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ORIGINAL ARTICLE

The Yacon FOS-rich syrup: Characterization, formulation into a coating with prebiotic potential, and application on minimally processed melon

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Abstract

This research aimed to characterize the syrup from Yacon (*Smallanthus sonchifolius* (Poepp.) H. Rob.) roots as a rich source of prebiotic fructooligosaccharide (FOS) and, thus, to formulate and characterize a gelatin-based coating enriched with Yacon syrup and to apply this coating on minimally processed melons. Then, the minimally processed melons were stored for 6 days at 10 °C and they were evaluated regarding their storage potential through quality, sensory and microbiological attributes, and bioavailability of FOS. Yacon syrup presents 17.22% of FOS, high antioxidant ferric reducing oxidant power (FRAP) and 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid (ABTS) activities, 60.88% of sugars, 66.25% of carbohydrates, 2,148.1 μg kg^{-1} of chlorogenic acid, and 13,897.2 μg gallic acid kg^{-1} of phenolic contents. The incorporation of 10% Yacon syrup in the gelatin matrix increased coating thickness, accentuated the yellow color, increased the hydrophilic character, and lowered moisture. Yacon syrup-enriched gelatin matrix coating preserved the postharvest quality of minimally processed melon for 5 days at 10 °C with increased functional properties due to FOS bioavailability and higher total phenolic and carotenoid contents.

Keywords: Functional foods; Antioxidants; Fructooligosaccharides; Bioavailability; Edible films; Shelf life.

Highlights

- Yacon syrup is a rich source of fructooligosaccharide (FOS) with 17.22%
- Yacon syrup presents high FRAP and ABTS antioxidant activities
- Gelatin with 10% yacon syrup shows great potential as a coating for fresh produce
- Gelatin with 10% yacon syrup contributes to bioactive nutritional properties

1 Introduction

The market for fresh-cut or minimally processed (MP) products has grown significantly due to their versatility and nutritional aspects (Yousuf et al., 2020). However, processing inflicts mechanical damage to plant tissue which may lead to undesirable changes in color, texture, and flavor with reduction of produce storage life. Therefore, the metabolic changes which plant organs undergo determine their storage potential, thus, postharvest technologies have been developed as means to preserve the quality, safety, and nutritional attributes of fruits and vegetables, whether *in natura* or processed forms (Velderrain-Rodríguez et al., 2019).

The postharvest technology based on edible coatings aims to prevent deterioration and delay senescence of fresh and minimally processed produce due to barrier properties against moisture and solutes loss, gas exchange, and microbial growth, with low impact on the sensorial attributes, in addition to representing an environment-friendly alternative to conventional packaging (Ncama et al., 2018; Yousuf et al., 2018; Bambace et al., 2019; Alvarez et al., 2021; Yousuf et al., 2021).

Bioactive or functional properties of coating matrices may be incremented by incorporation of additives that act as antioxidant, anti-browning, and antimicrobial agents (Gibson et al., 2017; Yousuf et al., 2018; Orozco-Parra, Mejía & Villa, 2020). In that context, fructooligosaccharides (FOS) extracted from different plant sources have been recently incorporated as functional ingredients in starch-based coatings and investigated based on their prebiotic health-promoting properties (Bersaneti et al., 2019; Orozco-Parra et al., 2020). FOS are referred to their degree of polymerization (DP) as DP6 and its hydrolytic products and are non-digestible carbohydrates that contribute to the proliferation of probiotic microorganisms present in the human intestinal tract (Gibson et al., 2017; Chen, Karboune, 2019).

Yacon (*Smallanthus sonchifolius* (Poepp.) H. Rob.) is a plant species whose roots are a rich source of FOS and thus are most frequently consumed *in natura*, although may also be processed into a FOS-rich syrup (Silva et al., 2018). Even though the microfiltered FOS-rich syrup from Yacon roots has not been thoroughly characterized, it has been added to yogurt and beverages with increased bioactive appeal and acceptability (Silva et al., 2017; Mendes et al., 2019). In addition, Adriano et al. (2019) reported that Yacon syrup consumption decreased insulin and postprandial blood glucose levels corroborating its health-promoting potential.

Thereby, this research characterized the syrup processed from FOS-rich Yacon roots, then developed and characterized a gelatin coating added with Yacon syrup, and investigated how the gelatin-based coating added with Yacon syrup influenced the postharvest quality, FOS bioavailability, microbiological, and sensory characteristics of MP melon. Melons were chosen as they are frequently commercialized as MP due to their relatively large size which represents an obstacle to the retail market and therefore could benefit from an increment in bioactive properties and storage potential.

2 Material and methods

2.1 Preparation and characterization of Yacon syrup

Yacon root was initially washed and sanitized in chlorinated water and then processed according to Silva et al. (2017). After the peel was manually removed, the edible portion was cut (1 cm^3) and immersed in citric acid solution (2.4% w/v) for 8 min, then pieces were homogenized using an industrial blender and microfiltered (Pall industries, model Membralox, France). The clarified filtered material was concentrated to 71 °Brix under vacuum (560 mm Hg) at the temperature of 60 ± 5 °C, and then, the concentrated syrup was stored at −18 ± 1 °C.

The Yacon syrup was characterized as recommended by the Association of Official Analytical Chemists (AOAC) (Association of Official Analytical Chemistry, 2016) by determining the soluble solids (SS) content with a digital refractometer (ATAGO Pocket Refractometer PAL-3, Japan) expressed in °Brix; the titratable acidity (TA) was determined and expressed as percentage (%) of citric acid, and the pH was measured using a

digital pH meter (Mettler Toledo, model F20, USA). The insoluble and soluble dietary fiber contents were determined according to enzymatic-gravimetric method 991.43 by AOAC (Association of Official Analytical Chemistry, 2016) and their sum represented the total dietary fiber, all were expressed in g kg^{-1}. The FOS content was determined by AOAC method 999.03 (Association of Official Analytical Chemistry, 2016) and expressed as %, in addition they were characterized based on their degree of polymerization (DP) by Thin Layer Chromatography according to Maciel et al. (2022) using a wavelength of 450 nm and data were processed using the Planar WinCATS Chromatography Manager software (Maciel et al., 2022; Shiomi et al., 1997). Analyses were performed in duplicate, and results were expressed as relative concentration (RC), calculated according to Equation 1, where A_{DPi} is the chromatographic area of an individual FOS DP (i = 3 to 6) and A_T, the sum of all chromatographic areas.

$$RC\ (\%) = \frac{A_{DPi}}{A_T} \times 100 \quad (1)$$

Total soluble sugars were determined by the Anthrone method (Yemn & Willis, 1954), proteins were determined using the Dumas method (VELP Scientifica Nitrogen Analyzer Dumas NDA 702, Italy), while lipids, ashes, and moisture contents were evaluated as proposed by AOAC (2016) and all were expressed as %. The total energy value was estimated following Atwater's caloric conversion values and expressed as Kcal (Monteiro et al., 2008). Water activity was determined using a chilled-mirror dew point technique (Decagon Devices Aqualab 4TE CX-2T, EUA) at 25 °C and expressed as aw. Mineral contents were analyzed as described by Miyazawa et al. (2009) and expressed as g kg^{-1}.

The instrumental color parameters were determined based on the CIELAB system as coordinates a* (grade of redness/greenness) and b* (grade of blueness/yellowness), luminosity (L, lightness from 0-black to 100-white), Hue angle (h), and chromaticity (C) using a spectrophotometer (ColorQuest XE HunterLab, Virginia, USA), by the excluded specular reflectance methods. Total polyphenol content and total antioxidant activity by ABTS [2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)] and FRAP (Iron-reducing antioxidant power) methods were determined using an extract prepared according to Rufino et al. (2010) and the assays were performed as follows: total polyphenol determined by the Folin–Ciocalteu method (Obanda et al., 1999) and expressed as mg gallic acid equivalent (GAE) kg^{-1}, total antioxidant activity by ABTS method as described by Re et al. (1999), and by FRAP method as described by Rufino et al. (2010) and results were expressed as µM Trolox kg^{-1} and µM Fe_2SO_4 kg^{-1}, respectively. Chlorogenic acid (CGA) was determined as described by Jaiswal et al. (2011) in a High Performance Liquid Chromatography-Photometric Diode Array (HPLC-PDA) instrument (Varian 920-LC, USA) coupled with a PDA set to 324 nm and expressed as µg of CGA kg^{-1}.

