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Use of maltodextrin and gum arabic for encapsulation of red cabbage anthocyanins

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ABSTRACT

Maltodextrin (MD) and two types of gum arabic (IRX 40642 and IRX 49345) were used to encapsulate anthocyanins of red cabbage. The solution of the encapsulated dye was evaluated by polarized light microscopy. The spray-dried powder (microspheres) containg anthocyanins (red cabbage juice obtained by disintegration and filtration) and encapsulating agent was characterized by Scanning Electron Microscopy (SEM) and water sorption isotherms; the product color characterization was measured using software of imaging analysis (Mathematica). The microspheres showed that in gum arabic solutions, the dye was located at the wall. Specifically, dried gum arabic microspheres had a better quality than that produced by the maltodextrin because the MD does not form microsphere, but serving only as wall material. GAB isotherm was well fitted on experimental water sorption data. Through the color parameters quantified in CIELab and CIELCH systems for anthocyanin solutions in the presence of three studied encapsulating agents, it was possible to observe that maltodextrin had little effect on the coloring of the dye solution, for example, through the analysis of the hue parameter H, which was least affected by changes in concentration or pH from 5.0 to 3.0. The gum arabic IRX 40642 showed an oxidized hue, while gum arabic IRX 49345 gave similar colors to the original dye at concentrations less or equal to 10%. Even with some limitations, it was concluded that the gums used in this study are suitable for the encapsulation of red cabbage anthocyanins.

KEYWORDS: maltodextrin; gum arabic; color parameters; sorption isotherms; spray-dried powder.

INTRODUCTION

Anthocyanins are pigments responsible for red and blue coloration of many vegetables. Additionally, they have anticholesterogenic, antimutagenic, antidiabetic or antioxidant functional properties among several others (GALVANO et al., 2004 and PRENESTI et al., 2007). Their thermo and photosensitivity promote color losses due to oxidation when extracted from the natural matrix. Although the conservation requirements of such sensible products have stimulated new researches, the addition of antioxidants and encapsulation has proved to be the most effective method. Microencapsulation is an effective way of stabilizing phenolic compounds, ensuring a longer shelf life as well as a range of possible industrial applications (MOSER et al., 2017, MAHDAVI et al., 2016b). In this context, there are many encapsulation techniques, among which some have been successfully assigned to anthocyanin. The selection of an encapsulation technique depends on specific applications and parameters such as physicochemical properties of the core and wall materials, required particle size, release mechanisms, process cost etc. (MAHDAVI et al., 2014).

A more appropriate and useful technique used to encapsulate flavors is spray-drying (SHEU and ROSENBERG, 1995; 1998; YOSHII et al., 2001), since it is a continuous and low cost process that produces dry particles of good quality, and the apparatus required are readily available according to the studies of Yousefi et al (2015), Lacerda et al. (2016), Lavelli et al. (2016), Santiago et al. (2016), Mahdavi, et al. (2016a) Mahdavi, et al. (2016b) and Moser et al. (2017).

The retention quality of the encapsulated product is a functional property dependent of the solid wall, and it involves materials such as carbohydrates and chemically modified natural polymers. Gum arabic is one of the most important natural polymers traditionally used in the microencapsulation; with a good retention capacity (SANKARIKUTTY et al., 1988, MAHDAVI et al, 2016b, RIBEIRO et al., 2020), which favors emulsion stability and protects it against oxidation (MADANE et al., 2006). Maltodextrin is non-expensive and mostly used as wall material, although it is considered inefficient by some researchers when used as a single encapsulating agent (SANKARIKUTTY et al., 1988, REYES et al., 2018). Moreover, it presents good results when combined to β-cyclodextrin, gum arabic and other materials (MAHDAVI et al., 2016a; MAHDAVI et al., 2016b; MOSER et al., 2017; SOUZA et al., 2017). According to Sheu and Rosenberg (1995) and O'Boyle et al. (1992), MD is able to achieve good results when pure or combined with other wall-solids that have high dextrose equivalent (DE) (which is a measure of the degree of starch polymer hydrolysis). In the study on the DE effect of maltodextrin on the stability of emulsified coconut-oil in spray-dried powder Matsuura et al. (2015) utilized maltodextrin of DE 2, 10 and 25, and their results showed that dextrose equivalence had no influence on the encapsulation do emulsified coconut-oil, but the reconstituted emulsion from MD of DE 10 was less stable than those from MDs of DE 2 and DE 25.

