Mahmud, 2008).

The gel of *Aloe barbadensis* Miller can be used as an edible coating due to its strong preserving properties (Mendy *et al*., 2019). Its gel is loaded with phytochemicals, anti-inflammatory, antioxidant, antibacterial agents (Rizwana *et al*., 2022). It reduces the rate of respiration, transpiration and delays the postharvest deterioration of agricultural produce (Kahramanoðlu, 2017) therefore in recent years, the use of *AV* gel coating in postharvest produce has been on the rise (Ali *et al*., 2020). The prospect of using *AV* gel as fruit coating is associated with extending the fruit's shelf life, maintaining the fruit's aesthetic quality, retaining the fruit's nutritional value, cost-effectiveness and suitable climatic conditions for its cultivation in many regions of Pakistan. The novel idea demonstrated in the present study reveals that *AV* gel coating is not merely concerned with reducing the utilization of synthetic fruit coatings but direct dietary utilization of *AV* gel-coated tomato fruits *i.e*., without removing or washing coated gel will aid medicinal benefits (*i.e*., improved digestion, anti-inflammatory effects, etc.) among consumers. On a commercial scale, *AV* gel coating's cost-effectiveness depends on the methods used for coating application (*i.e*., brushing, spraying, or immersion, etc.), the cost of *AV* gel, and large-scale fruit coating operations etc. Therefore, the present study was conducted to investigate the use of various concentrations of *AV* gel coating on the quality characteristics of tomato fruit during postharvest storage.

Materials and Methods

Plant materials. A homogenous batch of fresh and defect-free tomato fruits (cv. Roma) with uniform green colour, physiological stage (mature, unripe), size and weight were availed from a local agriculture field near Khesana mori, Sindh. Fresh *AV* (Aloe *barbadensis* Miller*)* leaves were obtained from the Horticulture garden of SAU, Tandojam.

Preparation of *AV* gel coating. The coating concentrations were prepared as per the method developed by Navarro *et al*. (2011) with slight modifications. Briefly, the *AV* leaf was washed with chlorinated water (50ppm), air dried, cut to remove spikes from leaf margins, and peeled off longitudinally to obtain the gel fillet. Afterward, the fillet was crushed to obtain mucilaginous gel and filtered. The filtered fraction was used for preparing *AV* gel concentrations *i.e*., 3, 6 and 9% (v/v) using distilled water (DW).

Coating quality attributes. All three *AV* gel coatings *i.e*., 3, 6 and 9% were assessed for pH value, total solid %, viscosity (cp), drying time (min) and coating weight (g) on fruit as per the method described by Chauhan *et al*. (2015).

Coating application. All tomato fruits were distributed into four (04) equal lots (L0, L1, L2 and L3). Each lot was dipped into 0.08% sodium hypochlorite solution for 3 min, washed with DW and air dried at room temperature. All tomato fruits from each lot were coded, weighed and coated with *AV* gel by immersing fruits in 3%, 6%, and 9% *AV* gel concentrations for 10 min. On each tomato fruit, the *AV* gel was coated three times by immersing it in the same manner. The tomato fruits in L0 were merely dipped in DW for 10 min and served as control. All lots were cabinet dried at 55 °C ± 1 till complete drying of coating material (*i.e*., 8.05 to 11.19 min). Afterward, fruits were weighed, packed in airtight polyethylene bags, sealed, coded and kept in a dark place for 21 days of storage at room temperature (24 °C ± 2 with humidity 23 to 28%) and assessed for tomato fruit quality characteristics.

Postharvest quality assessment. *Decay analysis.* The decay analysis (DA) was performed as per the method described by Chrysargyris *et al*. (2016). The fruit decay from each lot (L0 to L3) was evaluated using visual sense after every 7 days of storage period. The tomato fruit with surface mycelia development/fungal growth/ bruising was considered a decayed fruit. The formula given below was used to determine % of fruit decay.

