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Short communication

Evaluation of Postharvest Quality Attributes of Gum Arabic and Fruwash Coated Summer Squash

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ABSTRACT

The present investigation was envisaged to find out the effect of edible coating on postharvest quality of summer squash stored under cold storage. In this study, gum arabic (5, 10 and 15%) and fruwash were used as coating materials and their effect was evaluated in terms of colour hue, pectin methylesterase enzyme activity, total phenolics and total antioxidants activity. Among the various treatments, fruits coated with 10% gum arabic were best in retaining lower hue values (125.01), lower pectin methylesterase enzyme activity (0.00187 ΔA_{620} min^{-1} g^{-1} FW), total phenolics (≈30%) and higher antioxidants activity (26.46 µmol trolox equiv. g^{-1}). Results confirmed that that medium dose (10%) of gum arabic was most suitable for preserving fruit skin colour, lower enzymatic activity, higher retention of total phenolics and antioxidants compared to its higher and lower doses.

Key words: *Cucurbita pepo*, edible coating, hue angle, total phenolic content, total antioxidant activity

Summer squash (*Cucurbita pepo* L.) is an annual vegetable crop which belongs to Cucurbitaceous family. It is the main source of carbohydrates, dietary fibers, minerals (Ca, Mg, P and Zn) and many essential vitamins. Yellow to pink fruit flesh is richer in vitamin A than green-fleshed varieties due to the presence of carotenoids. Worldwide, it is grown commercially in many countries like United States of America, China, Europe, India and Japan. In India, the production is confined to a limited scale in Himachal Pradesh, Uttarakhand, Punjab, Haryana, Delhi and Uttar Pradesh. In India, there are limited varieties which are commercially cultivated like Australian Green, Pusa Alankar and Patty Pan. It can be grown in both field and greenhouse conditions that substantiates its importance and adaptability as a commercial crop across the globe. It can be grown as spring and summer seasonal crop due to its short duration (45 to 60 days after sowing ready for harvest) which makes it popular among farmers involved in protected cultivation. Further, owing to short shelf-life and quality deteriorative phenomenon, summer squash cultivation is mainly concentrated in peri-urban areas. Compared with other squashes, it is mostly consumed at the immature stage for culinary purposes before seeds begin to enlarge and harden. The whole tender fruit is edible, without discarding seeds and seed cavity tissues. Now a days a lot more varieties are available under summer squashes group having variation in shape, size, colour, and unit fruit weight. Thin, soft external rind and external glossiness are major indicators of a pre-maturity condition. Being a very soft rind vegetable, its handling transportation and storage requires specialized attention and quick disposal up to the consumer end. Among all cucurbits, squashes are highly perishable crop having shelf life of 2-3 days under ambient conditions. Loss of firmness and shriveling are serious and common postharvest problems in summer squash postharvest management. It is very sensitive to chilling injury (CI) during cold storage when stored without any treatment. The optimum storage temperature range varies between 5-10ºC depending on cultivar and production season. CI symptoms apparently appear on summer squash peel surface when stored below 5 ºC. It contains 90- 95% moisture and so the moisture loss remains higher during short period of storage, which makes it unacceptable for marketing as well as for consumer preference due to loss in textural integrity and freshness.

During recent times, edible coatings owing to their benefits *viz*. moisture and gas barrier properties, restricts exchanging volatile compounds, physical protection, carrier for functional ingredients, utilization as a packaging material and alternative to artificial film are being focused by the researchers. Edible coatings are generally applied on the surface of the produce in addition to or as a replacement for natural protective waxy coatings. Gum arabic is a

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cheap, abundant, biodegradable, edible and natural biopolymer used in the food and beverage industries and it is obtained as exudates of mature trees of acacia. Reported literature about the application of gum arabic to summer squash is lacking and therefore, this study was planned with an objective to evaluate the effect of different concentrations of gum arabic on shelf life of summer squash.

Fruits of Summer squash *cv*. Australian Green were obtained from Centre for Protected Cultivation Technology, Indian Agricultural Research Institute (IARI), New Delhi. The freshly harvested fruits were dipped in water and then air dried. The chemicals and reagents were procured from Merck India Ltd. Fruwash coating was provided by Dr. H.M. Chawla, Professor, Department of Chemistry, IIT, New Delhi. With a view to control shrivelling in summer squash fruits due to moisture loss, different surface coatings (Gum arabic and Fruwash) were applied at different concentration of gum arabic (5, 10 and 15%) and fruwash (constant) on the freshly harvested fruits at commercial maturity stage. The coated fruits were then dried and stored at 8 ± 2 ºC and 85- 90% relative humidity. Different parameters were recorded at 3 days interval. Peel colour was measured using Hunter Lab System (model: Miniscan XE PLUS). Hue angle from the freshly harvested as well stored summer squash were derived from a* and b* values using the equations: $h = \tan^{-1} (b^*/a^*)$ (degrees). Pectin methylesterase (PME) activity was measured by using the method of Hagerman and Austin (5) with minor modifications and it was expressed as ($0.328 \times A_{620} - 0.003$) "μmol min^{-1} g^{-1} FW". The total phenolic content of the fruit extracts were estimated by the using folin ciocalteu reagent by the method suggested by Singleton and Rossi (9) with slight modifications. The results were expressed as μg gallic acid equivalent/100g. Antioxidant capacity was determined by the CUPRAC method, which was standardized by Apak *et al*. (2). The results were expressed as μmol trolox equivalent g^{-1}. Two way analysis of variance was performed on the data sets using SAS 9.3 software (2) and significant effects ($p<0.05$) were noted. Significant difference among the means was determined by Duncan's Multiple Range Test (DMRT).

