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RESEARCH ARTICLE

Effectiveness of Edible Coating to Preservation of Passion Fruit

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Abstract

Passion fruit (*Passiflora edulis*) is considered an exotic species with attractive flavor and aroma. This is a rich source of bioactive compounds, as polyphenols. The interest in *P. edulis* has been increased because of its antioxidant compounds. Passion fruit is generally considered to have a short storage life, because it is a very delicate, perishable fruit. The main problem of postharvest losses associated with passion fruits is rapid loss of firmness. The objective of the present study was to identify the effect of different carrageenan concentrations (1.0%, 1.5%, 2.0%, 2.5%, 3.0%) and storage temperature (8 ^{o}C, 12 ^{o}C, 16 ^{o}C, 20 ^{o}C) to the weight loss, firmness, total soluble sugar and ascorbic acid in passion fruit (*Passiflora edulis*) fruits during preservation. Moreover, shelf life (0 day, 7 days, 14 days, 21 days and 28 days) of passion fruit (*Passiflora edulis*) fruit in storage also clarified. Results demonstrated that carrageenan 2.5% and storage temperature 8 ^{o}C could maintain passion fruit (*Passiflora edulis*) fruit quality for 28 days without any deterioration. This is an opportunity to develop value-added products reducing the postharvest losses, improving nutritional value and generating additional revenue for passion fruit growers.

Keywords: *Passion fruit, Carrageen an, coating, Firmness, Shelf life, Preservation.*

Introduction

The passion fruit tree (*Passiflora edulis*) belongs to family *Passifloraceae.* It is a woody climber, chiefly for its edible fruits [1]. There are two recognized forms of passion fruit: purple (*P. edulis* Sims) and yellow (*P. edulis var. flavicarpa*) [2]. The *P. edulis var. flavicarpa* fruits are round in shape, with a diameter between 8 and 10 cm and a green peel at maturity which later turns yellow. The edible part of the passion fruit (40%) consists of pulp with seeds, and 60% of the peel consists of mesocarp and epicarp [3].

Composition of passion fruit rind has a higher nutrient content than the pulp. The rinds are a good source of fiber and pectin [4].It's also a good source of carotenoid [5].

Passiflora edulis is one which looks like an ornamental plant but the fruits are having high medicinal values. It also contains high amount of vitamin C in the fruits. The fruit is used as a heart tonic, digestive stimulant, body cooling, anti-asthmatic, and bronchitis, diuretic and anti oxidant [6, 8].

Supplementation with piceatannol from passion fruit can improve metabolic health, including insulin sensitivity, blood pressure, and heart rate in overweight men [9].

There were several studies mentioned to passion fruit (*Passiflora edulis*) processing and preservation. Physico-chemical and sensory quality of juice from purple passion fruit under different storage temperature and time were assessed.

Fruits stored at 25 ± 1°C, developed off-flavour in juice after 5 days, while storage at 8 ± 1°C produced no off-flavor even up to 21 days. Fruits can be stored for 5 days only at 25 ± 1°C as the overall sensory quality of juice reduced significantly afterwards, while juice maintained the optimum overall quality up to 21 days at 8 ± 1°C [10].

Phytochemical composition and antioxidant stability of fortified yellow passion fruit (*Passiflora edulis*) was evaluated. A significant chemical interaction affecting antioxidant capacity was found for hydrophilic juice components, but none was observed in the presence of lipophilic phytochemicals.

Physicochemical attributes and overall quality of passion fruit juice were retained following pasteurization but were significantly impacted by degradative reactions during accelerated storage [11]. The shelf life of the organic passion fruit pulp, both fresh and pasteurized at 70oC and 90oC and stored under refrigeration, was evaluated.

The pulps pasteurized at 70°C and 90°C were suitable for consumption for a minimum shelf-life period of 207 days of storage under refrigeration and for the fresh pulp it was attributed a shelf-life period of 60 to 90 days [12]. The modified atmosphere packaging technique was explored in order to investigate the changes of passion fruit quality during low temperature storage.

