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RESEARCH ARTICLE

Preservation and extension of shelf life of *Malus domestica* using edible coating

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ABSTRACT

Fruits and vegetables are rich sources of micronutrients and macronutrients. They are reservoirs of antioxidants, bio-flavonoids, dietary fibres and flavouring compounds. Consumption of fruits and vegetables reduces the development of chronic diseases such as hypertension, coronary heart disease, asthma, etc. Apple (*Malus domestica*) is a commercially important fruit that is widely produced and consumed throughout the world. Fruits have short shelf life due to their perishable nature. Storage of fruits, post harvesting is one of the serious problems as they are prone to deterioration during handling, transport and storage. One of the major growth segments in food retail industry comprises of fresh and minimally processed fruits and vegetables. Wax coating is used mainly to preserve the fruits and to refract its colour which can be carcinogenic. Edible coating is one of the potential approaches for meeting this demand. The present study is carried out to increase the shelf life of apple using edible coating of gum Arabic in various concentration (3%, 5%, and 10%) along with aqueous solution of apple peel. It is observed that the use of a coating of gum Arabic and aqueous solution of apple peel retains the post-harvest fruit quality as compare to uncoated (control) fruit. The fruits were stored at room temperature for 14 days. Physiological loss in weight, pH, and sensory characteristics (colour, taste, and firmness) were analyzed at regular intervals during the storage period. The coated fruits survived the storage period of 14 days, whereas all the uncoated fruits (control) decayed within 14 days.

Keywords: Edible coating, Gum Arabic, Apple, sensory evaluation, shelf life.

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INTRODUCTION

In the recent times, the intake of fresh fruits has been rising due to their numerous health benefits. In response to the dynamic changes in current consumer demand and market trends, the area of Active Packaging is becoming increasingly significant. (Dilucia et al., 2020). The present study is carried out to increase the shelf life of apple using edible coating of gum Arabic in various concentration (3, 5, and 10%) along with aqueous solution of apple peel. Fruits and vegetables are essential constituents of daily diet and are in high demand from the majority of the population, irrespective of their geographical location, ethnicity, culture, etc. (Rojas-Grau et al., 2007). Post-harvest losses of fruits and vegetables are a serious problem because of their rapid deterioration during handling, transport, and storage. Edible coating over fruits and vegetables are used to improve their quality and shelf life (Kumar and Bhatnagar, 2014). An alternative approach involves the use of 'generally recognised as safe' (GRAS) edible coatings to minimise deterioration of quality caused by uncontrolled weight loss. Edible coatings form a semi-permeable barrier and limit moisture and gas exchange between the fruit and the surrounding atmosphere, resulting in reduced respiration

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and oxidation rates. Several polymers serve as the matrix in edible coating formulation which include proteins, lipids and polysaccharides. The application of edible coatings on fruits & vegetables is an effective method to improve their quality & thus, increase shelf-life. It can be safely eaten as a part of food (Raghav et al., 2016). Edible coating may carry functional ingredient such as antioxidants, nutrients and flavours to enhance food stability, quality, functionality and safety. Gum Arabic is a common edible polysaccharide with a GRAS status. It used in folk medicine and the food industry as a stabiliser and thickening agent in developing coatings and films. A new approach in this study has been done to extend shelf life of fruits by using edible coatings of natural antimicrobial compounds. Edible coatings with alginate can reduce weight loss, preserve quality of apples and prolong its shelf-life.

MATERIALS AND METHODS

Collection of samples

Fresh Apples (*Malus domestica*) were procured from the local market of Mumbai. They were selected on the basis of size, colour and absence of external injuries and marks.

Preparation of Gum Arabic solution

The crystals of Gum Arabic were purchased from local market and were crushed in a grinder to make fine powder. Solution of various concentrations, viz. 3%, 5% and 10% were made using distilled water. It was ensured that the powder was completely dissolved in the distilled water.

Preparation of Apple peel extract

To prepare Apple peel extract incorporated Gum Arabic coating, 100 g of apple peels were washed thoroughly with distilled water. The peels were then crushed in the grinder along with 50ml distilled water and then filtered through sieve. The solution was made up to 150 ml using the gum Arabic solution.

Storage Procedure

The fruits were then weighed and stored in fruit boxes. The experiments were replicated for each coating. Fruits without coating were used as control and were stored under same condition as coated fruits.

Titratable Acidity

Overripe fruits have very low levels of fruit acid and therefore lack characteristic flavour. For the estimation of Titratable acidity, fruits (longitudinal section of fruit was used) were homogenized and the resultant pulp was filtered. 10 ml of squeezed fruit juice was pipetted into a conical flask and diluted to 50 ml with distilled water. The sample was titrated against 0.1 N NaOH using phenolphthalein as indicator. The result was expressed as % total acid Titratable Acidity (TA). TA was determined according to the method as described by (Nair et al., 2020).

Titratable acidity = D x 0.064(NaOH solution is 0.1N) x C X 100 /(AXB)

Where, A= Weight of the sample. B= Volume of the sample taken for examination. C=Volume of the sample made with distilled water. D= Burette reading.

Physiological Loss in weight (PLW)

The Physiological Loss in weight (PLW) of Apples was calculated using Digital Weighing balance. It was calculated by subtracting the final weight of the apples from the initial weight. The results were then expressed in percentage using following formula: (A-B) x100/A. Where, A is the initial weight of fruits (0 day) and B is the fruit weight after the storage period.

Determination of pH

Fruits (longitudinal section of fruit was used) were homogenized and the resultant pulp was filtered. The pH of the fruit juice was determined using a digital pH meter as well as pH paper.