Decay (%) = No. of decayed fruits/total no. of fruits × 100

Fruit quality characteristics. The tomato fruits from all four lots were assessed for determining fruit quality characteristics after every 7 days of storage period *i.e*., pH value, total soluble solids (TSS)°Brix and weight loss % as per standard methods. Moisture %, ash %, fiber content % and carbohydrate % were determined as per the method of AOAC (2012). Titratable acidity (TA) was examined as per the method used by Teka (2013), sugar-acid ratio (SA ratio) was determined as per the method by Tigist *et al*. (2013), while vitamin C was evaluated by the titration method of AOAC (1995).

Statistical analysis. The method described by Gomez and Gomez (1984) was followed for statistical analysis of the data. A total of three replications were studied for all tests (DA and fruit quality characteristics). The data obtained were analyzed using Statistical Package for the Social Sciences-20 for one-way ANOVA. The mean values at P-value < 0.05 were evaluated.

Results and Discussion

Table 1 shows the quality attributes of *AV* gel concentrations, the highest pH value was found in 3% *AV* gel (6.01) followed by 6% (5.73) and 9% *AV* gel (5.54). This finding is consistent with the pH value of *AV* gel as reported by González *et al.* (2008). Total solids remained highest in 9% *AV* gel (8.09%) followed by 6% (5.47%) and 3% *AV* gel (2.34%). Athmaselvi *et al.* (2013) also found similar total solid content in *AV* gel coatings *i.e.*, 8.26%. At ambient temperature, 9% *AV* gel was demonstrated to have the highest viscosity (2.93cp) followed by 6% (2.36cp) and 3% *AV* gel (1.07cp). According to Rahman *et al*. (2017), *AV* gel contains viscous polysaccharides including glucomannan and acemannan which with sterols, phospholipids and fatty acids form a cross-linking network that gives viscosity to *AV* gel. This viscidness helps in uniform adherence of *AV* gel on the fruit surface. In terms of coating weight/fruit, 9% *AV* gel showed higher average values (0.20g) followed by 6% (0.19g) and 3% *AV* gel (0.17g). For drying, 3% *AV* gel took the longest time (11.19 min), followed by 6% (9.54 min) and 9% *AV* gel coatings (8.05 min).

Table 1. Average quality characteristics of different *AV* gel coating concentrations

Coating quality characteristics	*AV* gel coating concentrations		
	3% *AV*	6% *AV*	9% *AV*
pH	6.01	5.73	5.54
Total solids (%)	2.34	5.47	8.09
Viscosity at Am. T (cp)	1.07	2.36	2.93
Coating weight/fruit (g)	0.17	0.19	0.20
Drying time (min)	11.19	9.54	8.05

(*AV*= *Aloe vera*; Am. T=Ambient temperature (24 °C±2).

DA. DA was observed to assess the effectiveness of *AV* gel coatings in retarding tomato fruit deterioration. During storage, the average decay % in tomato fruits coated with *AV* gel remained slower and gradual as shown in Table 2. However, compared to *AV* gel-coated fruits, the uncoated tomato fruits exhibited significantly higher decay % with blossom end black rot and softened fruit pulp. Among all coating concentrations, 6% *AV* gel-coated fruits exhibited minimum decay (3.82%) followed by 9% (8.82%) and 3% *AV* gel coatings (16.69%). On the other hand, the decay % in uncoated samples was higher (52.38%) than in coated fruits. A previous study by Misir *et al.* (2014) also reveals that *AV* gel is effective in reducing the proliferation of micro-organisms, while as per Sinha *et al*. (2019), *Fusarium* species are common pathogenic agents responsible for postharvest tomato fruit decay.