The microbiological quality of the Yacon syrup was evaluated by the total count of filamentous fungus and yeasts, total coliforms, *Staphylococcus* spp., and *Salmonella* spp. according to the Bacteriological Analytical Manual of the U.S. Food and Drug Administration (FDA) (Andrews et al., 2014) and results were expressed as most probable number (MPN) mL^{-1} for total coliforms, absence/presence for *Salmonella* spp., and CFU mL^{-1} for the remaining.

2.2 Preparation and characterization of a gelatin coating added with Yacon syrup

The gelatin coating was prepared as follows, 10 g of bovine gelatin was hydrated in 100 mL of water, heated at 70 °C for 10 min, then, plasticizer glycerol (0.05:1, g g^{-1}) and 10% Yacon syrup (GY) (corresponding to 17.22% of FOS) were added (Fakhouri et al., 2018). As a control, a gelatin coating without Yacon syrup was prepared under the same conditions. Coatings or filmogenic gelatin solutions with and without Yacon syrup were degassed in a rotary evaporator (Fisatom model 803, Brazil) to remove air bubbles. Films were obtained by casting as the solutions were deposited on Mylar® type film fixed on 30 x 30 cm glass plates, spread with a leveling bar adjusted to a final thickness of 0.10 mm, and allowed to dry at 24 °C for 24 hours. The dried samples were cut and separated from the Mylar® surface.

2.2.1 Characterization of a gelatin coating added with Yacon syrup

Coatings or filmogenic solutions were characterized for color based on the CIELAB system and opacity was determined using a Varian Cary 50 Spectrophotometer cell (Agilent Technologies, USA), at the absorbance spectrum of 400 to 800 nm and expressed as absorbance units (A) × nanometers (nm, wavelength) per millimeter (mm, film thickness), A nm mm^{-1} (Irissin-Mangata et al., 2001). Film thickness was determined using a digital micrometer (Mitutoyo QuantuMike model, USA), and expressed in millimeters (mm). Moisture content conditioned at 50% RH was determined gravimetrically by heating at 105 °C using an infrared analyzer ID50 (Marte Científica, Brazil) and expressed as %. Water vapor permeability (WVP) was determined based on the E96-00 method (American Society for Testing and Materials, 2001) using an Arsec DCV040 desiccator with air circulation (Arsec, Brazil) and expressed as g mm kPa^{-1} h^{-1} m^{-2}. Water solubility was determined according to Pena-Serna & Lopes-Filho (2013) using an orbital shaker MA-410, (Marconi, Brazil) and expressed as %. Mechanical properties such as tension, elastic mode, and rupture were determined according to method D882-18 (American Society for Testing and Materials, 2001) using a Universal Testing Machine (Emic DL-3000, Brazil) with a load cell of 100 N, initial grip separation of 100 mm, and a crosshead speed of 12.5 mm min^{-1} and expressed as Mega Pascal (MPa) and %.

2.3 Characterization and storability of MP melons coated with gelatin added with FOS-rich Yacon syrup

2.3.1 Preparation of MP and coating of melons

Ripe melons (*Cucumis melo* var. *Reticulatus* Naud.) were purchased at a local market (Fortaleza-CE, Brazil), where they were selected for uniformity of maturation stage, size, and absence of defects or injuries. All processing and coating procedures were performed in a sanitized cold chamber (14 ºC). Before processing, whole melons were immersed for 20 min in sodium hypochlorite solution (2000 ppm, pH 7.0), rinsed in distilled water, and then, air-dried for 10 min. Sanitized fruits were manually peeled, seeded, and cut into 30 mm cubes (± 50 g), and half of the samples were dipped in the gelatin added with Yacon syrup (GY) coating solution for 2 min (prepared as shown above), and then, air-dried for 2 min, meanwhile, the other half were control samples immersed only in distilled water under similar conditions. Coated and control samples were placed into rectangular *polyethylene* terephthalate (PET) trays wrapped with a PVC MWRAP® film and stored at 10 °C for 6 days. Evaluations were performed daily for quality and antioxidant characteristics; tissue structure was evaluated on 0 (processing day), 2, 4, and 6 days (d); microbiological evaluations were performed on 0 and 6 d; while aroma volatiles were evaluated on 0 and 5 d, and bioavailability on 0, 1, 3 and 5 d. The trial consisted of 60 melons, and samples were composed of three trays (repetitions) per treatment with 12 melon cubes in each, and analyses were carried out in triplicates.

2.3.2 Quality and antioxidant characteristics of MP melons

Color parameters were determined at two opposite sides of each cube based on the CIELAB system as coordinates a* and b*, and luminosity. Mass loss was measured with a scale (Tecnal®, São Paulo, Brazil) before (A) and after each storage period (B), calculated as (A−B)/A and expressed as %. SS content was expressed in °Brix; TA was expressed as % of citric acid, and the pH was measured using a pHmeter according to AOAC (Association of Official Analytical Chemistry, 2016).

Variables of antioxidant metabolism were evaluated as total polyphenol determined by the Folin–Ciocalteu method (Obanda et al., 1999) and expressed as mg GAE kg^{-1} FM, while ABTS antioxidant potential was determined according to Re et al. (1999) and expressed as µM Trolox Kg^{-1} of fresh mass (FM). Yellow flavonoid content was evaluated as described by Francis (1982) and expressed as mg Kg^{-1} FM. Total carotenoid content was measured as described by Lichtenthaler (1987) and expressed as mg kg^{-1} FM.

2.3.3 Structural characteristics of MP melons

For the histological analysis, fruit samples were fixed (Karnovsky, 1965), then sectioned on a Slee Mainz CUT® 5062 microtome (Germany) and stained with Schiff's Periodic Acid (PAS) for neutral polysaccharides (McManus, 1948). Photomicrographs were taken using an Olympus® BX41 light microscope (Tokyo, Japan) connected to a camera (model UC30) and computer using Olympus cellSens® software. Scanning electron microscopic (SEM) analysis started with melon samples fixed as proposed by Karnovsky (1965), then dried at the critical point (Emitech K850 Dryer, UK), mounted on a stub, sputtered with silver (Quorum Q150T ES, UK) and the microstructure was viewed with a Quanta 450 FEG-FEI microscope.

2.3.4 Microbiological quality of MP melons

MP melons were evaluated for the total count of filamentous fungus and yeasts, total coliforms, *Staphylococcus* spp., and *Salmonella* spp. according to the FDA's Bacteriological Analytical Manual (Andrews et al., 2014), results were expressed as MPN g^{-1} for total coliforms, absence/presence for *Salmonella* spp., and CFU g^{-1} for the remaining.

2.3.5 Volatile aroma compounds of MP Melons

Extraction of aroma volatiles from MP melon was carried out by Headspace Solid-Phase Microextraction (HS SPME) using a 50/30 µm 2 cm polydimethylsiloxane/carboxen/divinylbenzene (PDMS/CAR/DVB) fiber (Supelco, Inc., Bellefonte, PA). Before analysis, the SPME fiber was preconditioned as recommended by the manufacturer. The separation and detection of the analytes were achieved using a Gas Chromatography-Mass Spectrometry (GC-MS) system (Agilent Technologies, USA) with a GC 7890B coupled to a 5977A mass selective detector (MSD), with a RTX 5 capillary column (30 m × 0.25 mm i.d.; df, 0.25 µm). The initial temperature was 45 °C for 5 min, and then ramped 10 °C/min from 45 to 80 °C, 5 °C/min from 80 to 240 °C, 5 °C/min from 240 to 260 °C and held at the final temperature for 5 min. MS spectra were obtained by electronic impact (EI) at 70 eV and collected at 1 scan/s over an *m*/*z* range of 35-400, using MSD ChemStation E.02.00493 software (Agilent Technologies, USA).