The MAP-2 (an ethylene absorber laminated LDPE with an OTR of 12000 cm 3 / m 2· day·atm) plastic showed the best results in maintaining fruit quality, gas composition, and extension of storage life (up to 51 days) [13]. The quality of yellow passion fruits stored under refrigeration and controlled atmospheres of different composition aiming to extend the postharvest life of the fruits was evaluated. The application of atmospheres with low oxygen concentration and high carbon dioxide level minimized quality losses.

At atmosphere with 5% O2 and 15% CO2, it was observed the lowest color change indexes and mass loss, and also the smallest decrease in acidity, soluble solids content, vitamin C, reducing sugars, and total soluble sugars [14]. Effect of storage conditions and duration on quality of passion fruit (Passiflora edulis Sims.) nectar was examined. Organoleptic evaluation revealed that passion fruit nectar containing 20% juice and 20°Brix was more acceptable. Total soluble solids, non-enzymatic browning, reducing, non- reducing and total sugars increased while, titratable acidity, vitamin C, total carotenoids, total phenols and total flavanoids decreased during storage.

Organoleptic quality of passion fruit nectar declined during storage. Microbial load in all the samples was within the acceptable limits even after three months of storage [15]. Physicochemical and microbiological analyses of passion fruit juice in dark and light bottles at 24°C and 4°C were conducted.

Fresh unpasteurized juice stored at 24°C and 4°C may safely be consumed within 1 and 2 days, respectively [16].Physiological and quality changes during postharvest ripening of purple passion fruit (*Passiflora edulis Sims*) was investigated. Passion fruit should be harvested only after 50% of fruit surface colour has developed, so as to allow for optimum postharvest storage, proper ripening, and development of characteristic flavour and fruit quality attributes [17].

Passion fruit jam; a new value added product was developed from underexploited passion fruit. Passion fruit jam developed with ratio of passion fruit juice to skin pulp of 1:1 was found more acceptable [18]. The effect of sonication on sensory quality and related chemical compounds of passion fruit juice during refrigerated storage was investigated.

Sonication of passion fruit juice is a treatment that does not affect the global sensory quality of the product [19].The seasonality of production and losses resulting from climate conditions, harvesting, transportation and perish ability of passion fruit were facing. Employing adequate technique to prolong their shelf-life of passion fruit was essential.

The objective of the present study was to identify the effect of different carrageen an concentrations (1.0%, 1.5%, 2.0%, 2.5%, 3.0%) and storage temperature (8 oC, 12 oC, 16 oC, 20 oC) to the weight loss, firmness, total soluble sugar and ascorbic acid in passion fruit (*Passiflora edulis*) fruits during preservation. Moreover, shelf life (0 day, 7 days, 14 days, 21 days and 28 days) of

passion fruit (*Passiflora edulis*) fruit in storage also clarified.

Materials and Method

Materials

We collected passion fruit (*Passiflora edulis*) fruits in Can Tho province, Vietnam. They were cultivated following Viet GAP to ensure food safety. After harvesting, collected nuts were stored at a temperature of 20˚C and they were conveyed to laboratory within 8 hours for experiments. These fruits were tumbled thoroughly under turbulent moving to remove dirt, dust and adhered unwanted material. Beside passion fruit we also used other materials during the research such as carrageenan, ethyl alcohol, propylene glycol. Lab utensils and equipments included digital weight balance, penetrometer, refractometer, biuret, and refrigerator.

Figure 1: Passion fruit (*Passiflora edulis*)

Methods

Preparation of Edible Coatings

Carrageenan (1.0 %, 1.5 %, 2.0 %, 2.5 %, 3.0 %) was prepared by dissolving 2.0g, 3.0g, 4.0 g, 5.0g, 6.0g of carrageenan powder in 200 ml of water ethyl alcohol mixture (3:1) at 80 ^{o}C and stirred for 10 min using magnetic stirrer. Ethyl alcohol was added in order to reduce drying time and obtain a transparent and shiny coating. 2% volume of propylene glycol was also added in the formulation as plasticizer. Passion fruit (*Passiflora edulis*) fruits were dipped in the film forming dispersions for 1min. After that, they were hung up and dried at room temperature with natural convection for 2– 3 h and then stored in refrigerator for further experiments.