Fruit quality characteristics. ***pH value.*** The pH changes in *AV* gel-coated and uncoated tomato fruits are shown in Table 3. All fruits showed a pattern of decreasing pH during storage whereas coated fruits

Table 2. Average decay (%) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Tomato fruit decay %				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	0	0	0	0	0.00^{c}
7th day	43.26^{c}	13.80^{def}	3.10^{cef}	5.66^{ef}	16.45^{b}
14th day	96.60^{a}	23.23^{cde}	5.30^{ef}	12.70^{def}	**34.45^{a}**
21st day	69.66^{b}	29.74^{cd}	6.90^{ef}	16.93^{def}	30.80^{ab}
Mean	**52.38^{a}**	16.69^{b}	3.825^{c}	8.825^{d}	

(Mean values with different letters are significantly different at P < 0.05).

displayed a slight manner of pH decline in comparison to uncoated fruits. At initial, all fruits had a similar pH range (4.68-4.70), while 6% *AV* gel-coated fruits delayed changes in pH value *i.e*., 4.68 at initial, while 4.41 on the 21st day of storage. However, 9% *AV* gel also performed better in declining pH followed by 3% *AV* gel. This might be due to the lower pH of *AV* gel that helped in maintaining the pH value of the fruit. A study by Adiletta *et al.* (2019) reveals that the pH value of uncoated figs was higher than coated figs since organic acids hydrolyze during respiration.

TA. During storage, TA of *AV* gel-coated tomato fruits increased regardless of *AV* gel concentrations (Table 4). Initially, no significant differences (P≤0.05) in TA were noted between *AV* gel-coated and uncoated fruits. On the 21st day of storage, the control sample had the highest TA (0.57%), while 6% *AV* gel-coated fruits had a significantly lower TA (0.36%). A lower TA is indicative of a lesser citric acid which is the most abundant organic acid found in tomato fruits. Jati *et al*. (2022) also found similar results showing an increase in TA during the storage of *AV* gel-coated tomato fruits. Normally, as tomatoes mature and ripen, there is a decrease in citric acid due to metabolic breakdown, increased ethylene production and respiration rate (Zhang *et al*., 2017). However, *AV* gel coating on tomato surface might have reduced gas penetration, inhibited ethylene production, slowed down the ripening process and delayed senescence (Maan *et al*., 2021).

TSS. The TSS increased in both coated and uncoated tomato fruits during storage, however, this increase was gradual in coated fruits (Table 5). At initial, TSS ranged between 4.13 to 4.15 °Brix in all coated and uncoated fruits. The highest TSS was noted in uncoated fruit (4.45 °Brix), while the lowest (4.25 °Brix) was in fruit coated with 6% *AV* gel on the 21st day of storage. TSS is a reliable indicator of a fruit's maturity level and reflects the concentration of sugars. Jati *et al*. (2022) found that tomato fruits coated with *AV* gel had higher TSS during storage. As tomato ripens, their polysaccharides break down into simple sugars, increasing TSS (John *et al*., 2018). However, the *AV* gel coating caused a minor increase in fruit TSS possibly due to reduced respiration and energy uptake, leading to a decreased hydrolysis of polysaccharides (Nourozi *et al*., 2020).

SA ratio. The SA ratio increased in all coated and uncoated tomato fruits (Table 6). Initially, the SA ratio ranged from 0.063 to 0.066. The uncoated tomato fruits showed the lowest SA ratio however on the 21st day of

Table 3. Average pH value of *AV* gel-coated tomato fruits during postharvest storage

Storage period	pH value				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	4.70	4.68	4.68	4.68	**4.68^{a}**
7th day	4.55	4.58	4.67	4.63	**4.60^{a}**
14th day	4.47	4.55	4.62	4.48	4.53^{b}
21st day	4.25	4.36	4.41	4.39	4.35^{c}
Mean	4.49^{b}	**4.54^{a}**	**4.59^{a}**	**4.54^{a}**	

(Mean values with different letters are significantly different at P < 0.05).