2.3.6 Bioavailability of FOS

The bioavailability of FOS from coated MP melon was assessed in sequential gastric and intestinal digestion phases according to the INFOGEST digestibility protocol (Brodkorb et al. 2019). The relative concentration (RC) was calculated by the concentration of FOS in the accessible fraction being divided by the concentration of FOS before the treatment with digestive enzymes and expressed in %. In each digestive phase, FOS values were characterized based on their DP according to Maciel et al. (2022).

2.4 Statistical analyses

The data obtained for the characterization of Yacon syrup were presented as mean ± standard deviation. For the characterization of filmogenic solution or coating, data were subjected to analysis of variance (ANOVA) using SISVAR 5.6, and means were compared using Tukey's test, with differences considered significant at $p \leq 0.05$. Coated MP melons were evaluated under factorial design 2x7 (coating treatments x storage time) with three replicates consisting of 12 melon cubes each, and data were subjected to ANOVA using SISVAR 5.6. Means were compared using Tukey's test, with differences considered significant at $p \leq 0.05$. Volatile compounds were analyzed as peak height data were processed in the Metaboanalyst 5.0 platform (Wang et al. 2023) with samples normalized using 2-octanol as internal standard and before analysis, data were normalized using Pareto-scaled, then results were presented in the form of heatmaps and boxplot.

3 Results and discussion

3.1 Characterization of Yacon syrup

The physicochemical characterization of Yacon syrup (Table 1) showed positive values of color parameters coordinates a, b, and C, thereby indicating red and yellow nuances and corroborating with the Hue angle that indicates Yacon syrup being yellowish, and luminosity (L) of 76.12, indicating a clear appearance. The total SS content in syrup was 70.7 °Brix, which is mainly associated with total sugars that represent 60.88% of the compounds contained in the syrup. Yacon syrup had a titratable acidity of 2.50%, pH of 3.96, and free water activity of 0.83 aw. Thus, Yacon syrup may be considered an acidic product probably due to its organic acid content which significantly contributes to syrup flavor and is a desirable factor for the food industry once acidity confers microbiological and chemical stability. Moreover, its water activity represents the potential to hinder deterioration reactions such as oxidation and microbiological contamination. The results observed for total SS, pH, acidity, and water activity found here for Yacon syrup indicated a great potential to preserve microbial growth and prevent deterioration if used as an additive.

Table 1. Physicochemical characteristics, chemical composition, and antioxidant activity of Yacon syrup.

Evaluations	Variables	Values*	CV (%)**
Physicochemical characteristics	Luminosity (L)	76.12 ± 0.06	0.07
	Coordinate a	5.36 ± 0.01	0.11
	Coordinate b	55.34 ± 0.05	0.09
	Chroma (C)	55.60 ± 0.05	0.09
	Hue angle (h)	84.46 ± 0.01	0.01
	Total soluble solids (SS) (°Brix)	70.7 ± 0.06	0.08
	Total titratable acidity (% citric acid)	2.50 ± 0.07	2.8
	pH	3.96 ± 0.07	1.86
	Total sugars (%)	60.88 ± 0.07	1.25
	Water activity (aw)	0.83 ± 0.01	1.66
Phenolics and antioxidant activity	Polyphenol (µg GAE kg^{-1})	13,897.20 ± 28.59	2.06
	Chlorogenic acid (µg kg^{-1})	2,148.10 ± 17.80	8.29
	ABTS (µM trolox kg^{-1})	9,430.00 ± 0.95	10.11
	FRAP (µM F_2SO_4 kg^{-1})	33,050.00 ± 1.81	5.47
Chemical composition	Carbohydrates (%)	66.25 ± 0.11	0.17
	Protein (%)	0.93 ± 0.01	0.59
	Lipids (%)	0.63 ± 0.06	9.17
	Ashes (%)	1.78 ± 0.01	0.38
	Energy value (kcal)	263.29 ± 0.99	0.38
	Moisture (%)	30.40 ± 0.08	0.25
	Phosphorus (g kg^{-1})	1.06 ± 0.10	9.14
	Potassium (g kg^{-1})	9.44 ± 0.87	9.21
	Calcium (g kg^{-1})	0.14 ± 0.01	10.10
	Magnesium (g kg^{-1})	0.25 ± 0.02	8.33
	Sulfur (g kg^{-1})	0.24 ± 0.02	9.74
	Sodium (g kg^{-1})	0.08 ± 0.01	13.33
	Copper (mg kg^{-1})	5.75 ± 0.5	8.70
	Iron (mg kg^{-1})	11.5 ± 1.29	11.23
	Zinc (mg kg^{-1})	6.75 ± 1.26	18.64
	Manganese (mg kg^{-1})	2.00 ± 0.00	0.00

*All values are expressed as mean ± standard deviation. **CV: coefficient of variation.

Yacon syrup was evaluated for variables associated with the antioxidant potential and total polyphenol content was 13,897.2 µg GAE.Kg^{-1} and CGA content was 2,148.1 µg kg^{-1} (Table 1). The total antioxidant activity observed by the ABTS method was 9,430.00 µM Trolox Kg^{-1}, while by the FRAP method, it was 33,050.00 µM $F_2SO_4.kg^{-1}$. Thus, Yacon syrup can be considered an antioxidant product capable of neutralizing oxidative reactive species once FRAP assay is based on the capacity to reduce metal (iron) ions while ABTS is based on the capacity to reduce organic radicals (Rufino et al., 2010). Moreover, chlorogenic acid, a hydroxycinnamic acid derivative present in Yacon, stands out due to its remarkable antioxidant, anti-inflammatory, anticancer, and antidiabetic properties (Santana-Gálvez et al., 2017).

Table 1 also shows the chemical composition of Yacon syrup, and the main constituents are carbohydrates with 66.25% justifying the high levels of total soluble sugars (60.88%) and SS (70.7 °Brix). Protein content was 0.93%, lipids represented 0.63% and energy value was 263.29 kcal. The inorganic residues represented 1.78% of Yacon syrup, which proved to be a good source of potassium with 9.44 g kg^{-1}, copper with 5.75 g kg^{-1}, iron with 11.5 g kg^{-1}, zinc with 6.75 g kg^{-1} and of manganese with 2.0 g kg^{-1} syrup. The moisture content of Yacon syrup was 30.40%, once it is associated with food stability, quality, and composition, such content is considered low which is positive for preventing deterioration due to microbial proliferation. Meanwhile, similarly low protein and lipid contents were previously reported for Yacon syrup, 0.17% lipid (Mendes et al., 2019) and 1.61% protein (Silva et al., 2018).

Dietary fibers and FOS content in the Yacon syrup are shown in Table 2, the total dietary fiber content is 19.0 g kg^{-1}, the insoluble fraction is 1.0 g kg^{-1} and the soluble fiber fraction is 18.0 g kg^{-1}. The FOS content in Yacon syrup is 17.22% and the major FOS present were trisaccharide 1-kestose (DP2, 40.50%), followed by tetrasaccharide nystose (DP3, 25.34%), pentasaccharide fructofuranosil (DP4, 12.65%) and DP6 (8.08%). Products with a minimum of 2.5 g are considered a source of FOS with the potential to improve the human intestinal flora and, once Yacon root presents such high FOS content, it has been prepared into beverages (Adriano et al., 2020) and flour (Machado et al., 2019). Yacon flour was previously reported to have 232.6 g kg^{-1} of total dietary fiber, 202.8 g kg^{-1} of soluble fraction, and 29.8 g kg^{-1} in the insoluble fraction (Martino et al., 2020).