The encapsulation quality of morphological characteristics is generally verified using Scanning Electron Microscopy - SEM (HOGAN et al., 2001), where the microsphere integrity can be observed. A functional coating cannot have pores or cracks, but must be a little wilted (O'BOYLE et al., 1992). Dent free surfaces frequently on small particles are related to the drying rate effect (SHEU and ROSENBERG, 1998). The quality of the resulting powder can also be evaluated by sorption isotherms (STENCL, 1999; ASCHERI, 1999), since the foodstuff hygrocapacity influences handling, processing, storage, and consuming of biological materials (LABUZA, 1968).

This work aims to evaluate the encapsulation ability of two wall materials, gum arabic and maltodextrin, containg to anthocyanins from red cabbage. The influence of the two wall materials are also evaluated regarding to color changes of the pigment and water susceptibility of the anthocyanin powder.

MATERIALS AND METHODS

POWDER ANTHOCYANIN PRODUCTION

Red cabbage juice was obtained through disintegration of the whole vegetable in a home juice extractor. The juice was filtered using a sintered filter and centrifuged at 5000 rpm for 20 min to separate the insoluble solids. The colorant concentration (mg of colorant by 100 mL of solution) was obtained for partially purified and whole juices with the aid of a spectrophotometer at 550 nm, at pH of 3.0 (COUTINHO et al., 2004).

Maltodextrin, MD DE30 (Lorenz Ltda) and gum arabic, GA IRX49345 and IRX40642 (Colloids Naturels Brasil Comercial Ltda), pharmaceutical degree, were used as encapsulating agents. GA IRX 40642 is an instant acacia gum, with high water solubility, ability to form film and low calorie (less than 2 Kcal g^{-1}) (LIMA, 2006). GA IRX49345 is an instant acacia gum, with high water solubility, pH of 4.0 and 5.0 in aqueous solution (25%) and viscosity of 70 to 130 mPa (RODRIGUES, 2004).

Anthocyanins from red cabbage were partially purified by adsorption-desorption process on Amberlite XAD7 resin (Acros Organics) according to Coutinho et al. (2004).

Wall materials (MD and/or GA) were previously hydrated in 50 mL McIlvaine buffer solution of pH 3.0 and 5.0 (citric acid and sodium hydrogen phosphate), (LOPES et al., 2006). Mixtures with dye solutions at concentrations of 5, 10, 25 or 40 % w/V MD and GA were agitated in a magnetic stirrer for different time intervals (1 and 2 h). Solutions were spray-dried (APV pilot scale, model PSD 52, evaporation capacity of 9.3 kg h^{-1}) at 180±5ºC inlet and 80±5ºC outlet air temperatures, respectively.

PHYSICAL STRUCTURE OF THE ENCAPSULATED ANTHOCYANIN

Polarized optical microscopy was used to observe microspheres formation in 20 $g.L^{-1}$ anthocyanins solutions with MD and GA IRX 49345 wall materials (40%), before spray-drying. The gum arabic IRX 40642 was not analyzed because it showed an oxidized hue.

The structure and surface morphology of dye-40% GA and dye-10% MD spray dried emulsions were investigated by SEM. A PHILIPS microscope, model XL-30, operating at 20 kV with tungsten source was used. Images from both back scattered and secondary electrons were considered. Image analysis to evaluate and quantify the particle sizes of the powders was performed in 70 particles using SizeMeter® software (Process Control Laboratory, UFSC, Brazil).

WATER SORPTION ISOTHERMS

Water sorption experiments were carried out to evaluate the effects of the spray-drying on pure material wall, concentration and carrier type on the dye powders behavior. Anthocyanin powders containing 10%MD, 40%MD and 40%GA IRX 49345 were tested and compared to commercial and processed (humidified followed by spray drying) MD. The experimental data were triplicated.