Table 4. Average TA (%) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Titratable acidity %				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	0.27	0.27	0.27	0.26	0.26^{c}
7th day	0.38	0.36	0.31	0.34	0.34^{b}
14ath day	0.46	0.38	0.34	0.38	0.39^{ab}
21ast day	0.57	0.41	0.36	0.44	**0.44^{a}**
Mean	**0.42^{a}**	0.35^{ab}	0.32^{c}	0.35^{ab}	

(Mean values with different letters are significantly different at P < 0.05).

Table 5. Average TSS (?Brix) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Total soluble solids (Brix)				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	4.15	4.14	4.13	4.15	4.14[d]
7th day	4.23	4.20	4.18	4.20	4.20[c]
14ath day	4.41	4.27	4.21	4.25	4.28[ab]
21st day	4.45	4.31	4.25	4.29	**4.32[a]**
Mean	**4.31[a]**	4.23[ab]	4.19[c]	4.22[ab]	

(Mean values with different letters are significantly different at $P < 0.05$).

Table 6. Average sugar-acid ratio of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Sugar-Acid ratio				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	0.063	0.065	0.066	0.064	0.064[d]
7th day	0.089	0.086	0.075	0.081	0.082[c]
14th day	0.104	0.089	0.081	0.091	0.091[b]
21st day	0.129	0.096	0.086	0.104	**0.103[a]**
Mean	**0.096[a]**	0.084[b]	0.077[c]	0.085[b]	

(Mean values with different letters are significantly different at $P < 0.05$).

storage uncoated tomato fruits had the highest SA ratio (0.129) followed by the 9% *AV* gel-coated fruit (0.104). Conversely, the lowest SA ratio was observed in fruit coated with 6% *AV* gel (0.086) and nevertheless remained the most effective *AV* gel coating concentration in maintaining the SA ratio in tomato fruits during the entire storage period. The sugar acid ratio is a measure of the sweetness and sourness of a fruit. As a fruit ripens, the ratio increases because the sugar content increases and the acid content decreases. This ratio is important for determining when the fruit is commercially and organoleptically ripe. Overripe fruits have a low ratio and lack characteristic flavor (Bejar *et al*., 2020).

Vitamin C (mg/100g). All coated and uncoated tomato fruits had similar vitamin C content (Table 7) at 0 day while over time vitamin C increased. On the 14th day, uncoated tomato fruits showed the highest vitamin C, however 9% *AV* gel-coated fruit had the highest vitamin C (42.20 mg/100g) on the 21st day. The 6% *AV* gel-coated fruit performed well in maintaining vitamin C throughout the storage period, whereas the 3% *AV* gel-coated fruit had lower content on the 14th day. On the 21st day, the uncoated tomato fruits had the lowest vitamin C (28.29 mg/100g). Tomatoes are rich in vitamin C with varying levels *i.e*., 10 to 60 mg/100 g (Mditshwa *et al*., 2017). *AV* gel-coated fruits may play an essential role in limiting oxygen availability and reducing fruit degradation thus preventing vitamin C oxidation (Khaliq *et al*., 2016). In the present study, *AV* gel-coated fruits had higher vitamin C, particularly those treated with 9% *AV* gel, likely due to the gel's ability to limit oxygen exposure and slow down vitamin C oxidation. The natural antioxidants in *AV* gel have a progressive role in protecting vitamin C from oxidation. The findings are aligned with a previous study by Chrysargyris *et al*. (2016) that *AV* gel-coated tomato fruits delayed vitamin C reduction during the storage period.

