P-027 **Sorption isotherms of microencapsulated *Origanum vulgare* L.**

Da Costa J.M.G. [1#], Hijo A.A.C.T. [1], Borges S.V. [1*], Silva E.K. [1], Marques G.R.[1]
[1]Food Science Departament, P.O. Box 3037, Zip Code 37200-000 [2]Federal University of Lavras, Lavras, Brazil
* Supervisor # Contact email : joycemgc@yahoo.com.br

INTRODUCTION AND OBJECTIVES

Water in food materials plays an important role in processing food products and their preservation. Moisture content in food influences physical and textural characteristics of a product as well as its chemical and microbiological stability (Mujumdar, 2000). Water adsorption by foods is a process wherein water molecules progressively and reversibly combine with the food solids via chemisorption, physical adsorption, and multilayer condensation (Basu et al., 2006). Recently, great progress in microencapsulation has been noted, although this technology has been used by the food industry for more than 60 years. The microencapsulation technology offers a new structure of the multicomponent product whose equilibrium moisture content (sorption isotherm) should, for many reasons, be experimentally determined (Adamiec, 2009). Although many microencapsulation techniques have been developed, spray-drying is the most common technology used in food industry due to low cost and readily available equipment. Food ingredients entrapped by spray-drying include fats, oils and flavor compounds (Baranauskiené et al., 2006).

The aim of this article was to determine the effect of microencapsulation processes by spray drying on the equilibrium sorption of water vapor at isothermal conditions of 25 ºC. Thus, the aqueous solutions of maltodextrin (10DE) and gum arabic emulsions with essential oil of oregano were spray dried under fixed process condition and analyzed for sorption properties.

MATERIALS AND METHODS

Materials and microencapsulation of essential oil oregano

Gum arabic was obtained as gift sample from RM-MAIA (Belo Horizonte-MG, Brasil). Maltodextrin DE-10 was given from Corn Products, Mogi Guaçu, SP, Brasil. Essential oil oregano was obtained from Laszlo Aromaterapia Ltda, Belo Horizonte-MG, Brasil. Twenty-five percent w/v solution of gum arabic and seventy-five percent w/v of maltodextrin were dispersed in distilled water and final volume made to 900ml. It was rehydrated for about 12 h at refrigerated temperature (10-12 °C). 10% based on the carrier used of Essential oil oregano was added to the mixture. The mixture was emulsified in a shear homogenizer for 5 minutes at 3000 rpm until complete dispersion of the essential oil. The resulting slurry was spray dried model MSD 1.0 Labmaq of Brasil, with inlet and outlet temperature maintained at 180 °C and 105 °C, respectively, feed rate at 0.96 L h^{-1}, and air rate of drying at 45 L min^{-1}. The powders produced were stored in proper sealed and opaque containers for later analysis of sorption properties.

Adsorption isotherms determination

The water sorption isotherms were determined by using an integral gravimetric method which consisted to reach the thermodynamic equilibrium of several microencapsulated essential oil oregano samples with controlled relative humidity environments regulated by saturated salt aqueous solutions in sealed jars (Multon et al., 1991). Seven salts (LiCl, $MgCl_2$, K_2CO_3, $Mg(NO_3)$, $NaNO_2$, NaCl and KCl) were used to determine the sorption isotherms in the range of water activity from about 0.1 to 0.86. The basket with 0.5 g of sample was weighed until constant weight. The corresponding aw values were directly obtained from literature data at some investigated temperatures or from extrapolation or interpolation when data were missing at a given temperature (Pajonk, 2001). Experiments were performed in triplicate and each point represented the mean of the three values. Experimental temperature investigated was chosen in the average temperature range usually encountered in industrial, equal to 25 ºC. Determination of the total moisture content was determined by the oven drying method at 105 ºC for 24 h. Experiments were performed in triplicate and each point represented the mean of the three values.