Sorption isotherms were determined by the static gravimetric method using saturated salt solutions of KOH, KCH_3CO_2, $MgCl_2.6H_2O$, $K_2CO_3.2H_2O$, $Mg(NO_3)_2.6H_2O$, $NaNO_2$, NaCl, $(NH_4)_2SO_4$, KCl and K_2SO_4 at temperature of 30±3ºC and a known relative humidity, according to Rockland (1960).

The values of the equilibrium moisture (X) were calculated on a wet basis (% WB). The dry mass was determined in an oven at 105±5°C until constant weight was reached. The water mass was obtained from the difference between the sample mass at equilibrium and the dry mass. At equilibrium, the water activity (a_w) of a food is equal to the value of the relative humidity of air (HR) in that closed environment.

The GAB (Guggenheim, Andersen, de Boer) model (Equation 1) was fitted to experimental data using non-linear regression of Quasi-Newton and least square loss function methods, considering C>0.

$$\frac{X}{X_m} = \frac{C\,k\,a_w}{(1-k\,a_w)(1-k\,a_w+C\,k\,a_w)} \qquad \text{(Equation 1)}$$

where: C is the Guggenheim constant: C = c' exp [(H_1 – H_m)/RT)], c' is a first order coefficient, k is the correction factor of properties of the molecules in the multilayer with respect to the volume of the liquid: k = k' exp (H_l – H_n)/RT, H_l is the heat of condensation of pure water vapor, H_m is the total heat of sorption of the first layer on primary sites, H_n is the heat of sorption of water molecules in multilayers, a_w is the water activity, X is the equilibrium moisture content, X_m is the moisture content of the monolayer, R is the universal gas constant and T is the temperature, (K).

Water content of the dye powder samples was measured in a vacuum oven at 70±2 °C for 48 hours or until constant weight.

COLORATION POWER AND COLOR CHARACTERIZATION

The color of red cabbage juice was characterized at natural extraction condition (pH ~ 6.0), pH 5.0 and 3.0. These pH values were used for the partial purification by adsorption-desorption method of anthocyanins (COUTINHO et al., 2004; LOPES et al., 2007).

Coloration power of the dried encapsulated powder was obtained by the absorbance measure at 550 nm of 20 g L^{-1} pigment solutions, produced at different concentrations of wall materials (5%, 10%, 25% or 40% MD, 40% of GA and 20% GA+20%MD). In the combined formulation of GA and MD, maltodextrin remains soluble in the solution and it is incorporated into the microsphere wall during the drying process making the surface smoother and more uniform, as also observed by Dias (2009). Congo red in 0.01N calcium carbonate solution was used as a standard for the calibration curve. In order to evaluate the wall material interference on the juice color, characterizations were carried out using mixtures of red cabbage juice with maltodextrin DE 30 or gum arabic (IRX 40642 and IRX 49345).

The color parameters were obtained by photographic method in fixed volumes samples of 20 g L^{-1} aqueous anthocyanin solutions at the different concentrations and wall materials types. The red cabbage (*Brassica oleraceae*) has the following anthocyanins: cyanidin-3-soforoside-5-glycoside acylated with malonyl, p-cumaroil, di-p-cummaroil, feruloil, diferuloil, sinapoil and disinapoil esters (JACKMAN and SMITH, 1992). Also, red cabbage has a high concentration of anthocyanins; on average 1.75 mg g^{-1} of red cabbage (LANCASTER et al, 1997).

Two D-65 lamps of illuminating system were positioned at 45° over the samples. A digital cyber-shot camera (Sony, model DSC-P 71) with 3.1 MPixel resolutions, 20 cm perpendicularly placed over the surface sample was used to snap pictures. In sequence, image treatment was done on a selected area from the photos, and pixel to pixel images were transformed to color indexes using Mathematica 5.1 software. CIELab and CIELCH average color indexes as well the color index (CI, Equation 2) and color difference (ΔE*, Equation 3) were respectively calculated (YEATMEN et al., 1960 and EMADY et al., 2015).

$$CI = \frac{2000\,abs(a)}{L\left(a^2 + b^2\right)^{1/2}} \qquad \text{(Equation 2)}$$

$$\Delta E^* = \sqrt{\left(L^* - L^*_{ST}\right) + \left(a^* - a^*_{ST}\right) + \left(b^* - b^*_{ST}\right)} \qquad \text{(Equation 3)}$$

where L is the lightness, L* is the value in the lightness axis, *a* is the value in the axis (-a* green and +a* red), b is the value in the axis (-b* blue and +b* yellow), ST is the standard subscript.

