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Effect of Convective Drying of *Myrtus communis* on the Yield and Quality of Essential Oils

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ABSTRACT
The medicinal and aromatic plants in particular the sheets of myrtle have much importance for the pharmacopeia, perfumery, the confectionery. This study enters within the framework of the valorization of this plant produced in Tunisian north. It is a question of studying the drying of this plant and the influence of this drying on the efficiency and the quality of essential oils. In order to determine the water content final to optimize the conditions of storage and drying of product, a determination of the isotherms of adsorption-desorption was carried out using the static gravimetric method. The curves obtained are then approached by empirical models. Another experimental study is devoted to the determination of the kinetics of drying under controllable conditions of temperature and moisture.

Key words: Drying, myrtle, adsorption, desorption, modeling

INTRODUCTION
Convective drying is an essential operation in many processes that lead to development of basic materials to finished products. The objective of drying plant aromatic and medicinal plants is to reduce the water activity of these products and to ensure their conservation value. This phenomenon must meet certain criteria related to product quality (Ahmed *et al*., 2002; Kouhila *et al*., 2002; Dvin *et al*., 2011).

In order to contribute to studies on the determination of optimal conditions for plant conservation, this study has been done to study the kinetics of drying leaves of myrtle (*Myrtus communis* harvested in northern Tunisia (Bizerte region).

The *Myrtus communis* is the only natural species of the family Myrtaceae in the Mediterranean. In Tunisia, the myrtle grows naturally in the north west of Tunisia and Cape Bon. This species is highly sought for the operation of these fruits and the essential oil extracted from these leaves and its distillate, known as the angel of water.

The determination of sorption isotherms of leaves of *Myrtus communis* is an essential step in the study of the drying and preservation, because it determines the moisture balance (Yogananth *et al*., 2011). It provides valuable information on the equilibrium moisture of the product. The first objective in this study is to determine experimentally the isotherms of adsorption and desorption.

The second is devoted to obtaining the drying kinetics of *Myrtus communis* in conditions aerothermal controlled temperature and humidity of drying air.

MATERIALS AND METHODS

The experimental apparatus consists of eleven glass jars each with insulated closing this glass jars is filled to quarter depth with saturated salt solution (KOH, $MgC1_2$, K_2CO_3, $NaNO_3$, KCl and $BaCl_2$) (Greenspan, 1977), so as to have a relative humidity which varies from 5 to 97%. For the desorption process, the sample of fresh *Myrtus communis* are put in the sample holder. But, for the adsorption process, *Myrtus communis* is dehydrated in an oven regulated at temperature of 50°C until reaching maximum dehydration.

The sample is weighted every four days. When the mass of sample become stationary, the experiment is stopped and the sample are weighted and placed in an oven whose the temperature is fixed at 105°C. This operation lasts 24 h.

The objective of this operation is to determine the dry masses of sample M_d.

The moisture content X_{eq} of the product at hygroscopic equilibrium:

$$X_{eq} = \frac{M_w - M_d}{M_d} \tag{1}$$

The same operation is repeated for both adsorption and desorption processes at temperature 30, 40 and 50°C.

RESULTS AND DISCUSSION

The hygroscopic equilibrium of *Myrtus communis* is determinated in 15 days for adsorption and 20 days desorption. The results of these experiments are presented in Fig. 1-3 at different