Fruit Quality Assessments

The physical and chemical compositions including weight loss (%), firmness (N), total soluble solid (^{o}Brix), ascorbic acid (mg/ml), and antioxidant activity (DPPH, µg/ml; FRAP, mmol Fe^{2+} /g**)** in fresh and coated passion fruit (*Passiflora edulis*) were analyzed.

Weight loss (%): To evaluate weight loss, separate samples in 3 replicates of each treatment were used. The same samples were evaluated for weight loss each time at weekly intervals until the end of experiment. Weight loss was determined by the following formula: Weight loss (%) = [(A−B)/A] x 100 where A indicates the fruit weight at the time of harvest and B indicates the fruit weight after storage intervals (A.O.A.C., 1994).

Firmness (N): Firmness was measured as the maximum penetration force (N) reached during tissue breakage, and determined with a 5 mm diameter flat probe. The penetration depth was 5 mm. Passion fruit (*Passiflora edulis*) was cut into halves and each half was measured in the central zone.

Total soluble solids (^{o}Brix): Individual passion fruit (*Passiflora edulis*) fruit from each of the treatment was grinded in an electric juice extractor for freshly prepared juice. Soluble solids content was measured using T/C hand refractometer in ^{o}Brix.

Ascorbic acid (mg/ml): Ascorbic acid content was measured using 2, 5-6 dicholorophenol indophenols' method described by A.O.A.C (1994).

Antioxidant activity: Antioxidant activity was investigated by using in vitro DPPH (µg/ml) and FRAPS (mmol Fe^{2+} /g) assays.

Effect of Different Carrageenan Concentrations to Weight Loss, Firmness, Total Soluble Solid, Ascorbic Acid, Antioxidant Activity of Passion Fruit (Passiflora Edulis) Fruit

Effect of different carrageenan concentrations (1.0%, 1.5%, 2.0%, 2.5%, 3.0%) to weight loss (%), firmness (N), total soluble solid (^{o}Brix), ascorbic acid (mg/ml), antioxidant activity DPPH (µg/ml) and

FRAPS (mmol Fe^{2+} /g) was assessed. All samples were preserved in 8°C for 7 days.

Effect of Storage Temperature to Shelf Life of Passion Fruit (Passiflora edulis) Fruit

After finding the appropriate carrageenan coating concentration (%), shelf life of passion fruit (*Passiflora edulis*) fruit was also evaluated by the effect of different storage temperature. Passion fruit (*Passiflora edulis*) fruits which were set in trays in were divided into four groups (8 °C, 12 °C, 16 °C and 20 °C). Weight loss, firmness, total soluble solid, ascorbic acid, antioxidant activity were assessed during preservation (7 days) to demonstrate the appropriate storage temperature.

Shelf-life of Passion Fruit (Passiflora edulis) Fruit during Preservation

After finding the appropriate carrageenan concentration, storage temperature; shelf life of passion fruit (*Passiflora edulis*) fruit during preservation was also evaluated by sampling at different intervals (0, 7, 14, 21, 28 days). Weight loss, firmness, total soluble solid, ascorbic acid, antioxidant activity were assessed.

Statistical Analysis

The Methods were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVII.

Results & Discussion

Physical and Chemical Characteristics in Fresh Passion Fruit (*Passiflora edulis*) Fruit

The physical and chemical compositions in fresh passion fruit (*Passiflora edulis*) fruit were analyzed. Resuts were mentioned in Table 1.

Table 1: The chemical compositions in fresh passion fruit (*Passiflora edulis*) fruit

Parameter	Firmness (N)	Total soluble solid (°Brix)	Ascorbic acid (mg/ml)	Antioxidant activity (DPPH, µg/ml; FRAP, mmol Fe^{2+} /g)
Value	1868.39±101.2	9.37±0.02	14.78±0.01	83.79±0.02; 2.23±0.01

Fruit firmness, total soluble solid and ascorbic acid are major attributes that dictates the postharvest life and quality of fruit in general and passion fruit (*Passiflora edulis*) in particular. According to one study, antioxidant activity (DPPH 84.23 µg ml^{-1}; FRAP value 1.89 mmol Fe^{2+} g^{-1}) in passion fruit were obtained [20].