RESULTS AND DISCUSSION

ENCAPSULATION CAPACITY

Encapsulating solutions of the red cabbage anthocyanin can be observed in Figures 1.a and 1.b for MD and GA IRX 49345 wall materials, respectively. Figure 1.c shows the image of the solution without wall material for comparative parameter. A microsphere formation can be observed at the center of the Figure 1.b with a great concentration of anthocyanin at the edge of the microsphere.

The limiting wall has a considerable concentration of the pigment, confirming the high capacity of GA, an emulsifier agent, to form microspheres in aqueous solution. In the MD photography (Figure 1.a), no microspheres were observed, however the circles represent air bubbles, similar to Figure 1.c. On the other hand, MD plays the role of dispersion product in order to increase the solids concentration and makes drying easy, because a drying test of pure dye, in concentrated solution, proved to be unfeasible: the material, probably due to an exceptional hygrocapacity, does not allow obtaining a powder, as it adheres to the dryer walls.

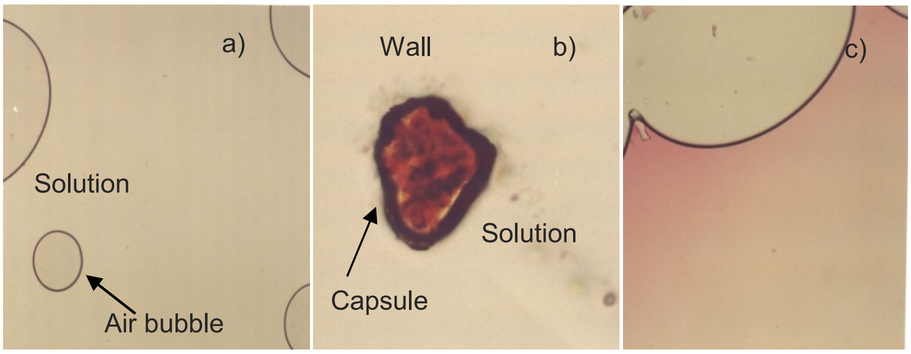

Figure 1. Optical photographies of the encapsulation solutions. a) maltodextrin MD; b) gum arabic GA IRX 49345; c) pure anthocyanin solution.

EVALUATION OF THE PHYSICAL STRUCTURE OF THE POWDER ANTHOCYANIN

Microphotographs of microspheres from spray dried powder containing 40% GA IRX 49345 and 10% MD are shown in Figures 2.a and 2.b, respectively. Figure 2.a shows retracted and wilted forms accompanied by some cracks, while in Figure 2.b, the spherical structures observed for MD have no retractions, but they were considerably cracked, as observed in other studies (COUTINHO, 2002).

The qualitative evaluation of the obtained microspheres shows the GA IRX 49345 as an adequate encapsulation material that protects dye and evidences microspheres capable of releasing the product needed.

Without fissures or cracks, the continuous and round walls of the gum arabic microspheres (Figure 2.a), are of greatest importance to avoid losses as much as possible, offering greater protection and retention of the encapsulated material. The presence of concavities or flattening on the surface is a characteristic property of the microspheres produced by atomization using gum arabic as encapsulating agent (ASCHERI, 1999 and TRINDADE and GROSSO, 2000). Hollow gum arabic microspheres (cracked marc in Figure 2.a) were also found by Rosenberg et al. (1990) for volatile materials, and dye should be retained at the inner side of the wall.

It is observed, after drying, microspheres formed by 10% MD (Figure 2.b) were round- and no cavities or flattening were observed. Few broken microspheres were observed, indicating the maltodextrin as a promising solid dispersion agent, since no microspheres were observed. In the same direction, O'Boyle et al (1992), Sheu and Rosenberg (1995) and Ersus and Yurdagel (2007) also consider maltodextrin as an encapsulating agent.