Table 2. Dietary bioactive content and microbiological analyzes of Yacon syrup.

Evaluations	Variables	Values
Dietary Bioactives	Soluble fiber (g kg^{-1})	18.0
	Insoluble fiber (g kg^{-1})	1.0
	Total dietary fiber (g kg^{-1})	19.0
	Fructooligosaccharides (FOS %)	17.22
	DP6 (% RC*)	8.08 ± 0.40
	Fructofuranosil(%RC*)	12.65 ± 0.86
	Nystose (%RC*)	25.34 ± 2.79
	Kestose (%RC*)	40.50 ± 9.58
Microbiological analyzes	Total coliforms (MPN mL^{-1})	< 3.0
	Salmonella spp.	none
	Staphylococcus spp. (CFU mL^{-1})	< 10
	Molds and yeasts (CFU mL^{-1})	6.5 x 10^1

*RC: relative concentration.

The microbiological analysis of Yacon syrup showed the absence or reduced levels of total coliforms *Salmonella* spp. and *Staphylococcus* spp. and low counts of mold and yeast; thus, the absence of pathogenic microorganisms ensures the processing of Yacon roots is adequate for food quality and safety (Table 2).

3.2 Characterization of gelatin matrix added with Yacon syrup as a FOS source

The gelatin matrix added with 10% Yacon syrup (GY) was characterized as a film in comparison to a control gelatin coating (Table 3). The optical properties differed statistically between both films, GY film luminosity (L) was 96.33 while gelatin control was 96.85, however, results indicated both are translucent. Coordinate a* had negative values for both films indicating a greenish color, while coordinate b* of the GY film indicated a more yellowish color (2.61) than control (0.84) which reflected on the C values that indicated a higher color saturation of GY film (2.63) than the control (0.84), and Hue angle values above 90º also indicate films have a yellow hue. The opacity of the GY film was statistically lower (152.30 A nm mm^{-1}) than the control gelatin film (220.20 A nm mm^{-1}), which was opaque, while the thickness of the GY film was 64% greater than the control film probably due to the increment of solids as fibers (Table 2) and macromolecules (Table 1).

Table 3. Properties of films consisting of gelatin only and gelatin added with 10% Yacon syrup (GY).

Evaluations	Variables	Films*		
		Gelatin	GY	CV (%)**
Optical properties	Luminosity (L)	$96.85^{a} \pm 0.02$	$96.33^{b} \pm 0.02$	0.02
	Coordinate a	$-0.04^{b} \pm 0.01$	$-0.30^{a} \pm 0.02$	7.52
	Coordinate b	$0.84^{b} \pm 0.02$	$2.61^{a} \pm 0.16$	6.69
	Chroma (C)	$0.84^{b} \pm 0.02$	$2.63^{a} \pm 0.17$	6.76
	Hue angle (h)	$92.93^{b} \pm 0.35$	$96.61^{a} \pm 0.06$	0.27
	Opacity (A nm mm^{-1})	$220.20^{a} \pm 7.08$	$152.30^{b} \pm 16.39$	7.38
Water-related characteristics	Thickness (mm)	$0.069^{b} \pm 0.01$	$0.113^{a} \pm 0.02$	17.28
	WVP (g mm kPa^{-1} h^{-1} m^{-2})	$1.22^{b} \pm 0.06$	$2.11^{a} \pm 0.13$	6.09
	Moisture (%)	$15.97^{a} \pm 0.75$	$8.49^{b} \pm 1.16$	8.01
	Insoluble matter (%)	$0.12^{a} \pm 0.05$	$0.22^{a} \pm 0.10$	44.62
Contact angle	0 second	$79.20^{a} \pm 3.16$	$67.40^{b} \pm 0.61$	3.10
	30 seconds	75.20a ± 4.69	$64.43^{b} \pm 4.46$	4.77
	60 seconds	$62.63^{a} \pm 6.48$	$73.13^{a} \pm 1.10$	6.85
	90 seconds	$72.13^{a} \pm 6.59$	$58.83^{b} \pm 1.99$	7.43
	120 seconds	$71.87^{a} \pm 8.30$	$58.60^{a} \pm 1.51$	9.14
Mechanical properties	Tension (MPa)	$82.71^{a} \pm 1.54$	$32.72^{b} \pm 3.18$	4.34
	Rupture (%)	$6.96^{b} \pm 2.17$	$12.98^{a} \pm 4.41$	34.86
	Elastic mode (MPa)	$2,788.74^{a} \pm 66.01$	$1,181.43^{b} \pm 191.99$	7.23

*Between films, means with different letters are significantly different at $\rho \leq 0.05$ according to Tukey's test. **CV: coefficient of variation.

Gelatin films are originally yellow due to the extraction by thermal denaturation or hydrolysis of collagen present in bovine connective tissue, however, the GY film had a more intense yellow color possibly due to 0.14 mg.100 g^{-1} DM of carotenoids present in Yacon root (Pacheco et al., 2020). Results presented here indicate that addition of Yacon syrup changed the morphology and crystalline structure of the film into a more open and amorphous structure that allows deeper penetration of light into the film and, thus, the reduction of its opacity (Fakhouri et al., 2018). Therefore, the greater transparency of the GY film should exert less influence on the visual sensory characteristics of coated produce. These optical properties represent an important quality factor as they influence the appearance of food products and, therefore, consumer acceptability (Syahida et al., 2020).

The water vapor permeability (WVP) was significantly higher in the GY film (2.11 g mm kPa^{-1} h^{-1} m^{-2}) than in the control film (1.22 g mm kPa^{-1} h^{-1} m^{-2}). The addition of Yacon syrup reduced the moisture of the gelatin film from 15.9% to 8.4% possibly due to a decrease in the hydrophilic groups available to bind to water (Zhang et al., 2019), however, the insoluble matter content of both films did not differ statistically. The contact angle with water represents the hydrophilicity of the film surface, and both films presented values lower than 90º indicating surfaces with a hydrophilic character, although the GY film had overall statistically lower values than the control.

WVP represents the efficiency of edible films to act as a water barrier to the transmission of water vapor between food and the environment (Zhang et al., 2019; Sun et al., 2020). Thus, interactions between gelatin and Yacon syrup molecules would possibly lead to more empty spaces at the protein matrix interface allowing vapor permeation (Rangaraj et al., 2021). Moreover, the results observed here for contact angle indicate the film incorporated with Yacon syrup may be favorably applied on MP fruits once hydrophilic coatings maintain a hydrated and shiny appearance of the fruits for a longer period (Zhang et al., 2019).

The evaluation of the mechanical properties shows the maximum tensile strength of the control film was 82.71 MPa, which was significantly reduced with the addition of Yacon syrup to 32.72 MPa. Control film (6.9%) exhibits less deformation at the breakpoint than the GY film (12.98%), which presents greater deformation and a lower elastic modulus (1,181.43 MPa), therefore, less rigidity and greater flexibility than control (2,788.74 MPa).

According to Syahida et al. (2020), the tensile strength of food packaging films should be greater than 3.5 MPa, as observed here for both evaluated films, once tensile tests measure the stiffness, strength, and flexibility of a film indicating its ability to maintain structural integrity throughout the production and handling process. The greater flexibility of GY film may be explained by the SS, fibers, and lipids contained in Yacon syrup (Tables 1 and 2) can act as natural plasticizers, and according to Xu et al. (2019), interfere with the film matrix and prevent the formation of hydrogen bonds, weakening the intermolecular interactions between polymer chains, increasing the free volume. Overall, our results indicated the coating based on gelatin added with 10% Yacon syrup had the potential to be evaluated as postharvest technology to conserve quality and improve the bioactive properties of MP fruits.