Effect of Different Carrageenan Concentrations to Weight Loss, Firmness, Total Soluble Solid, Ascorbic Acid, Antioxidant Activity of Passion Fruit (*Passiflora edulis*) Fruit

Effect of different carrageenan concentrations (1.0%, 1.5%, 2.0%, 2.5%, 3.0%) to weight loss (%), firmness (N), total soluble solid (°Brix), ascorbic acid (mg/ml), antioxidant activity DPPH (µg/ml) and FRAPS (mmol Fe^{2+} /g) was assessed. All samples were preserved in 8°C for 7 days.

Results were depicted in table 2. As clearly shown in Table 2, all edible coatings significantly ($P< 0.05$) retard the changes in passion fruit (*Passiflora edulis*) weightl loss, firmness, total soluble solid, ascorbic acid antioxidant activity as compared to control samples. 2.5% carrageenan coating was appropriated for further experiments.

Table 2: Effect of different carrageenan concentrations to weight loss (%), firmness (N), total soluble solid (°Brix), ascorbic acid (mg/ml), antioxidant activity (DPPH, µg/ml; FRAP, mmol Fe^{2+} /g) of passion fruit (*Passiflora edulis*) fruit during preservation (8°C after 7 days)

Carrageenan concentration (%)	Weight loss (%)	Firmness (N)	Total soluble solid (°Brix)	Ascorbic acid (mg/ml)	Antioxidant activity	
					DPPH, (µg/ml)	FRAP, (mmol Fe^{2+} /g)
Control	17.31 ±0.01^{a}	1864.11 ±102.4^{d}	8.75 ±0.01^{c}	13.22 ±0.03^{c}	80.14 ±0.01^{c}	2.09 ±0.02^{b}
1.0	16.36 ±0.02^{b}	1875.42 ±104.1^{c}	8.94 ±0.01^{bc}	13.29 ±0.01^{bc}	80.38 ±0.01^{bc}	2.10 ±0.01^{ab}
1.5	14.79 ±0.01^{c}	1880.22 ±111.4^{bc}	9.11 ±0.01^{b}	13.33 ±0.03^{b}	80.44 ±0.02^{b}	2.12 ±0.00^{ab}

2.0	12.47 ±0.00^{d}	1886.54 ±109.2^{b}	9.16 ±0.00^{ab}	13.37 ±0.01^{ab}	80.52 ±0.03 ^{ab}	2.14 ±0.03^{ab}
2.5	**10.04 ±0.01^{e}**	**1895.11 ±102.5^{a}**	**9.20 ±0.01^{a}**	**13.45 ±0.01^{a}**	**80.88 ±0.02^{a}**	**2.15 ±0.01^{a}**
3.0	9.98 ±0.02^{e}	**1898.04 ±113.1^{a}**	9.20 ±0.01^{a}	13.47 ±0.01^{a}	80.90 ±0.01^{a}	2.15 ±0.01^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

One research studied the influence of a modified atmosphere - wax emulsions and plastic film - on the shelf life of the yellow passion fruit. Plastic film (Cryovac D-955, 15 mm thickness) reduced fresh weight loss and fruit wilting, kept higher fruit and rind weight and higher pulp osmotic potential over the storage period.

However, it was not efficient in the control of rottenness. Sparcitrus wax (22-23% polyethylene/maleyc resin) caused injury to the fruit, high fruit weight losses and wilting and resulted in lower pulp osmotic potential; this wax lead to a higher concentration of acid and a lower relation of soluble solids/acidity.

Among the tested waxes, Fruit Wax (18-21% carnauba wax) was the best, promoting reduced weight loss, wilting and rottenness [21].