It is evident that irrespective of treatments there is rapid increase in h* angle up to end of the experiment, which indicate change in green colour of fruit (Fig.1). With respect to the material used for coating, the decrease in hue angle was significantly delayed. Up to 6 days of storage, marked increase in h* angle didn't showed any significant difference among the treatments indicating the retention of bluish green colour. However after that, relatively faster increase in h* angle was recorded. At the end of storage, highest h* angle (130.04) was recorded in control fruits, while it was lowest (125.01) in 10% gum arabic treated fruits followed by fruwash (125.68) treated fruits. At the end of storage period, color of the control samples became greenish yellow. Increase in hue angle during storage was due to degradation of chlorophyll from the skin turning yellowish. It is reported that 10% GA reduced the fruit skin changes and maintain the colour (Eskandari *et al*., 3). Retention of fruit skin colour could be due to slower rate of respiration in coated fruits and lesser tissue softening and color changes (Gurjar *et al*., 4)

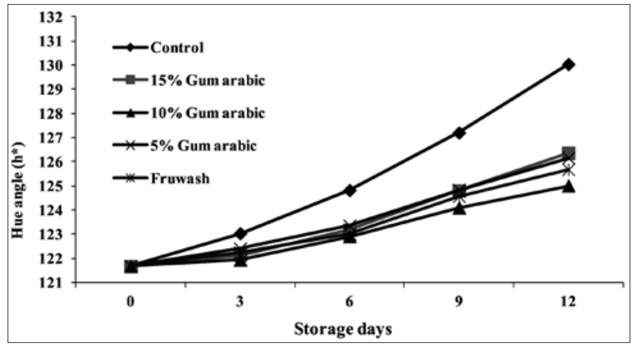

Fig. 1. Effect of gum arabic and fruwash coating on hue angle (h*) of summer squash stored at 8 ± 2 °C and 85-90% R.H.

Irrespective of the different treatments, continuous increase in PME activity was recorded with the advancement of storage period. Insignificant difference was recorded up to 3 days of storage. However after that, control fruits exhibited rapid increase compared with other treatments. At the end of storage, highest PME activity (0.00303 ΔA_{620} min^{-1} g^{-1}) was observed in untreated control fruits followed by 15% gum arabic (0.0023 ΔA_{620} min^{-1} g^{-1}) treated fruits, while it was lowest (0.00187 ΔA_{620} min^{-1} g^{-1} FW) in 10% gum arabic treated fruits (Fig. 2). However; no significant differences were observed among the 5% GA and fruwash at the end of the storage period. Fruit tissue softening and loss of fruit firmness was attributed to the reduction of cell membrane components, like pectin and destruction of cell wall integrity mainly due to the enzymes such as polygalacturonase and pectin methylesterase. Pectin is hydrolyzed by pectin methylesterase enzyme, so its cell wall integrity and firmness were reduced. The minimum PME activity was recorded in 10% gum arabic coating could be attributed to the fact that all the coatings material form a physical barrier around the fruit leading to depletion of oxygen and subsequently decrease in the enzyme activity. 10% gum arabic treated summer squash also have lower

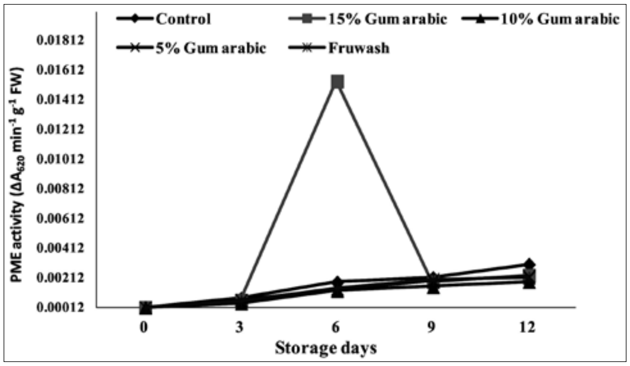

Fig. 2. Effect of gum arabic and fruwash coating on pectin methylesterase activity (ΔA_{620} min^{-1} g^{-1} FW) of summer squash stored at 8 ± 2 ºC and 85-90% R.H.

water loss so the fruit firmness is maintained and less PME activity in coated fruits compared with untreated samples. The findings are corroborated with the study performed on pear (Zhou *et al*., 10) and sweet pepper (Rao *et al*., 7), respectively.