3.3 Evaluation of MP melons coated with gelatin added with FOS-rich Yacon syrup

The postharvest quality of MP melons uncoated and coated with gelatin added with Yacon syrup (GY) was evaluated during six days of storage at 10 °C (Table 4), and GY coating reduced the mass loss as control lost an average of 6.23% while coated fruit lost 5.48%, at day 6. Regarding the color parameters (Table 4), only luminosity differed between treatments, thus at day 6, GY-coated fruit had lower values of 59.36 than the control, 63.39. Values of coordinates a* and b* remained constant during storage without significant differences between treatments. The total SS content of GY-coated MP melons was higher, 6.41 ºBrix than the control with 5.33 ºBrix, although both decreased significantly during storage. The total titratable acidity increased during storage reaching 0.21% in control fruits meanwhile, the pH values decreased from 6.41 to 4.74 in the control fruits, without significant difference between treatments.

The lower mass loss indicated that the GY coating possibly impacted processes such as respiration and water evaporation due to its role as a barrier to O_2, CO_2, and water vapor. Temiz & Özdemir (2021) coated strawberries with gelatin enriched with inulin and probiotic *Lactobacillus rhamnosus.* The authors reported that uncoated fruits showed a greater mass loss (38%) than fruits coated with only gelatin, gelatin-probiotic, and gelatin-inulin-probiotic that lost 24%, 17%, and 21%, respectively, and this result was due to reduced water evaporation and respiration rate, which consequently reduced the perishability of strawberries. Meanwhile, the higher SS can be explained due to compounds present in Yacon syrup added to the coating as sugars and polyphenols (Table 1), and the latter could also be associated with slightly darkened coated MP melons possibly due to changes in surface reflection properties (Pacheco et al., 2020).

Table 4. Postharvest quality and antioxidants of minimally processed melon uncoated and coated with gelatin added with Yacon syrup (GY) stored at 10 °C*.

Quality				*Antioxidants*			
Variables	**Days**	**Uncoated**	**GY coated**	**Variables**	**Days**	**Uncoated**	**GY coated**
Mass loss (%)	0	-	-	Total Polyphen. (mg GAE kg^{-1} FM)	0	555.12 ^{Aa}	555.12 ^{Ad}
	1	4.20 ^{Ad}	3.97 ^{Ad}		1	458.03 ^{Bbc}	776.74 ^{Aab}
	2	4.60 ^{Acd}	4.21 ^{Bcd}		2	446.33 ^{Bc}	816.59 ^{Aab}
	3	4.98 ^{Abc}	4.41 ^{Bc}		3	426.29 ^{Bc}	967.87 ^{Aa}
	4	5.05 ^{Ab}	4.84 ^{Ab}		4	553.85 ^{Ba}	753.97 ^{Ac}
	5	4.98 ^{Abc}	4.59 ^{Bbc}		5	491.79 ^{Babc}	801.85 ^{Aab}
	6	6.23 ^{Aa}	5.48 ^{Ba}		6	553.08 ^{Bab}	852.03 ^{Ab}
Luminosity (L)	0	65.45 ^{Aa}	61.48 ^{Bab}	Yellow Flavonoids (mg kg^{-1} FM)	0	4.00 ^{Aa}	4.00 ^{Ab}
	1	62.79 ^{Ab}	62.52 ^{Aa}		1	3.32 ^{Ba}	4.96 ^{Aab}
	2	65.02 ^{Aab}	60.18 ^{Bab}		2	3.63 ^{Ba}	4.88 ^{Aab}
	3	64.56 ^{Aab}	61.20 ^{Bab}		3	3.64 ^{Ba}	5.97 ^{Aa}
	4	63.22 ^{Aab}	62.68 ^{Aa}		4	4.39 ^{Ba}	5.69 ^{Aa}
	5	65.05 ^{Aab}	62.00 ^{Bab}		5	4.18 ^{Ba}	5.18 ^{Aab}
	6	63.39 ^{Aab}	59.36 ^{Bb}		6	4.15 ^{Ba}	5.17 ^{Aab}
Soluble solids (°Brix)	0	6.96 ^{Ba}	7.62 ^{Aab}	Total Caroten. (mg kg^{-1} FM)	0	66.41 ^{Ab}	66.41 ^{Ae}
	1	6.61 ^{Bab}	7.67 ^{Aa}		1	70.65 ^{Bb}	141.32 ^{Ac}
	2	6.90 ^{Bab}	7.26 ^{Abc}		2	63.38 ^{Bb}	139.44 ^{Ac}
	3	6.67 ^{Bab}	7.86 ^{Aa}		3	77.85 ^{Bab}	171.52 ^{Ab}
	4	6.62 ^{Bab}	7.06 ^{Ac}		4	72.25 ^{Bb}	107.15 ^{Ad}
	5	6.53 ^{Bb}	7.59 ^{Aab}		5	76.90 ^{Bab}	127.48 ^{Acd}
	6	5.33 ^{Bc}	6.41 ^{Ad}		6	96.62 ^{Ba}	201.57 ^{Aa}
Titrable acidity (%)	0	0.14 ^{Ab}	0.08 ^{Bd}	TAA** (µM Trolox kg^{-1} FM)	0	13,748.07 ^{Ab}	13,748.07 ^{Ade}
	1	0.18 ^{Aab}	0.20 ^{Aab}		1	22,099.45 ^{Ba}	54,747.34 ^{Ab}
	2	0.20 ^{Aa}	0.17 ^{Abc}		2	14,038.97 ^{Bb}	48,218.66 ^{Ac}
	3	0.19 ^{Aa}	0.14 ^{Bc}		3	25,704.06 ^{Ba}	86,550.47 ^{Aa}
	4	0.18 ^{Aab}	0.17 ^{Abc}		4	11,446.59 ^{Bb}	21,292.24 ^{Af}
	5	0.17 ^{Aab}	0.13 ^{Bc}		5	14,423.86 ^{Bb}	33,230.66 ^{Ad}
	6	0.21 ^{Aa}	0.23 ^{Aa}		6	12,271.78 ^{Bb}	22,932.79 ^{Aef}
pH	0	6.41 ^{Aa}	5.99 ^{Bbc}				
	1	6.17 ^{Aab}	5.71 ^{Bc}				
	2	6.15 ^{Aab}	5.72 ^{Bc}				
	3	6.16 ^{Bab}	6.35 ^{Aa}				
	4	5.98 ^{Ab}	6.02 ^{Ab}				
	5	6.11 ^{Ab}	5.89 ^{Bbc}				
	6	4.74 ^{Ac}	4.64 ^{Ad}				

*Different capital and lowercase letters indicate significant differences between coating treatments and storage periods at $p < 0.05$, respectively. **Total antioxidant activity.

Variables related to the antioxidant potential of GY-coated MP melons were evaluated and results are shown in Table 4. The total polyphenol content of GY-coated melons increased from 555.12 at day 0 to 852.03 mg GAE kg^{-1} FM at day 6 and was significantly higher than in control fruit, which maintained constant levels. Among phenolic contents, the yellow flavonoid content showed similar behavior with GY-coated melons presenting a 25% higher content than the control. Meanwhile, the carotenoid content increased during the storage of melons from both coating treatments however, coated melons had a higher value with 201.57 mg kg^{-1} FM at day 6, than the control. The total antioxidant activity (TAA) of MP melons was constant during the storage of control fruit, however, coating significantly increased reaching 22,932.79 µM trolox kg^{-1} FM, on day 6. The higher total polyphenol and flavonoid content of GY-coated melons may be associated with the high phenolic content present in the Yacon syrup (Table 1), as well as the higher carotenoid content of coated melons once according to Pacheco et al. (2020), the carotenoid content of Yacon roots was 0.14 mg $100g^{-1}$.