Effect of Storage Temperature to Weight Loss, Firmness, Total Soluble Solid, Ascorbic Acid, Antioxidant Activity of Passion Fruit (*Passiflora edulis*) Fruit

After finding the appropriate carrageenan coating concentration (%), shelf life of passion fruit (*Passiflora edulis*) fruit was also evaluated by the effect of different storage temperature. Results were elaborated in Table 3. Storage temperature for passion fruit (*Passiflora edulis*) should be 8 ^{o}C which was appropriated for further experiments.

Table 3: Effect of storage temperature to weight loss (%), firmness (N), total soluble solid (^{o}Brix), ascorbic acid (mg/ml), antioxidant activity (DPPH, µg/ml; FRAP, mmol Fe^{2+} /g) of passion fruit (*Passiflora edulis*) fruit

Storage temperature (^{o}C)	Weight loss (%)	Firmness (N)	Total soluble solid (^{o}Brix)	Ascorbic acid (mg/ml)	Antioxidant activity	
					DPPH, (µg/ml)	DPPH, (µg/ml)
8 ^{o}C	**10.04 ±0.01^{c}**	**1895.11 ±102.5^{a}**	**9.20 ±0.01^{a}**	**13.45 ±0.01^{a}**	**80.88 ±0.02^{a}**	**2.15 ±0.01^{a}**
12 ^{o}C	10.42 ±0.02^{b}	1842.04 ±104.3^{ab}	9.04 ±0.02^{ab}	13.21 ±0.03^{ab}	80.56 ±0.03^{ab}	2.10 ±0.02^{ab}
16 ^{o}C	10.78 ±0.00^{ab}	1824.38 ±101.1^{ab}	8.85 ±0.01^{b}	13.03 ±0.00^{b}	80.43 ±0.01^{ab}	2.03 ±0.01^{ab}
20 ^{o}C	11.47 ±0.03^{a}	1801.27 ±103.7^{b}	8.46 ±0.02^{c}	12.66 ±0.00^{c}	80.05 ±0.01^{b}	1.97 ±0.03^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Physico-chemical and sensory quality of juice from purple passion fruit under different storage temperature and time were assessed. The maximum loss in fruit weight was recorded under room temperature (25±1°C) followed by at 11±1°C. There was an increase in juice percentage up to 9 and 13 days under room temperature and storage at 11±1°C respectively.

The optimum flavour in juice was up to 5 days at 25±1°C and up to 21 days at 8±1°C. A significant reduction in sourness was recorded on 5th day under all treatments and the scores for sourness became almost constant after 17 days.

The maximum increase in the mean scores of sweetness on 5th day was observed at 25±1°C followed by at 11±1°C. The optimum level of juice sweetness was maintained up to 21 days at 8±1°C. Total soluble solids content increased in initial stage followed by reduction.

There was a reduction in the titrable acidity up to 21 days at 8±1°C. A decreasing trend in the reducing and non-reducing sugar of passion fruit was observed under all the treatments. Fruits stored at 25±1°C, developed off-flavour in juice after 5 days, while storage at 8± 1°C produced no off-flavor even up to 21 days. Fruits can be stored for 5

days only at 25±1°C as the overall sensory quality of juice reduced significantly afterwards, while juice maintained the optimum overall quality up to 21 days at 8±1°C [22]. Storage stability and physicochemical properties of passion fruit juice microcapsules by spray-drying was verified. The aim of this work was to microencapsulate passion fruit juice by spray-drying in two different biopolymers blends: Gum Arabic-mesquite gum-maltodextrin [23].

Shelf-life of Passion Fruit (*Passiflora edulis*) Fruit during Preservation

After finding the appropriate 4% carrageenan concentration, storage temperature at 8 °C; shelf life of passion fruit (*Passiflora edulis*) fruit during preservation also evaluated by sampling in different intervals (0, 7, 14, 21, 28 days). Results were also mentioned in Table 4. Quality of passion fruit (*Passiflora edulis*) fruits which were coated by 4% carrageenan and stored at 8 °C was maintained for 28 days without any deterioration.