Moisture %. The moisture % of tomato fruits was affected by concentrations of *AV* gel coating and storage period (Table 8). All coated and uncoated tomato fruits showed higher moisture content on the 7th day of storage. However, on the 21st day of storage, coated fruits exhibited the highest moisture in fruits coated with 9% *AV* gel. Among all *AV* gel coating concentrations, the 6% and 9% *AV* gel concentrations restored moisture content in comparison to the 3% *AV* gel concentration. The results indicate that *AV* gel coating is effective in mitigating moisture loss during postharvest storage of tomato fruits. Parvin *et al*. (2018) also found that the moisture % was lower in uncoated tomato fruits, while

Table 7. Average vitamin C (mg/100g) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Vitamin C (mg/100g)				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	13.82	13.81	13.80	13.48	13.72^{d}
7th day	20.56	18.53	16.85	18.20	18.53^{c}
14th day	44.60	31.55	28.85	30.20	33.80^{b}
21st day	28.29	32.22	40.18	42.20	**35.72^{a}**
Mean	**26.81^{a}**	24.02^{d}	24.92^{c}	26.02 b	

(Mean values with different letters are significantly different at P < 0.05).

Table 8. Average moisture (%) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Moisture (%)				Mean
	Control (Without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	80.16	80.07	80.11	80.16	80.12^{c}
7th day	83.37	82.37	81.11	81.26	82.02^{b}
14th day	84.30	83.24	82.18	83.49	83.30^{ab}
21st day	81.17	82.12	84.90	85.43	**83.40^{a}**
Mean	82.25^{ab}	81.95^{c}	82.07^{b}	**82.58^{a}**	

(Mean values with different letters are significantly different at P < 0.05).

higher in coated fruits during storage. This may be due to the role of *AV* gel coating as a barrier between fruit and the environment, preventing exposure to oxygen and reducing water loss through transpiration. ECs may change the surrounding atmosphere of fruit by forming a semi-permeable layer, shielding it from water loss and oxygen exposure (Mitelut *et al*., 2021).

Ash %. At Initial, there was no significant difference (P≤0.05) in ash content among all coated and uncoated fruits (Table 9). However, as storage progressed, variations in ash content were observed. On the 7th and 14th days, uncoated tomato fruits had the highest ash % while on the 21st day, the 9% *AV* gel-coated fruits showed the highest ash content (5.57%) however the 6% *AV* gel-coated fruit had the lowest ash content (5.31%). Ajiboye and Gboyinde (2020) also observed similar results as *AV* gel-based coatings showed the highest ash content compared to other treatments in cucumber fruits during storage. The ash content is an organic aspect of food that reflects the range of minerals present in it (Olalude *et al*., 2015).

Fibre %. During storage, the fibre content in coated and uncoated tomato fruits increased gradually (Table 10). The uncoated fruit had 10.13% fibre which increased

Table 9. Average ash (%) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Ash (%)				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	5.16	5.17	5.18	5.17	5.17^{b}
7th day	5.47	5.31	5.19	5.36	5.33^{ab}
14th day	5.56	5.43	5.25	5.40	**5.41^{a}**
21st day	5.35	5.47	5.31	5.57	**5.42^{a}**
Mean	**5.38^{a}**	5.34^{ab}	5.23^{b}	**5.37^{a}**	

(Mean values with different letters are significantly different at P < 0.05).

to 11.42% on the 21st day. Coated tomato fruits had lower fibre content than uncoated fruits on the 7th and 14th day. The 6% *AV* gel-coated fruits presented the lowest fibre content. However, on the 21st day, the 3% *AV* gel-coated treatment had the highest fibre content at 11.46%. Tomatoes are a rich source of both soluble and insoluble dietary fibres such as cellulose, hemicelluloses, pectin etc. These fibers are not easily digested and are believed to improve gut health and prevent diseases such as cancer, diabetes, cardiovascular diseases, and obesity etc. (Delzenne *et al*., 2020; Merenkova *et al*., 2020).

Carbohydrates %. During the storage period, the carbohydrate content in tomato fruits decreased (Table 11) however, this decrease was lower in *AV* gel-coated fruits. Initially, coated and uncoated tomato fruits had similar carbohydrate content, while at the end of the storage period, the uncoated tomato fruit had the lowest carbohydrate content. The tomato fruit coated with 6% *AV* gel had the highest carbohydrate. In a study, Kamis *et al*. (2004) observed a gradual decrease from 3.92 to 2.84% in total carbohydrate content as the stages of ripening progressed from the green to the red stage of tomato fruits. The carbohydrates break down into simpler compounds in fruits during ripening (Pan *et al*., 2021). The tomato fruits without coating showed decreased carbohydrate content due to increased metabolism. The *AV* gel coating agents retard carbohydrate metabolism by significantly lowering the enzymatic activity (Shakir *et al*., 2022).