The results presented in table 1 reveals that all the treatments have significant influence on phenolic content of summer squash during storage. Both the GA and Fruwash retained significantly higher total phenol content over the control during entire storage period. The maximum amount of total phenolic content in 10% GA coated fruit was observed stating that they maintained higher amounts of antioxidants than uncoated as well as fruit coated with higher concentrations (15%) GA. Among the coating materials, GA was found superior over fruwash; however the lower and higher dose doesn't gave good results in respect of total phenol content during entire storage period. The 10% GA was reported to enhance the antioxidants activity; while lower concentration (5%) had less phenolic content which may be due to higher respiration rate. The findings are in agreement with Ali *et al*. (1); substantiating that 10% gum arabic was best in maintaining the total phenolics in tomato stored at 20°C with 80–90% RH for 20 days due to sustaining the cell wall integrity and delay in senescence. Treatment with higher concentration of GA (15%) also resulted in less phenolic content owing to senescence, because anaerobic respiration may have started due to poor supply of oxygen. Other possible reason for higher phenolic compounds in coated fruits is that the optimum concentration of GA could have reduced the activities of enzymes like PAL, PPO, POD and chlorophyllase because PPO and POD are directly involved in the biosynthesis of phenolic compound in fruits and vegetables.

Irrespective of treatments, on 3rd day the antioxidant capacity initially decreased slightly in all the treatments including control, but after that there was increase in antioxidant capacity in all the treatments except in untreated control. At end of storage, among the different treatments, highest antioxidant capacity (26.46 µmol trolox equiv. g^{-1}) was recorded in fruits treated with 10% GA followed by (24.64 µmol trolox equiv. g^{-1}) fruwash, while it was lowest (17.64 µmol trolox equiv. g^{-1}) in untreated control fruits (Table 2). Summer squash fruits treated with 10% GA retained ≈50% higher antioxidant capacity compared to control. The main antioxidant compounds in summer squash are chlorophylls, total carotenoids, lutein and beta-carotene, etc. The increase in antioxidants capacity in coated fruits may also be due to increase in phenolic contents as in general, a positive correlation has been reported between total phenolic content and total antioxidant capacity (Reyes and Cisneros-Zevallos, 8; Mahattanatawee *et al*., 6).

In conclusion, the present study confirmed that gum arabic as a coating material has beneficial effect on retention of postharvest quality attributes of summer squash during storage. This suggests that gum arabic not only increase the shelf life but also preserves the total phenolics and antioxidant activity during storage. Gum arabic is a novel edible coating material and it is recommended

Table 1. Effect of gum arabic and fruwash coating on total phenolic content (µg GAE/100g FW) of summer squash stored at 8 ± 2 ºC and 85-90% R.H.

Treatments	Storage period (days)					
	0	3	6	9	12	Mean
Control	412.10^a	324.63^e	223.36^j	185.75^m	143.25^p	257.82^e
15% GA	412.10 ^{a}	375.67^b	278.58^g	242.13^i	159.50^n	293.60^b
10% GA	412.10 ^{a}	369.13^{bc}	291.38^f	262.13^h	203.81^k	307.71^a
5% GA	412.10 ^{a}	364.13^c	279.67^g	193.75^l	162.23^n	282.38^c
Fruwash	412.10 ^{a}	348.33^d	226.75^j	186.63^m	151.21^o	265.00^d
Mean	412.10^a	356.37^b	259.94^c	214.08^d	164.00^e	

Table 2. Effect of gum arabic and fruwash coating on total antioxidant capacity (μmol trolox equiv. g^{-1}) of summer squash stored at 8 ± 2 ºC and 85-90% R.H.

Treatments	Storage period (days)					
	0	3	6	9	12	Mean
Control	26.29^{bcdef}	25.09^{fgh}	23.73^{i}	21.01^{j}	17.64^{k}	22.75^{c}
15% GA	26.29^{bcdef}	25.68^{defg}	27.02^{abc}	26.27^{bcdef}	23.75^{i}	25.80^{b}
10% GA	26.29^{bcdef}	25.88^{cdefg}	27.90^{a}	27.30^{a}	26.46^{bcde}	26.77^{a}
5% GA	26.29^{bcdef}	25.56^{efg}	26.89^{abcd}	26.27^{bcdef}	23.90^{hi}	25.78^{b}
Fruwash	26.29^{bcdef}	25.94^{cdef}	27.10^{abc}	25.16^{fg}	24.64^{ghi}	25.83^{b}
Mean	26.29^{a}	25.63^{b}	26.53^{a}	25.20^{c}	23.28^{d}	

*Means with same superscript letter are not significantly different.

that it can be used for postharvest applications for extending the storage life of fruits and vegetables at commercial scale.

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