Sensory Analysis for evaluating fruit quality

Sensory analysis was carried out by selected panellists. The fruits were randomly selected from each batch and served on white plates. The sensory quality of each batch of fruits was rated based on colour, Taste and fruit firmness. For peel colour (5- bright red, 4- 30% to 75 % dark brown). For fruit firmness (5- very firm, 4- firm, 3- moderately firm, 2- soft, 1 – very soft). Fruit taste was evaluated on a 5 point hedonic scale (Hedonic scale term used in tasting panels where the judges indicate the extent of their like or dislike for the food.). i.e., from 5- very sweet, 4- sweet, 3-moderately sweet, 2-little bland, 1- bland) as an indicator of respiration rate and ripening. (Singh, N. 2019).

RESULTS AND DISCUSSION

The titratable acidity was determined as shown in Table 1. Titratable acidity (TA) in the coated fruits decreased with the storage period in both control and coated fruit. However, the decrease of TA was less pronounced in coated fruit compared to control. Overall results were better for 10% coating. The pH value was also calculated as shown in Table 2. The average value of pH in the control at the beginning was 5.5 and was found to increase to 7.5 till 14^{th} day of storage period. However, there were minimal changes in the pH of the coated fruit as compared to control fruit. Physiological loss in weight which is one of the significant properties in case of perishable fruit reveals maximum loss in control (Table 3).

For sensory evaluation; colour, firmness and taste was evaluated by panel members as shown in Table 4. Colour was evaluated based on the colour of the peel of fruit (Using a scale of 1 to 5) with ‘5’ as score for bright red and ‘1’ for dark brown. The coated fruit appeared more bright red as compared to control on the 14th day of storage period. Firmness values of 7^{th} days uncoated fruits were lesser compared to coated fruits which shows that coated fruits have more firmness than uncoated fruits. Taste score was evaluated based on the Hedonic scale which showed a significant difference as compared to control fruit. Sensory qualities of apple fruit were closer to the original on day 1, when edible coating was used.

Similar work (El-Anany and Ayman 2009) was done on Anna Apple (*Malus domestica* Borkh) which showed changes in physiochemical analysis (TA, sensory evaluation, physiological weight loss). However, the fruits were stored in cold storage and remained fresh for 50 days.

Applications of GA edible coating incorporating additives such as plasticizers and antimicrobial agents coating on fruits and vegetables were thoroughly observed by Tiamiyu et al.,2023. However, the current study was carried out in room temperature (30º C) and the GA mix did not contain any pesticide or antimicrobial agent in it.

Table 1: Titratable acidity (%) of the edible coated Apple and uncoated Apple.

Storage period (Days)	Control	3% concentration	5% concentration	10% concentration
1st Day	0.4 ±0.01	0.4 ±0.01	0.4 ±0.02	0.4 ±0.01
7th Day	0.14±0.03	0.23±0.02	0.24±0.01	0.19±0.02
14th Day	0.065±0.04	0.15±0.01	0.23±0.04	0.17±0.05

Table 2: pH of the edible coated Apple and uncoated Apple .

Storage period (Days)	Control	3% concentration	5% concentration	10% concentration
1st Day	5± 0.5	5± 0.5	5± 0.5	5± 0.5
7th Day	6± 0.5	5± 0.5	5± 0.5	5± 0.5
14th Day	7± 0.5	5± 0.5	6± 0.5	6± 0.5

Table 3: Physiological weight loss in fruits during storage

Storage Period (Days)	Control	3% concentration	5% concentration	10% concentration
1st Day	32.02±0.06	42.17±0.1	51.35±0.1	58.12±0.08
7th Day	7.23±0.09	2.17±0.05	2.01±0.07	2.05±0.08
14th Day	12.01±0.0.09	6.22±0.0.07	5.23±0.11	6.20±0.06

Table 4: Effect of edible coating on sensory qualities of Apple fruits stored at 30±3 degree Celsius

Storage period (Days)	colour	Firmness	Taste
1st Day			
Control	3±1	2±1	4±1
3% concentration	4±1	3±1	4±1
5% concentration	4±1	4±1	4±1
10% concentration	3±1	3±1	4±1
7th Day			
Control	2±1	2±1	2±1
3% concentration	3±1	3±1	3±1
5% concentration	3±1	2±1	3±1
10% concentration	4±1	3±1	4±1
14th Day			
control	2±1	2±1	1±1
3% concentration	2±1	3±1	3±1
5% concentration	3±1	2±1	3±1
10% concentration	3±1	3±1	3±1

CONCLUSION

In the present investigation, an attempt was made to enhance the shelf life of apple fruit using edible gum Arabic coating along with apple peel extract. Changes in the different parameters like pH, titratable acidity, Physiological loss in weight, Sensory qualities of apples were studied over varying storage time periods. The fruits were observed on 1st day, 7th day and 14th day after coating. It was observed that using 3%, 5%, and 10% coating, the post-harvest fruits showed different percentage of deterioration. In case of coated fruits using 3% gum Arabic with apple peel extract, 30 % of the fruit deteriorated after 14 days. With 5% coating it was around 20% and using 10% there was no observable deterioration. Sensory evaluation of fruits coated with 10% concentration of Gum Arabic and apple peel had a better taste and firmness. The appearance of the fruits was better in fruits coated with 10% concentration of mix compared to other concentrations applied. The quality of the apples could be retained better by using coating as compared to uncoated (control) fruits. The coated fruits (10%) survived the storage period of 14 days, whereas all the uncoated fruit (control) decayed within 14 days. The present work was carried out in ambient temperature (30º C) and the GA mix was not having any pesticide or any antimicrobial agent in it. So, it can be concluded that this method of preservation of apples is a convenient, organic and a viable option.

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