Particle diameters obtained from the SEM microphotographs showed sizes of 7.83±5.59 µm and 7.26±5.68 µm for gum arabic and maltodextrin particles, respectively. Ersus and Yurdagel (2007) mentioned particle sizes from 3 µm to 20 µm for spray dried microspheres MD-black carrot (*Daucus carota* L.) anthocyanins.

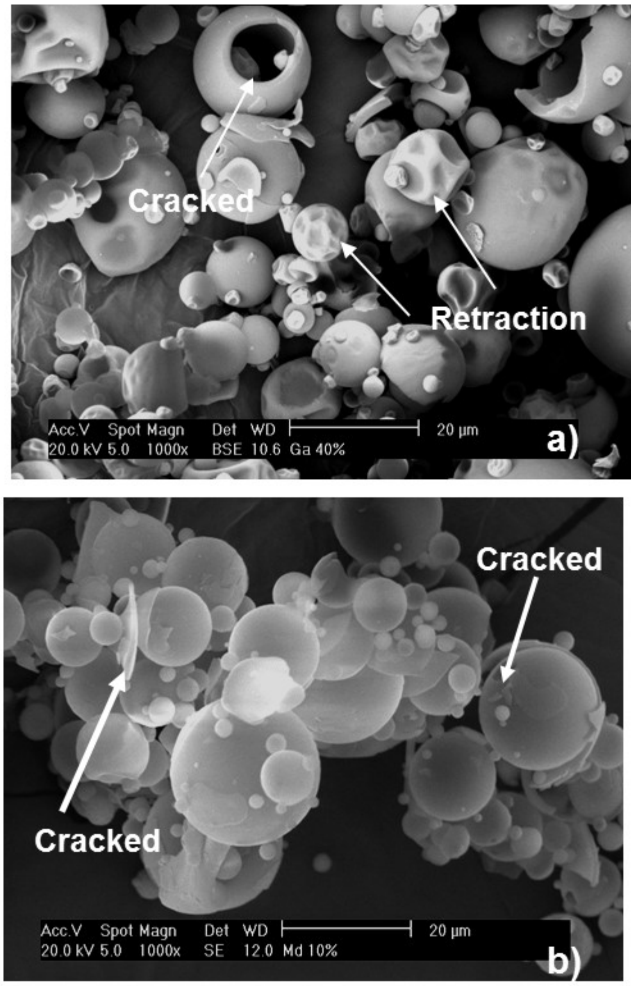

Figure 2. Microcapsules obtained from spray dried powder with a) 40% of GA IRX 49345 (Magnification factor 1000x); b) MD 10% (Magnification factor 1000x).

SORPTION ISOTHERMS OF ANTHOCYANIN POWDERS

GAB model parameters were fitted on experimental data from water sorption isotherms of anthocyanin powders. Figure 3 illustrates the GAB behavior of mixtures containing 10% MD and 40% MD. Maltodextrin presents a higher hygroscopy than gum arabic, because MD presents a high degree of dextrose (30 DE) in its composition.

Table 1 shows the GAB parameters values for each case studied: commercial MD, humidified-spray-dried commercial MD and red cabbage juices containing 10%MD, 40%MD and 40% GA IRX 49345. Special limiting loss function C>0 was needed, as there was no sensibility to the parameter. The differences among experimental data were not statistically significant (5.0%), therefore, a common GAB isotherm (Figure 4) could be fitted for all situations reducing the determination coefficient (R^2) from 0.999 to 0.973.

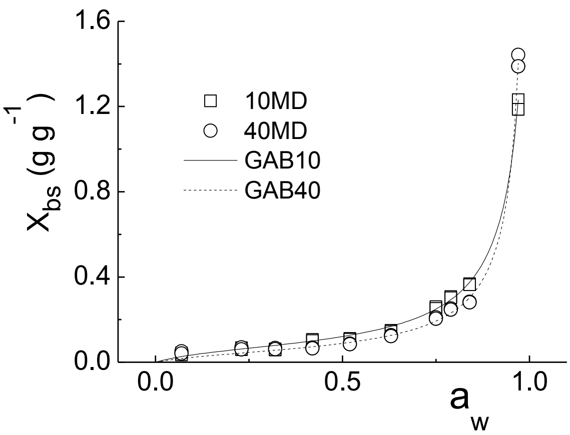

Figure 3. GAB isotherm parameters fitted to experimental data for anthocyanin powders containing 10% MD and 40% MD

Table 1. Fitted parameters of GAB equation on water adsorption isotherms.