Mathematical Modeling

Mathematical models to describe the isotherms are listed in Table 1. It is important to note that predictions for the drying experiments and adsorption isotherms were performed with a quasi-Newton estimation method, with a convergence criterion of 1.00 x 10^{-4}, an initial value of 0.10 and an initial estimate of 0.50, for all of the model parameters. The adsorption isotherms data were fitted with three semi-theoretical adsorption isotherms models (Table 1), where X for each model was obtained using the equation respective. The agreement was determined using the coefficient of determination (R^2) and the estimated standard error (SE).

Table 1: Mathematical models that were used to describe the adsorption isotherm

Model	Equations
Jaafar and Michalowski	$X = \frac{K_1 K_2}{(1 - n_1 a_w)[1 + (K_2 n_1) a_w]}$
Peleg	$X = K_1 aw^{n1} + K_2\ aw^{n2}$
Oswin	$X = K_1 (\frac{a_w}{1-a_w})^{k}{}_{2}$

Where: X is defined as the moisture of sample (g water /g dry mass); a_w is water activity; and K_1, K_2, n_1 e n_2 are the model parameters of Peleg, Oswin and Jaafar and Michalowski. The agreement was determined using the coefficient of determination (R^2) and the estimated standard error (SE), calculated by:

$$R^2 = \frac{\sum_{i=1}^{n} (PRED - \overline{OBS})^2}{\sum_{i=1}^{n} (OBS - \overline{OBS})^2} \ ; \ SE = \sqrt{\frac{\sum_{i=1}^{n} (OBS - PRED)^2}{n}}$$

where OBS corresponds to observed value, $\overline{OBS}$ corresponds to the average value of all observed values, PRED is the predicted value and n is the number of observations (Jaafar & Michalowski, 1990).

RESULTS AND DISCUSSION

Table 2 shows the parameters that were obtained when the mathematical models were compared to the experimental microencapsulated essential oil oregano adsorption isotherm at 25 ºC.

Table 2. Parameters of adsorption isotherms models and agreements for microencapsulated essential oil oregano at 25 ºC

Models	Constants					
	K_1	K_2	n_1	n_2	R_2	SE
Peleg	0,014	0,970	0,014	0,970	0,973	3E-06
Jaafar and Michalowski	0,001	7,208	0,480	------	0,999	1E-07
Oswin	0,014	0,377	------	------	0,991	1E-06

Table 2 shows the parameters that were obtained when the mathematical models were compared to the experimental microencapsulated essential oil oregano adsorption isotherm at 25 ºC. The best values of R^2 were obtained with the equation of Jaafar and Michalowski (1990) for tested temperature of 25 ºC. This result is in agreement with the work of Nascimento et al. (2011), in which the authors compared 41 mathematical models of sorption isotherms to 53 food products and found that the best agreement was obtained with the model of Jaafar and Michalowski (1990). A comparison between the experimental data and the data predicted by the model of Jaafar and Michalowski for temperature of 25 ºC are shown in Figure 1.

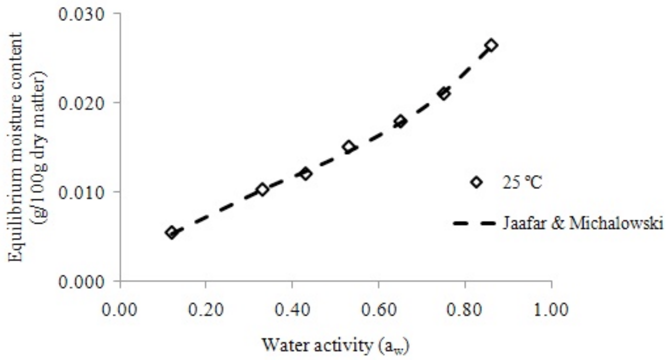

Figure 1: Adsorption isotherm of microencapsulated essential oil oregano compared to the Jaafar and Michalowski model at 25 ºC.

CONCLUSIONS

Among the mathematical models tested the model of Jaafar and Michalowski (1990) gave the best agreement with experimental data at 25 ºC of microencapsulated essential oil oregano adsorption isotherms.

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ACKNOWLEDGEMENT

To the FAPEMIG and CNPq for the financial support.