Weight loss %. The *AV* gel-coated tomato fruits exhibited a significant decline in weight loss % during storage (Table 12). The 6% *AV* gel-coated tomato fruits displayed a prominent role in maintaining weight loss during storage. On the 21st day, the uncoated fruits had the highest weight loss (3.55%), while the 6% *AV* gel-coated treatment showed the lowest weight loss. Similar results were also observed by Jati *et al*. (2022) in which weight loss was lower in *AV* gel-coated tomato fruits compared to uncoated fruits. The weight loss % of stored tomato fruits is a crucial factor affecting their appearance and acceptability, as moisture loss can cause wrinkled skin. *AV* gel coating may prevent excessive weight loss by limiting oxygen contact and inhibiting tomato respiration, ultimately preserving their freshness and appearance (Shah and Hashmi, 2020).

Table 10. Average fibre (%) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Fibre (%)				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	10.13	10.17	10.18	10.17	10.16^{d}
7th day	11.47	10.81	10.21	10.40	10.72^{c}
14th day	12.56	12.43	12.25	12.40	$\mathbf{12.41^{a}}$
21st day	11.42	11.46	11.38	11.43	11.42^{b}
Mean	$\mathbf{11.39^{a}}$	11.21^{ab}	11.00^{b}	11.1^{b}	

(Mean values with different letters are significantly different at P < 0.05).

Table 11. Average carbohydrate (%) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Carbohydrate (%)				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	5.08	5.09	5.08	5.08	$\mathbf{5.08^{a}}$
7th day	4.20	4.66	4.87	4.72	4.61^{b}
14th day	3.95	4.45	4.70	4.36	4.36^{c}
21st day	3.55	4.35	4.60	4.25	4.18^{d}
Mean	4.19^{c}	4.63^{b}	$\mathbf{4.81^{a}}$	4.60^{b}	

(Mean values with different letters are significantly different at P < 0.05).

Table 12. Average weight loss (%) of *AV* gel-coated tomato fruits during postharvest storage

Storage period	Weight loss (%)				Mean
	Control (without coating)	3% *AV* gel-coated fruit	6% *AV* gel-coated fruit	9% *AV* gel-coated fruit	
0 day	0	0	0	0	0
7th day	1.77	1.66	1.33	1.46	1.55[c]
14th day	2.62	2.12	0.85	2.02	1.90[b]
21st day	3.55	3.05	2.60	3.00	**3.05[a]**
Mean	**1.98[a]**	1.70[b]	1.19[c]	1.62[c]	

(Mean values with different letters are significantly different at $P < 0.05$).

Conclusion

The *AV* gel as an edible coating exhibited efficacy in maintaining postharvest quality and extending the storage life of tomato fruits in comparison to uncoated (control) tomato fruits. It is therefore concluded that among all *AV* gel coatings, 6% *AV* gel exhibited a promising role in preserving the overall quality attributes of tomato fruit during 21st days of storage at ambient temperature (24 °C±2) followed by 9 and 3% *AV* gel coatings.

Recommendations

Based on the findings of the study, it can be recommended that using a 6% concentration of *AV* gel as an edible coating may be effective in preserving quality characteristics and extending the shelf life of tomato fruits therefore, it is suggested that *AV* gel coating at 6% concentration can be adopted by tomato fruit farmers, transporters, distributors, retailers and households for reducing postharvest losses and maintaining quality characteristics of tomato fruits during the storage period.

Conflict of Interest. The authors declare that they have no conflict of interest.

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