Specific curve	X_m	C	K	R
MD_{com}[a]	0.059	2.270	0.979	0.999
MD_{com} spray[b]	0.074	2.293	0.960	0.999
10% MD[c]	0.071	7.285	0.972	0.999
40% MD[c]	0.052	5.989	0.993	0.999
40% GA[c]	0.055	6.596	0.956	0.999
Common isotherm[d]	0.058	8.873	0.978	0.973

NOTE: [a]commercial maltodextrin; [b]spray dried commercial maltodextrin; [c]dye spray dried with 10% MD, 40% MD and 40% GA; [d]common GAB parameters fitted to all cases studied.

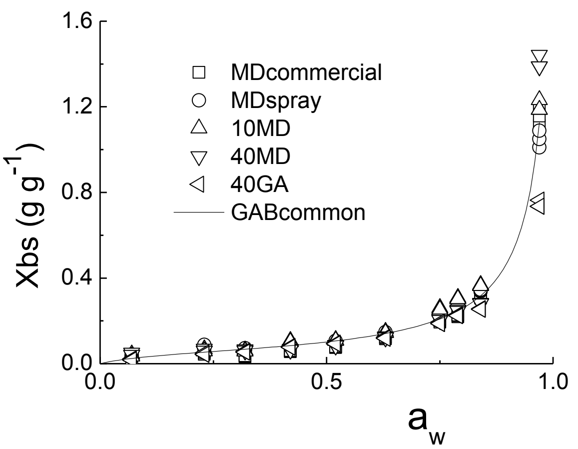

Figure 4. Common parameter set of GAB isotherm fitted to experimental data for the cases studied.

COLORATION POWER AND COLOR CHARACTERIZATION

The effect of MD addition on the color intensity was measured by the anthocyanin concentrations (Figure 5). It can be observed that as MD concentration increases, coloration intensity decreases following an exponential behavior ($C = 39.267e^{-0.0774[MD]}$, $R^2 = 0.9967$). It is possible to conclude that Maltodextrin (MD) acts as solid diluents, in this case.

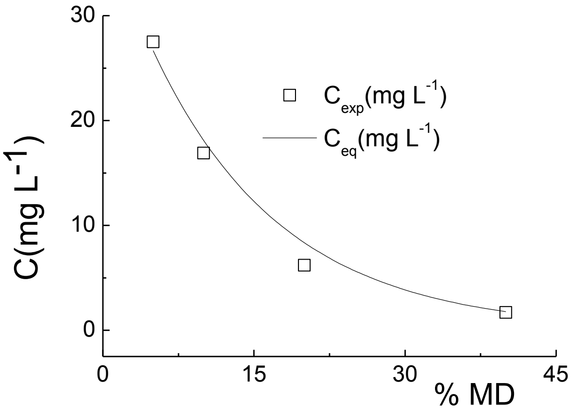

Figure 5. Anthocyanin solution concentration of 20 g L^{-1}, as a function of MD content.

Table 2 presents the resulting anthocyanin concentrations by dilution of 20 g L^{-1} of anthocyanins powder at 3 different wall material compositions: 40% GA, 20% GA+ 20% MD, 40% MD. It was observed that GA IRX 40642 gives twice the absorbance with 20% GA+ 20% MD, and four times the absorbance with 40% pure MD. It was also observed that GA clouds the solution, adding brown nuance. This result is in accordance to O'Boyle et al. (1992) that verified that GA used as the only encapsulating agent gives a low quality DNFH pigment.

Table 2. Colorant power of anthocyanins with different wall materials.

Wall material	C (mg L^{-1})
40% MD	1.7
20%MD+20%GA IRX 49345	3.7
40% GA IRX 49345	6.9

The natural red cabbage juice and mixtures with 5, 10, 25 and 40% of MD, GA IRX 40642 or GA IRX 49345 solutions at pH of 3.0 and 5.0 were characterized by L*, a*, b*, C*, H, IC and ΔE* parameters (Tables 3, 4 and 5).