The higher phenolic and carotenoid contents must have contributed to the higher total antioxidant activity of the GY-coated melons, once these are potent antioxidants (Vuolo et al., 2019). These results indicate a positive effect of the gelatin coating containing Yacon syrup on the antioxidant potential of processed melon and previously, studies have associated coatings incremented with such bioactive compounds to human health-promoting properties as anti-inflammatory, antimutagenic, anticarcinogenic and reduction of cardiovascular diseases and cancer, both comorbidities associated with obesity (Gonnet et al., 2010; Gülçin, 2012; Santos-Buelga et al., 2019; Maqsood et al., 2020). It has also been reported that phenolic contents may increase the antioxidant content of the intestinal lumen or serve as a fermentable substrate for the colonic microbiota and subsequently release absorbable and beneficial metabolites (Durán-Castañeda et al., 2023), as those observed by the Yacon syrup FOS.

The structural integrity of tissues through histological optical analysis could be shown in this study (Figures 1A-H), while SEM micrographs showed the microstructure of coated and control MP melons (Figures 2A-H). Up to day 4, the mesocarp of both coated and control melons consisted of turgid and adjacent parenchymatous cells and well-defined cell walls (Figures 1C and 1G). Meanwhile, on day 0, it was possible to observe the homogeneous and uniform coating intimately adhered to the surface of the fruit (Figure 2E), in comparison with the uncoated sample that presented cracks and irregular contours of the cell structures (Figure 2A). As storage progressed, on day 6, control samples showed tissue disorganization with large intercellular spaces and plasmolyzed cells with loosening of cell walls (Figure 1D), which based on the reaction with PAS that identifies neutral polysaccharides, may be explained by the dissolution of pectic substances with the breakdown of cross-links between wall components such as pectin and cellulose. Meanwhile, GY-coating maintained cell turgidity and tissue integrity of MP melons (Figure 1H). On day 6, microstructural changes as cracks and pores were further evidenced on the surface of control fruits (Figure 2D), while coating conferred less heterogeneity (Figure 2H).

Koh et al. (2017) also verified by SEM that chitosan, pectin, and alginate formed homogeneous coatings with good adhesion to the surface of MP melon. Moreover, coating of melons with chitosan added with trans-cinnamaldehyde prevented tissue disorganization, which was observed in control samples evidenced by plasmolysis and dissolution of the cell wall mainly associated with cell wall hydrolytic activity of polygalacturonase (Carvalho et al., 2016).

The microbiological quality was evaluated at days 0 and 6 of storage at 10 °C (Table 5), and control MP melons presented a high degree of contamination on day 6, therefore they were not further evaluated, but only the GY-coated melons. On day 0, the total coliform count was 93 MPN g^{-1} and increased on day 6, to > 1,100 MPN g^{-1} in coated fruits, meanwhile, *Salmonella* spp. was not detected. On day 0, the initial mesophyll count of processed melons was 1.4 x 10^4 CFU g^{-1} and increased during storage. On day 0, the initial count of molds and yeasts was <1 CFU g^{-1} and increased on day 6, to 1.12 x 10^6 CFU g^{-1} in coated melons.

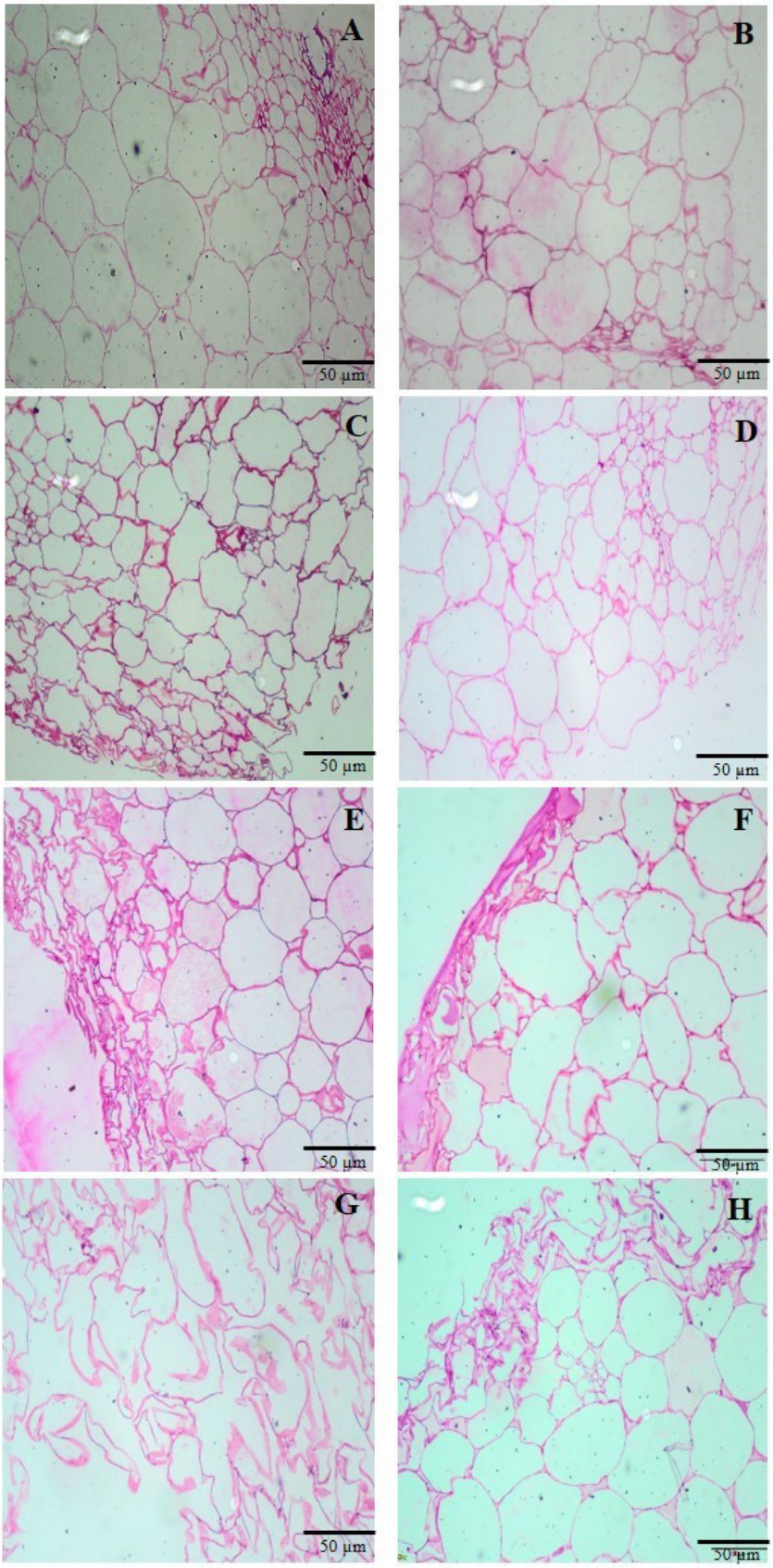

Figure 1. Histology of uncoated MP melon stored for (A) 0; (C) 2; (E) 4 and (G) 6 days and of gelatin added with Yacon syrup (GY) coated melon stored for (B) 0; (D) 2; (F) 4; and (H) 6 days at 10 °C stained with Schiff's periodic acid (PAS). Bar: 50 µm.