Table 4: Shelf life of passion fruit (*Passiflora edulis*) fruit during preservation

Preservation time (days)	Weight loss (%)	Firmness (N)	Total soluble solid (°Brix)	Ascorbic acid (mg/ml)	Antioxidant activity	
					DPPH, (µg/ml)	DPPH, (µg/ml)
0	0^{d}	1895.11 ±102.5^{a}	9.20 ±0.01^{a}	13.45 ±0.01^{a}	80.88 ±0.02^{a}	2.15 ±0.01^{a}
7	1.18 ±0.01^{c}	1844.28 ±103.2^{ab}	9.08 ±0.03^{ab}	12.97 ±0.03^{ab}	79.17 ±0.03^{ab}	2.04 ±0.02^{ab}
14	3.20 ±0.01^{b}	1823.19 ±104.1^{b}	8.96 ±0.02^{b}	12.84 ±0.00^{b}	78.84 ±0.03^{b}	1.98 ±0.03^{ab}
21	3.56 ±0.03^{ab}	1801.42 ±105.1^{bc}	8.90 ±0.03^{bc}	12.77 ±0.01^{bc}	78.67 ±0.03^{bc}	1.94 ±0.01^{ab}
28	4.11 ±0.02^{a}	1778.39 ±103.6^{c}	8.82 ±0.00^{c}	12.61 ±0.02^{c}	78.54 ±0.02^{c}	1.90 ±0.03^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

According to one research, the physical and physico-chemical characteristics of extracted fruit pulp of passion fruit with different skin color (yellow, light and dark purple) under refrigeration temperatures and storage times. The extracted pulp of passion fruit was stored at different temperatures: 10 °C, 25 °C; - 30 °C and - 80 °C and at four different storage periods: 0; 10; 20 and 30 days. Te coloration of the fruit peels influenced the preservation of pulp color during the storage period and conditions. Purple fruits showed no change in the color of the pulp, even under different conservation procedures.

The passion fruit pulp can be stored up to 30 days while preserving the physical and physico-chemical characteristics [24]. In another study, full ripe fruits of purple passion fruit were packed in perforated and non-perforated high density polyethylene (HDPE 0.03 mm, 0.05 mm, 0.08 mm) and low density polypropylene (LDPP 0.025 mm) and stored at ambient (26.5°C, 65.7% RH) and 5°C. Fruits packed in perforated HDPE of 0.03 mm thickness showed a shelf-life of 28 days at 5°C as against 4 days for control.

Quality and nutritional value of fruit were better preserved, but there was slight reduction in flavour and colour of juice. The quality parameters, total soluble solids, titratable acidity, sugars and ascorbic acid contents were at par with initial value even after 28 days of storage [25]. Post-harvest conservation of passion fruit was conducted by packing in PVC packages 12µm and 30µm thick, LDPE bags 100 µm and 200 µm thick, and without packaging (control), stored under ambient conditions at an average temperature of 21.3 °C and average relative humidity of 77.8 %, and in refrigerated conditions in a cold room at 10°C and 90% relative humidity for 14 days.

At the beginning of storage and at three, seven, 10 and 14 days of storage the fruits were analyzed for titratable acidity, soluble solids, Ratio, fresh weight loss, hue angle and post-harvest diseases. The experiment had a completely randomized design with three replicates.

The 12µm PVC package, under refrigeration, was the most efficient in the conservation of P. setacea fruit. It presented low fresh weight loss; Null percentage of fungal infestation; soluble solids above 11% until the tenth day of storage; Titratable acid content above 2.5% throughout the experiment. Besides, the

fruit, at the end of 14 days of storage, did not show evidence of fermentation and no water condensation inside the packages [26].

Conclusion

Passiflora edulis has been commonly used as a food and possesses various medicinal properties. The high perishability of the yellow passion fruit (*Passiflora edulis* f. flavicarpa) reduces its postharvest conservation and availability. These losses of quality and commercial value occur due to the high respiration and loss of water. Te preservation of the pulp for long periods while maintaining similar physical and physico-chemical properties as in fresh fruit is needed to meet the demands of consumers.