Table 3 shows the influence of pH on red cabbage juice color. Lower pHs intensify the red component and decrease the bluish influence. All parameters are greatly affected by the pH variation, except the luminosity, L.

According to Brouillard (1983), significant anthocyanins color variations occur near the pK values, where the concentration of the flavilium cation and the quinoidal base are equal. The flavilium cation is red, while the quinoidal base is blue. Therefore, as the pH changes the protons equilibrium between the two chromophores, that modifies concentrations of each species. At pH of 3.0, the amount of flavilium cation in solution is much more important than the quinoidal base; however, it decreases as the pH increases, presenting pink color in low pH solutions as shown in Table 3. Furthermore, it goes from a medium purple (natural juice) to a deep pink (pH 3.0). A pH difference of 0.5 (from 5.5 to 5.0) gives a color variation ΔE* of about 8- a difference almost not observed by the human eye. On the other hand, a pH alteration from 5.5 to 3 gives an ΔE* of approximately 37.

Table 3. Color parameters for solutions of red cabbage anthocyanins.

Samples		L*	a*	b*	C	H	IC	ΔE*	Color
pH	3.0	57.33	70.94	-9.61	71.58	172.28	34.57	37.335	
	5.0	57.01	17.88	-14.58	23.07	140.81	27.19	8.16	
	Natural	55.48	29.87	-41.36	51.02	125.84	21.11	--	

Similar colors must have similar parameters. From Table 4, the addition of GA IRX 40642 in red cabbage juice pH 3.0 shows great differences in a* and b* parameters when compared to the pure juice; low concentrations (5% and 10%) of GA IRX 40642 change from deep pink to red color, while higher concentrations (25% and 40%) change the samples to yellowish color resulting in an oxidized appearance. This behavior is also described by the hue parameter (H) that goes from the second to the first quadrant of the CIELCH system. Very different H shows very different color patterns.

Table 4. Color parameters for solutions of red cabbage anthocyanins, pH 3.0

Samples		L*	a*	b*	C*	H	IC	ΔE*	Color
GA40642	5%	57.77	64.34	22.51	68.16	19.28	12.98	32.68	
	10%	56.94	53.70	31.30	62.16	30.24	11.64	30.34	
	25%	57.42	30.59	55.68	63.53	61.22	12.52	16.77	
	40%	59.10	28.62	60.68	67.10	64.75	14.87	14.43	
GA49345	5%	57.57	69.69	-7.97	70.15	173.48	0.32	34.52	
	10%	56.01	62.59	-7.05	62.99	173.57	3.56	35.48	
	25%	56.73	24.50	-1.26	24.53	177.04	19.35	35.21	
	40%	55.08	36.86	6.25	37.38	9.62	10.24	35.80	
MD	5%	56.38	71.03	-9.77	71.69	172.17	0.51	35.14	
	10%	57.46	72.52	-8.92	73.06	172.99	1.20	34.55	
	25%	55.38	66.46	-13.70	67.86	168.35	5.26	35.37	
	40%	56.71	63.51	-13.80	64.99	167.74	6.12	34.46	
Juice pH 3.0		57.33	70.94	-9.61	71.58	172.28	34.57	--	

Less important changes are shown when GA IRX 49345 is added: 5% and 10% addition almost do not change the red cabbage juice color at pH 3.0. On the other hand, higher concentrations (25% and 40%) give rosy brown and light coral tonalities, respectively. Yellow nuances (b*>0) are observed at higher concentrations. MD 5% solutions show the closest parameters set to the red cabbage juice at pH of 3.0. However, as MD concentration increases, they deviate from that standard, until they become similar to the red cabbage juice at pH 3.0. High concentrations give blue tonalities to the solutions. Notwithstanding, all color differences (ΔE*) are important and easily observed by the human eye. As observed in Table 5, colors tend to a blue tonality due to a higher pH. In such situations, the predominance of the quinoidal base occurs, as structure of the anthocyanins. The color characterization showed samples with luminosity at the middle of the scale, in all cases studied.