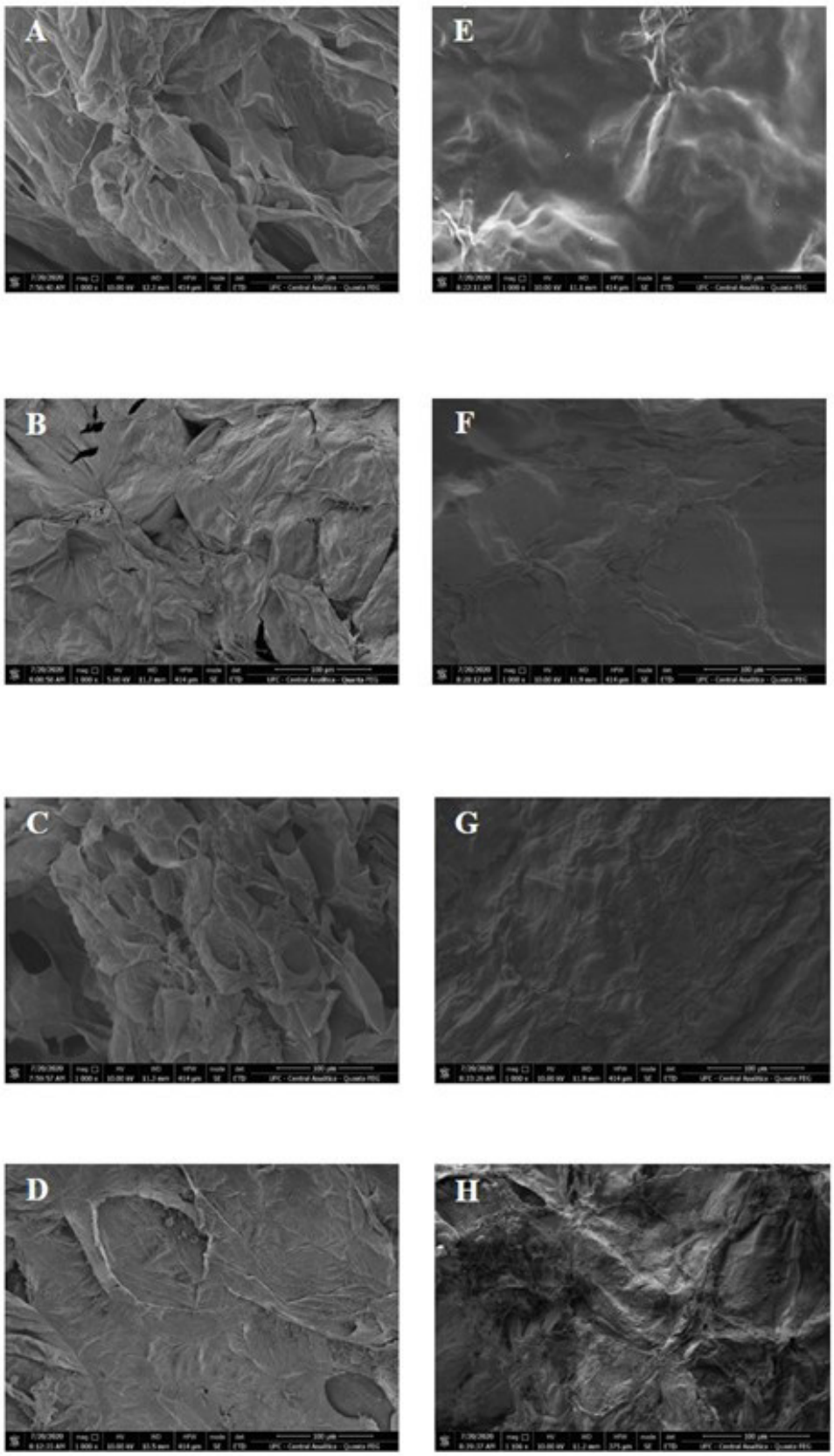

Figure 2. Scanning electron micrographs (100x) of uncoated MP melon stored for A) 0; B) 2. C) 4 and D) 6 days and of gelatin added with Yacon syrup (GY)-coated melon stored for E) 0; F) 2. G) 4 and H) 6 days at 10 ºC.

Table 5. Microbiological analysis, relative FOS concentration and bioavailability of minimally processed melon uncoated and coated with gelatin added with Yacon syrup (GY) stored at 10 °C.

	Microorganisms	Storage (Days)	Treatments	
			Uncoated	GY coated
Microbiological analysis	*Total Coliforms (MPN g^{-1})*	0	93	93
		6	-	>1,100
	Salmonella spp. (25 g)	0	Too low to count	Too low to count
		6	-	Too low to count
	Mesophilic flora (CFU g^{-1})	0	1.4 x 10^4	1.4 x 10^4
		6	-	Too numerous to count
	Mould and yeast (CFU g^{-1})	0	< 1	< 1
		6	-	1.12 x 10^6

	Digestion (phases)	Storage (Days)	Relative concentration (%)*			
			DP6	Fructofuranosil	Nystose	Kestose
FOS bioavailability	Gastric	*0*	NQ	7.37 ± 0,81^{Aa}	19.87 ± 2.20^{Aa}	98.30 ± 9,68^{Ba}
	Intestinal		NQ	10.21 ± 6.88^{Ba}	27.04 ± 5.04^{Aa}	168.45 ± 34.99^{Aa}
	Gastric	*1*	NQ	2.81 ± 2.26^{Aa}	3.26 ± 1.32^{Ba}	5.40 ± 3.86^{Ca}
	Intestinal		NQ	4.22 ± 5.19^{Ba}	15.00 ± 5.19^{Aa}	57.61 ± 21.55^{Ba}
	Gastric	*3*	NQ	6.07 ± 1.09^{Ab}	16.91 ± 6.94^{ABa}	15.03 ± 2,68^{Cb}
	Intestinal		2.89 ± 2.43^{Aa}	27.70 ± 0.49^{Aa}	24.83 ± 0.28^{Aa}	43.35 ± 2.60^{Ba}
	Gastric	*5*	NQ	5.05 ± 0.23^{Ab}	19.62 ± 2,57^{Ab}	154.50 ± 16.15^{Aa}
	Intestinal		3.02 ± 0.56^{Aa}	17.55 ± 3.56^{ABa}	28.38 ± 0.40^{Aa}	244.13 ± 31.36^{Aa}

*Capital letters represent a significant difference between storage times and lowercase letters significant difference between gastric and intestinal phases at 5% significance by Tukey's Test. DP, degree of polymerization. NQ, not quantified. (-), Not evaluated once unsuitable for consumption.

Based on the results observed for total coliforms and *Salmonella* spp. and according to Resolution 12 from January 2nd, 2001, of the Brazilian National Health Surveillance Agency-Agência Nacional de Vigilância Sanitária (ANVISA) (Brasil, 2001), which establishes a maximum limit of 5×10^2 NMP.g^{-1} for thermotolerant coliforms and the absence of *Salmonella* spp. in 25 g of whole or fractioned fresh vegetables to be considered acceptable for direct consumption, the gelatin coating added with Yacon syrup preserved an acceptable microbiological quality. Regarding mesophilic microorganisms, Brazilian legislation does not prescribe limits for in fruits and vegetables (Brasil, 2019). However, molds and yeasts increased on day 6 above the limit of 10^3 and 10^4 CFU.g^{-1}, respectively, allowed by the Brazilian legislation as established by ANVISA in the Normative Instruction 60 from December 26th, 2019 (Brasil, 2019). Thus, after 6 days of storage at 10 ºC, both GY-coated and control uncoated melons were considered inappropriate for consumption.

The analysis of the aromatic volatiles of GY-coated and uncoated MP melons stored at 10 ºC resulted in the identification of metabolites belonging to different chemical groups, including esters, alcohols, aldehydes, terpenoids, and sulfur compounds (Figure 3). There are two clusters of aromatic metabolites with different behavioral patterns regarding their production rate: first, include volatiles present in the coated (T0) and control (T5) fruits, and second, include volatiles present in the control (T0) and coated (T5) fruits. The heatmap indicates that the gelatin coating added with Yacon syrup influenced the emission of volatiles in general of MP melons, once at day 0, coated fruits showed the greatest abundance of aromatic compounds, which decreased until day 5. Meanwhile, at day 0, control fruits showed a lower abundance of aromatic compounds which increased until day 5. Regarding the aromatic metabolites of control melons, isobutyl acetate and benzyl alcohol are the most abundant on day 0, while acetaldehyde, 2,3 butanediol diacetate, 3-nonen-1-ol, 3,6 nonadien-1-ol, D-limonene, disulfide dimethyl, benzoin, 1,3 butanediol, 1 octene-3-iol increased during storage.

