Equilibrium Moisture Content and Heat of Desorption of Garlic

Inês F.A. Mariz, Luís S. Pais, Filomena F. Barreiro, José A.C. Silva*
LSRE Laboratory of Separation and Reaction Engineering, Pólo II, Instituto Politécnico de Bragança, 5301-857 Bragança, Portugal.

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Garlic (*Allium sativum* L.) has been cultivated for centuries all over the world on account of its culinary and medicinal properties. Clinical trials have shown that garlic has important health benefits. The most encouraging results have occurred in the area of cholesterol reduction (Reuter et al., 1996). The compound responsible for these benefits is allicin, which gives garlic's characteristic flavour and odour. More recently, it has found uses as a raw material in the pharmaceutical industry and, in its dried form, as an ingredient of precooked and instant convenience foods, which has led to a sharp increse in the demand for dried garlic.

Figure 1 shows a schematic diagram of the apparatus used for determination of desorption isotherms of garlic at 5, 15, 25 and 35ºC, in the relative humidity range from 11 to 98%, using the standard static, gravimetric techique with the Novasina AW SPRINT (Novasina, Pfäffikon, Switzerland). The experimental desorption data (Figure 2) was fited to BET and GAB equations to predict the desorption behaviour of garlic.

For the computation of BET and GAB model parameters from moisture desorption data, the BET ($k = 1$) and GAB ($k \neq 1$) equations were transformed into the following linear relation:

$$\frac{ka_w}{(1-ka_w)X} = a + bka_w \qquad \text{with} \qquad a = \frac{1}{X_m C} \qquad \text{and} \qquad b = \frac{C-1}{X_m C}$$

where X is the moisture content (kg of water/kg dry mass), a_w is the water activity, X_m is the monolayer moisture content and C and k are the fitting constants of the BET and GAB model.

Figure 3 shows a plot of $ka_w / X_e\left(1-ka_w\right)$ *versus* ka_w for the analysis of the most suitable model to describe the isothermal water desorption garlic at 5ºC. Figure 3 clearly shows that the GAB model is the best to fitting desorption data. The fitting constants of the GAB model obtained through this procedure are shown in Table 1 for the other temperatures. It is interesting to note that monolayer moisture content, calculated from the GAB equation, decreased with increasing temperature.

The isosteric heats of desorption of water (Q_n^{st}) were determined from the equilibrium data at differents temperatures using the Clausis-Clapeyron equation:

$$\left[\frac{dl\ln a_w}{dT}\right]_{X_e=const} = \frac{Q_n^{st}}{RT^2}$$

As can be observed in Figure 4, Q_n^{st} values ranged from 415.73 kJ/kg at moisture content of 0.05 kg of water/kg dry mass to 85.16 kJ/kg at 0.3 kg of water/kg dry mass.

The results obtained in this study, are now being used in the development of a drying unit for garlic, by a suitable technique.

* Corresponding author. Tel + 351-273-303125. E-mail: jsilva@ipb.pt
Escola Superior de Tecnologia e Gestão
Campus Santa Apolónia, Apartado 1134
5301-857 Bragança

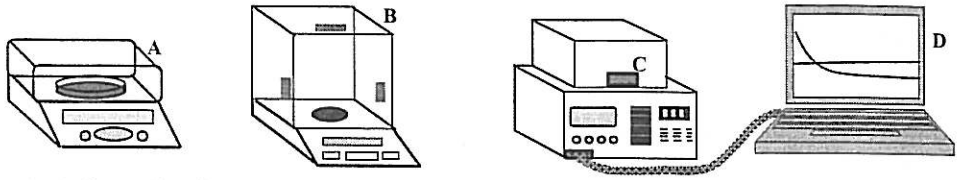


Figure 1. Schematic diagram of apparatus used in the determination of desorption isotherms: (A) Sartorius MA45 (moisture balance); (B) Denver Instrument (analytical balance); (C) Novasina AW SRINT (water activity measuring) and (D) Computer for data recorded.

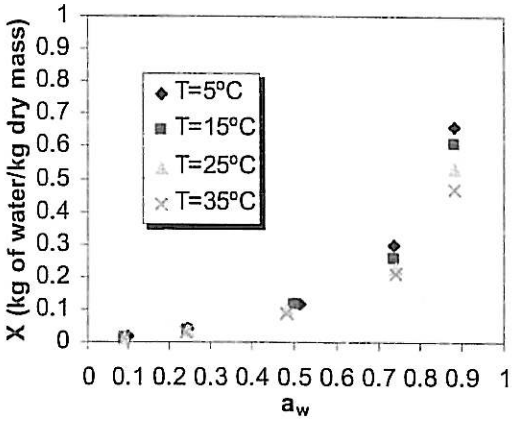
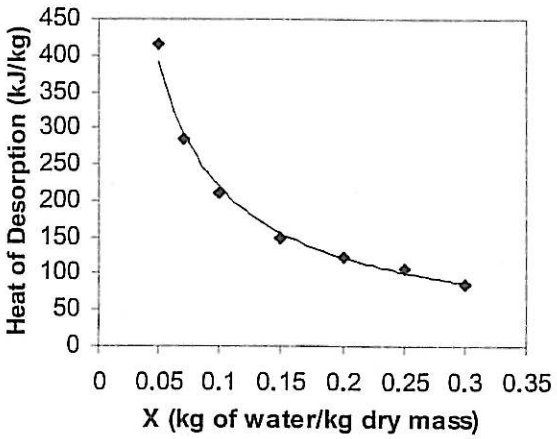


Figure 2. Moisture desorption isotherms of garlic at 5, 15, 25 and 35°C.

Table 1. Fitting constants of GAB equation to the desorption isotherms of garlic.

T (°C)	X_m	C	k
5	0.0988	1.4613	0.9833
15	0.0888	1.5034	0.9865
25	0.0763	1.5994	0.9892
35	0.0723	1.5261	0.9792



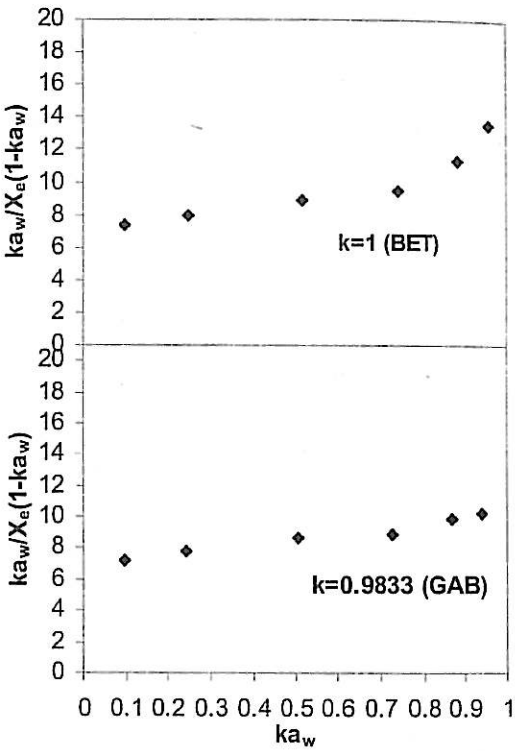


Figure 3. Plot of $ka_w / X_e\left(1-ka_w\right)$ vs ka_w for the analysis of the desorption of garlic at 5°C: $k=1$ (BET isotherm); $k=0.9833$ (GAB isotherm).

Figure 4. Net Isosteric heat of desorption of garlic expressed mathematically as a potency function of moisture content:

$$Q_n^{st} = 31.381X^{-0.8428}$$

Acknowlegement

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References

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