Table 5. Color parameters for solutions of red cabbage anthocyanins, pH 5.0

Samples		L*	a*	b*	C*	H	IC	ΔE*	Color
GA40642	5%	56.54	20.75	8.30	22.35	21.79	12.64	32.84	
	10%	58.36	23.56	36.80	43.70	57.37	29.21	18.48	
	25%	59.80	5.167	49.07	49.34	83.99	26.86	3.50	
	40%	61.18	11.50	62.10	63.15	79.51	37.24	5.95	
GA49345	5%	58.06	19.38	-9.49	21.58	153.89	3.82	30.93	
	10%	56.31	27.44	-8.23	28.65	163.30	7.61	34.02	
	25%	58.74	14.63	1.92	14.75	7.47	7.49	33.76	
	40%	57.91	11.37	11.67	16.30	45.74	10.32	24.10	
MD	5%	57.47	10.63	-9.15	14.03	139.28	-0.68	26.38	
	10%	60.96	14.13	-11.39	18.15	141.13	1.70	25.54	
	25%	57.28	8.53	-6.54	10.75	142.52	-0.52	27.72	
	40%	58.41	5.31	-4.18	6.76	141.81	-0.39	26.91	
Juice pH 5.0		57.01	17.88	-14.58	23.07	140.81	27.19	--	

CONCLUSIONS

After drying, Polarized light microphotographies showed, that only GA has the capacity to encapsulate anthocyanin. Through SEM microphotographs, it was observed a higher quality for the GA spheres than for MD spheres.

GAB isotherm was well fitted on experimental water sorption data. Moreover, the evaluation of color parameters showed that maltodextrin does not change the hue pigment significantly when a concentrated dye used is diluted within pH ranging from 5.0 to 3.0. The gum arabic IRX 40642 showed an oxidized hue, while gum arabic IRX 49345 presented colors similar to the original dye at concentrations less than or equal to 10%.

Although different materials were used to encapsulate red cabbage anthocyanins, no significant differences were observed among the dye powders' experimental results, regarding interaction with ambient moisture. Specific water vapor sorption isotherms were fitted to each case studied, but the description by only one equation was satisfactory.

Therefore, even with some limitations, it can be concluded that the gums used in this study are accredited for the encapsulation of anthocyanins of the red cabbage.

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Uso de maltodextrina e goma arábica para encapsulação de antocianinas de repolho vermelho

RESUMO

A maltodextrina (MD) e dois tipos de goma arábica (IRX 40642 e IRX 49345) foram usados para encapsular antocianinas de repolho roxo. A solução do corante encapsulado foi avaliada por microscopia de luz polarizada. O pó spray-dried (microesferas) contendo antocianinas (suco de repolho roxo obtido por desintegração e filtração) e agente encapsulante foi caracterizado por Microscopia Eletrônica de Varredura (MEV) e isotermas de sorção de água; a caracterização da cor do produto foi medida por software de análise de imagens (Mathematica). As microesferas mostraram que em soluções de goma arábica, o corante estava localizado na parede. Especificamente, as microesferas de goma arábica desidratada tiveram uma qualidade melhor do que a produzida pela maltodextrina porque o MD não forma microesferas, servindo apenas como material de parede. A isoterma GAB foi bem ajustada em dados experimentais de sorção de água. Através dos parâmetros de cor quantificados nos sistemas CIELab e CIELCH para soluções de antocianinas na presença dos três agentes encapsulantes estudados, foi possível observar que a maltodextrina teve pouco efeito na coloração da solução corante, por exemplo, através da análise do parâmetro matiz H, que foi menos afetado por mudanças na concentração ou pH de 5,0 a 3,0. A goma arábica IRX 40642 apresentou matiz oxidado, enquanto a goma arábica IRX 49345 deu cores semelhantes ao corante original em concentrações menores ou iguais a 10%. Mesmo com algumas limitações, concluiu-se que as gomas utilizadas neste estudo são adequadas para o encapsulamento de antocianinas de repolho roxa.

PALAVRAS-CHAVE: maltodextrina; goma arábica; parâmetros de cor; isotermas de sorção, pó seco por pulverização.

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