References

1. Gaudêncio Pereira dos Santos, Lourival Ferreira Cavalcante, José Adeilson Medeiros do Nascimento, Antonio João de Lima Neto, Sherly Aparecida da Silva Medeiros, Ítalo Herbert Lucena Cavalcante (2018) Nutritional status of yellow passion fruit fertilized with phosphorus sources and doses. Journal of Soil Science and Plant Nutrition, 18 (2): 388-402.
2. Hai-xai L, Rong G, Jie Z, Jiao-Jiao Z, Dan-wei Z, Zi-chuan D, Tong Z, Hua-Bin L (2016) Bioactivities of passion fruit. Int. J. Trad. Nat. Med., 6(1): 26-34.
3. Anulika Mercy Kanu, Agwu Chukwuemeka Okorie, Chidiebere Uche, Ugochi Nwoke Awa (2017) Phytochemical screening and antimicrobial activity of ethanoic extract of Passiflora edulis var. flavicarpa seed on selected pathogens. Universal Journal of Microbiology Research, 5(3): 35-39.
4. Maria Luiza Zeraik, Janete H Yariwake (2012) Analysis of passion fruit rinds (Passiflora edulis): Isoorientin quantification by HPTLC and evaluation of antioxidant (radical scavenging) capacity. Quim. Nova, 35(3): 541-545.
5. A Z Mercadante, G Britton, DB Rodriguez-Amaya (1998) Carotenoids from Yellow Passion Fruit (Passiflora edulis). J. Agric. Food Chem., 46(10): 4102-4106.
6. VN, Ariharan, Devi VN, Nagendra Prasad P (2013) Nutraceutical studies on passiflora edulis - passion fruit. International Journal of Pharma and Biosciences, 4: 176-179.
7. Phamiwon Zas, Sheila John (2016) Diabetes and medicinal benefits of Passiflora edulis. World Journal of Pharmaceutical Research, 5(3): 453-465.
8. Juliana Kellyda Silva, Cinthia Baú Betim Cazarin, Talita C.Colomeu, Ângela Giovana Batista, Laura M.M. Meletti, Jonas Augusto Rizzato Paschoal, StanislauBogusz Júnior, Mayra Fontes Furlan, Felix Guillermo Reyes Reyes, Fábio Augusto, Mário Roberto Maróstica Júnior, Ricardode Lima Zollner (2013) Antioxidant activity of aqueous extract of passion fruit (Passiflora edulis) leaves: In vitroand in vivo study. Food Research International, 53(2): 882-890.
9. Munehiro Kitada, Yoshio Ogura, Hiroko Maruki-Uchida, Masahiko Sai, Taeko Suzuki, Keizo Kanasaki, Yuna Hara, Hiromi Seto, Yuka Kuroshima, Itaru Monno, Daisuke Koya (2017) The Effect of piceatannol from passion fruit (Passiflora edulis) seeds on metabolic health in humans. Nutrients, 9(10): 1142.
10. Kishore Kundan, A Pathak, K Shukla, Rohit Bharali Rinku (2011) Effect of storage temperature on physico-chemical and sensory attributes of purple passion fruit (Passiflora edulis Sims). Journal of Food Science and Technology, 48: 484-488.
11. Talcott, Stephen, S Percival, Susan, Pittet-Moore, Jennifer, Celoria Charity (2003) Phytochemical composition and antioxidant stability of fortified yellow passion fruit (Passiflora edulis). Journal of Agricultural and Food Chemistry, 51: 935-41.
12. Natália S Janzantti, Graciela C Santos, Magali Monteiro (2014) Shelf life of fresh and pasteurized organic passion fruit (Passiflora edulis f. Flavicarpa deg.) pulp. Journal of Food Processing and Preservation 38: 262-270.
13. Maniwara P, Boonyakiat D, Poonlarp PB, Natwichai J, Nakano K (2015) Changes of postharvest quality in passion fruit (Passiflora edulis Sims) under modified atmosphere packaging conditions. International Food Research Journal, 22(4): 1596-1606.

