Foods 2024 Conference

The 5th International Electronic Conference on Foods

28–30 October 2024 | Online

MDPI

GLASS TRANSITION, ISOTHERMS AND MICROSTRUCTURE EVALUATION OF THYME-ENRICHED PUMPKIN SNACKS

Divito Ana[1,2]; Ansorena Ma. Roberta[1,3]; Buera Pilar[3,4]; Goyeneche Rosario[1,3]; Villagrán Nicolás[4]; Rolandelli Guido[3,4]; Dos Santos Cristina[4]; Di Scala Karina[1,3]

(1) Grupo de Investigación en Ingeniería en Alimentos (GIIA), Facultad de Ingeniería, Universidad Nacional de Mar del Plata.
(2) Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT), Argentina.
(3) Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina.
(4) Facultad de Ciencias Exactas y Naturales, Departamentos de Industrias y Departamento de Química Orgánica, Universidad de Buenos Aires.

INTRODUCTION & AIM

The enrichment of dehydrated vegetables with essential oils to obtain innovative snacks with health promoting properties may cause microstructural changes. In order to design new functional foods, understanding water sorption properties, phase transitions, and microstructure are essential tools. This study aimed to evaluate the glass transition, isotherms, and microstructure (SEM, fractal analysis and confocal microscopy) of pumpkin snacks dehydrated at 70°C as affected by different enrichment methods: free and encapsulated thyme oil.

METHOD

Pumpkin slabs were convectively dehydrated at 70ºC (v=5 m/s) and enriched with free and β-cyclodextrin encapsulated thyme oil. GAB and D`Arcy-Watt (GDW) models were applied to simulate the sorption behavior of samples. Glass transition temperatures (Tg) were achieved by DSC methodology. Microscopy image analysis was conducted using a ZEISS SUPRA 40 Scanning Electron Microscope (FE-SEM) and a ZEISS LSM 980 Confocal Fluorescence Microscope. Fractal dimension (FD) was calculated using the software ImageJ (FracLac plugin).

RESULTS & DISCUSSION

GDW and GAB models showed good fits to the experimental sorption data for all samples (Table 1).

GDW: Y= (((Qm*K*X)/(1+(K*X)))*((1-(P*(1-W)*X))/(1-(P*X))))

GAB: Y= (V*C*K*X)/((1-(K*X))*(1-(K*X)+(C*K*X)))

GDW			
Best-fit values	Control	Free oil	Microcapsules
Qm	1.83	0.4104	0.9656
K	1196	13.55	404.2
P	0.007584	0.002063	0.004525
W	1.859	0.1297	0.3023
R^2	0.9996	1	0.9998

GAB			
Best-fit values	Control	Free oil	Microcapsules
V (mmol/g)	6.298	6.016	5.858
C	5.157	14.72	30.25
K	0.9617	0.9535	0.9674
R^2	0.9992	0.9999	0.9998

Table 1. Fitting parameters for the GDW and GAB models.

	RH (%)	Tg (ºC)
Control	3,04	29,81
	7,48	-5,08
	21,98	-53,16
Free oil	4,44	20,02
	9,2	-6,4
	20,92	-41,73
Microencapsulated oil	5,33	29,33
	10,06	-2,04
	21,06	-44,09

Table 2. Tg values for control and enriched samples (free and microencapsulated oil) at different relative humidity percentages.

Tg values were in the range of -53.16 - 29.81ºC. As the percentage of water increased, a decrease in the glass transition temperature was observed. This phenomenon can be attributed to the plasticizing effect of water.

SEM images showed the effects of the different enrichment techniques on the snacks microstructure. FD in control and enriched samples showed lower values in the center compared to the contour of the snacks (shrinkage effect). Fractal dimension (FD) quantifies the complexity of a structure by assessing variations at different scales. Higher FD values reflect greater complexity. Samples enriched with thyme oil microcapsules presented the highest FD.