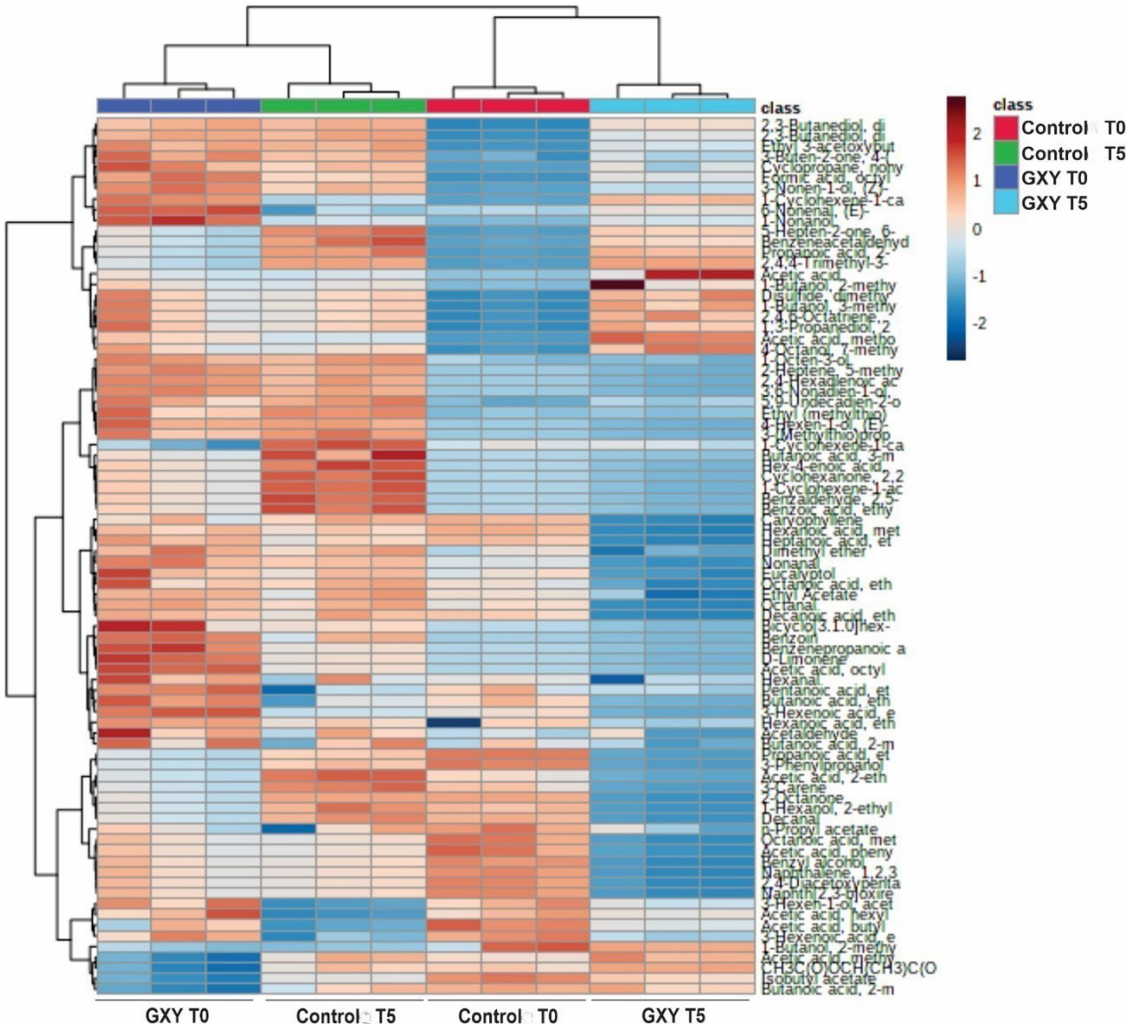

Figure 3. Heatmap with hierarchical clustering of metabolites from uncoated and gelatin added with Yacon syrup (GY)-coated MP melons stored for 0 and 5 days at 10 °C.

Therefore, the increase in volatile observed in control fruits may be associated with the senescence process, while the decrease observed in coated melons may be explained by the lower metabolic rate due to the barrier properties of the coating. Mannucci et al. (2017) reported that apples coated with gelatin presented lower volatiles as acetate esters, which generally increase with ripening, due to delayed maturation as consequence of the lower respiration which reflects the gas barrier properties of the coating. In addition, it has been previously reported that aromatic metabolites, isobutyl acetate, and benzyl alcohol, are the most characteristic of ripe melons (Condurso et al., 2012; Shi et al., 2020; Farcuh et al., 2020). Aldehydes such as acetaldehyde and hexanal, terpenoid compounds such as (E, Z)-3,6-nonadien-1-ol, and alcohols such as benzyl alcohol, all identified in this research were also found in climacteric melon varieties and increases in their concentrations have been associated with ripening and senescence (Senesi et al., 2005; Beaulieu, 2006; Bellincontro et al., 2006, Vallone et al., 2013; Nagashima et al., 2021).

The *in vitro* simulated digestion of GY-coated MP melons was carried out to analyze FOS resistance to gastrointestinal hydrolyzing conditions which would ensure its bioavailability and, thus prebiotic potential to intestinal microflora (Table 5). The fructose oligomer DP6, and its hydrolysis-products DP4 fructofuranosyl, DP3 nystose and DP2 kestose were the main FOS present in GY-coated melons (Table 5), as also observed for Yacon syrup (Table 2). The simulated gastrointestinal digestion showed that the largest fructose oligomer DP6 was observed only in the intestinal phase from day 3 of storage, indicating its release was possibly delayed due

to its larger size and the plasticizing effect of the coating (Table 5). Meanwhile, the DP4, DP3, and DP2 fructose oligomers were verified in both gastric and intestinal phases throughout the storage period. Moreover, on day 5 of storage, the concentrations of nystose and fructofuranosyl were significantly ($p < 0.05$) higher in the intestinal phase, while kestose was significantly higher on day 3, indicating the partial hydrolysis of fractions of Yacon FOS during digestion. In general, we can conclude that the FOS added to melons through the gelatin coating may not be completely hydrolyzed during digestion and, therefore, FOS contents present the potential to exert their role as prebiotics to intestinal microflora and thus, promote health.

In agreement with our results, Figueiredo et al. (2020) evaluated the action of digestive enzymes on FOS during *in vitro* simulated digestion and observed a small degradation of kestose and nystose, thus considering these results positive once FOS are prebiotic agents. Pei et al. (2023) did not observe a significant difference in FOS composition between the different phases of digestion in the oral, gastric, and intestinal environments, suggesting that little FOS can be digested.

4 Conclusions

Results showed that Yacon syrup has bioactive potential due to high prebiotic FOS and phenolic contents, relevant physicochemical and microbiological properties besides a desirable mineral content and, thus has great potential for the enrichment of food systems. Moreover, the edible coating consisting of gelatin matrix added with Yacon syrup presented adequate physical resistance and optical properties, in addition to water vapor permeability and mechanical properties suitable for food packaging, thus may hereafter, be evaluated on fresh and processed fruits to increment the bioactive properties and contribute to postharvest quality conservation.

Thus, the application of a gelatin coating added with Yacon syrup as a source of FOS in MP melons showed good results for the maintenance of the physicochemical quality and structural integrity of the fruits during cold storage. In addition, the coating increased the antioxidant potential of MP melons through increments in phenolic and carotenoid contents, besides the increase in prebiotic FOS. However, the coating did not prevent the development of microorganisms after 5 days under the conditions in which the melon was stored, although those were in better condition than the control fruits that showed such an advanced degree of deterioration by pathogens not being evaluated. Thus, the results observed here allow us to conclude that the proposed coating increased the functional properties of MP melons, maintaining their quality for up to 5 days at 10 ºC.

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