14. Francinaide Oliveira, da Silva Cerqueira, Eder Dutra de Resende, Derliane Ribeiro Martins, Juliana Lauredo Valle dos Santos, Sergio Agostinho Cenci (2011) Quality of yellow passion fruit stored under refrigeration and controlled atmosphere. Ciênc. Tecnol. Aliment., Campinas, 31(2): 534-540.

15. SM Charan, Saji Gomez, KB Sheela, PB Pushpalatha, KT Suman (2017) Effect of storage conditions and duration on quality of passion fruit (Passiflora edulis Sims.) nectar. Asian J. Dairy & Food Res, 36(2): 161-165.

16. Phoebe P Kaddumukasa, Samuel M Imathiu, Julius M Mathara, Jesca L Nakavuma (2017) Influence of physicochemical parameters on storage stability: Microbiological quality of fresh unpasteurized fruit juices. Food Sci. Nutr., 5(6): 1098-1105.

17. Alemwati Pongener, Vidyaram Sagar, Ram Krishna Pal, Ram Asrey (2014) Physiological and quality changes during postharvest ripening of purple passion fruit (Passiflora edulis Sims). Fruits, 69(1): 19-30.

18. Sujata Jena (2013) Development of a preserved product from underutilized passion fruit and evaluation of consumer acceptance. Journal of Food Research and Technology, 1(1): 11-20.

19. Vicente M Gómez-López, María E Buitrago, María S Tapia, Amaury Martínez-Yépez (2018) Effect of ultrasonication on sensory and chemical stability of passion fruit juice during refrigerated storage. Emirates Journal of Food and Agriculture, 30(1): 85-89.

20. Ludmilla Santos Silva de Mesquita, José Wilson Carvalho de Mesquita, Richard Pereira Dutra, Marisa Cristina Aranha Batista, Sonia Malik, Flavia Maria, Mendonça do Amaral, Maria Nilce de Sousa Ribeiro (2016) Extraction parameters affect flavonoids content and antioxidant activities in Passiflora edulis. Journal of Chemical and Pharmaceutical Research 8(10): 99-107.

21. Wagner Ferreira da Mota, Luiz Carlos, Chamhum Salomão, Paulo Roberto Cecon , Fernando Luiz Finger (2003) Waxes and plastic film in relation to the shelf life of yellow passion fruit. Scientia Agricola, 60(1): 51-57.

22. Kundan Kishore, KA Pathak, Rohit Shukla (2011) Effect of storage temperature on physico-chemical and sensory attributes of purple passion fruit (Passiflora edulis Sims). J. Food Sci. Technol., 48(4): 484-488.

23. H Carrillo-Navas, DA Gonzalez-Rodea, J Cruz-Olivares, JF Barrera-Pichardo, A Roman-Guerrero, C Perez-Alonso (2011) Storage stability and physicochemical properties of passion fruit juice microcapsules by spray-drying. Revista Mexicana de Ingenieria Quimica, 10(3): 421-430.

24. Letícia da Silva Araújd, Eva Maria Rodrigues Cdsta, Taliane Leila Sdares, Idália Souza dos Santds, Dnildo Nunes de Jesus (2017) Effect of time and storage conditions on the physical and physico-chemical characteristics of the pulp of yellow and purple passion fruit. Food Science and Technology, 37(3): 500-506.

25. Singh, Akath Yadav, DS Patel, Ramkishor Bhuyan M (2007) Effect on shelf-life and quality of passion fruit with polyethylene packaging under specific temperature. Journal of Food Science and Technology, 44: 201-204.

26. Maria Madalena Rinaldi, Alexei de Campos Dianese, Ana Maria Costa, Angelo Aparecido Barbosa Sussel, Fabio Gelape Faleiro, Nilton Tadeu Vilela Junqueira (2017) Effect of different packaging materials on the shelf life of passion fruits during ambient and low temperature storage. Journal of Postharvest Technology, 05(1): 7-16.