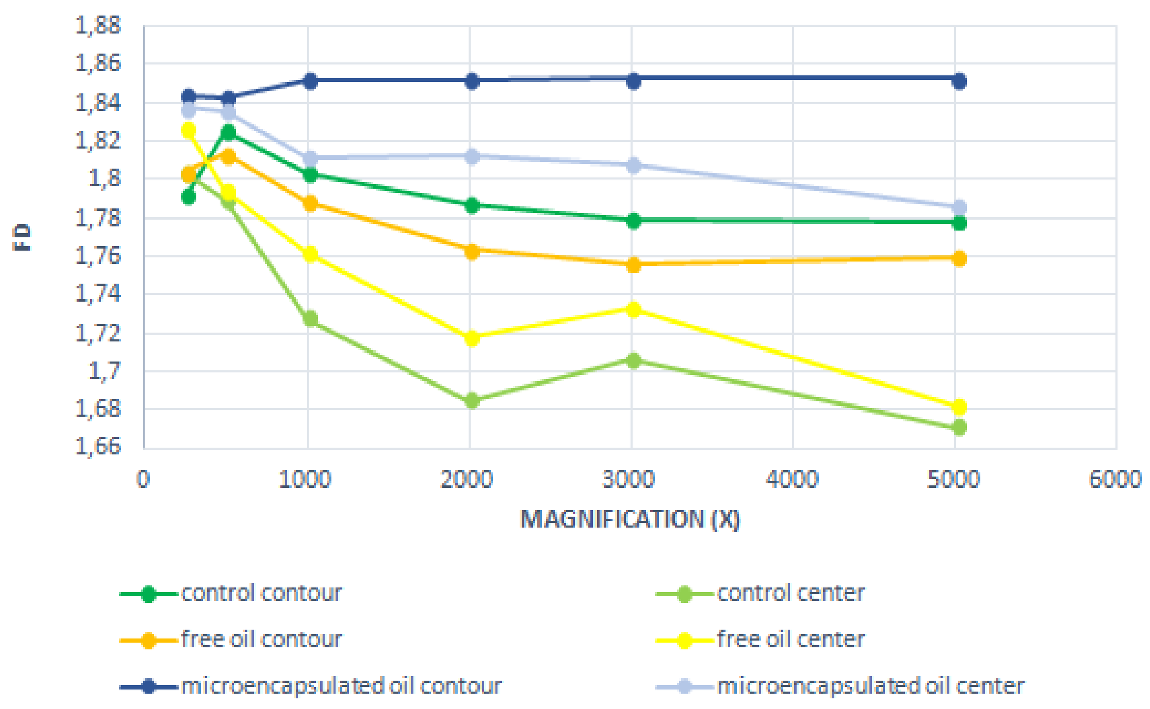

Fig. 2. DF values obtained from SEM image analysis at different magnifications.

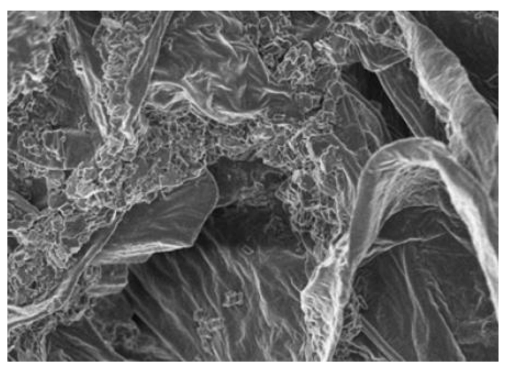

Fig. 3. Sample impregnated with β-CD microcapsules dried at 70ºC (5000X).

The images obtained through confocal microscopy revealed the presence of lipids in the samples exposed to both free and microencapsulated oil. Lipid aggregates exhibited a distinctive angular morphology characteristic of beta-cyclodextrin microcapsules (data not shown).

CONCLUSION

The impact of enrichment techniques as well as dehydration on microstructural and thermodynamic properties of pumpkin snacks highlighted their potential applications and emphasized the assessment of food microstructure as an optimization tool for the design of new functional foods.