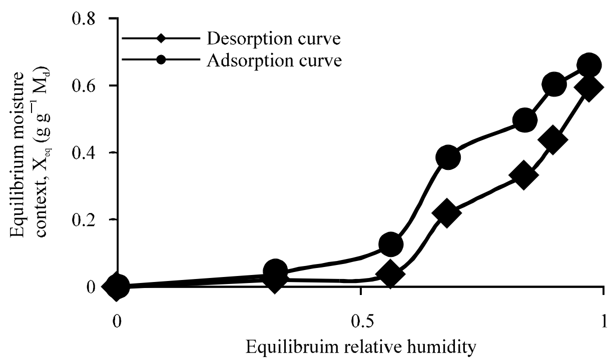

Fig. 1: Isotherm of adsorption and desorption of Myrtle for T = 30°C

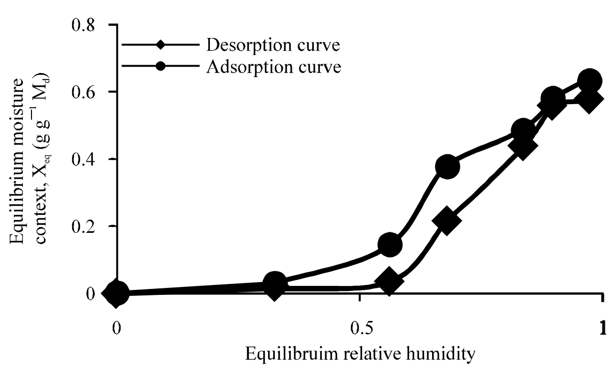

Fig. 2: Isotherm of adsorption and desorption of Myrtle for T = 40°C

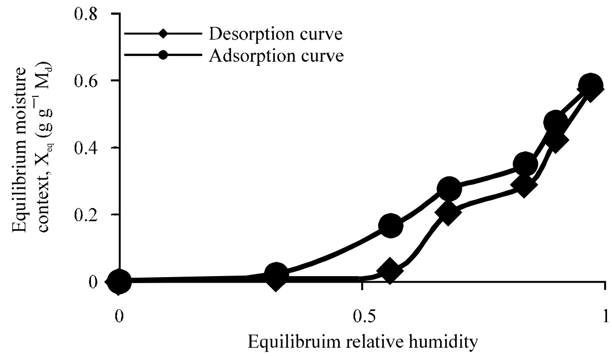

Fig. 3: Isotherm of adsorption and desorption of Myrtle for T = 50°C

temperature. These isotherms have the same profile for many food materials in the literature (Pfost *et al.*, 1976; Ait Mohamed *et al.*, 2005; Bag *et al.*, 2009; Barbosa-Canovas and Vega-Mercad, 1996; Chou and Chua, 2001; Van den Berg and Burin, 1981).

These Fig. 1-3 show that the equilibrium moisture content increases with decreasing temperature at constant relative humidity. And yet, one can notice that the adsorption curve does not overlap with the desorption curve showing a hysteresis phenomenon. Several studies in the literature are suggested to explain this phenomenon. They showed that the hysteresis is due to the fact that the deformation of the body during their dehydration is not going so elastic (Ait Mohamed *et al.*, 2005; Al-Muhtaseb *et al.*, 2002; Ghribi and Chlendi, 2011).

Modeling of the adsorption and desorption isotherms: Many models have been proposed in the literature for the adsorption and desorption isotherms (Lahsasni *et al.*, 2002). In this present study, we use Chung-Pfost, BET, Henderson, Oswin, Smith... to describe the relationship between the equilibrium moisture content data and the relative humidity. The mean relative error was used to evaluate the fitting quality. According this error, the Chung-Pfost model describes well the isotherms.

Drying kinetics of *Myrtus communis* equipment: The experimental device for studying the kinetics of drying tunnel is a controlled atmosphere that we have equipped with the appropriate measuring instruments.

This is a wind tunnel where you can control the temperature, velocity and humidity (Hii *et al.*, 2011; Chong *et al.*, 2008).

Experimental protocol: After fixation of different experimental conditions, the products to be dried are placed on a support grid and traversed by hot air. When the mass of plant becomes constant, we stopped the operation. Knowing the wet mass, the dry mass is obtained by putting the plant at the end of every experiment in an oven regulated at 105°C until dewatering completely the product.

Influence of temperature: Figure 4 show that the moisture content X_{eq} of the product of myrtle decreases when the temperature of the drying air increases. From these results, we note the absence of phase 0 and phase 1, there is only the presence of the falling rate period (phase 2). This result is compatible with the drying literature (Van den Berg and Burin, 1981; Al-Muhtaseb *et al.*, 2002).

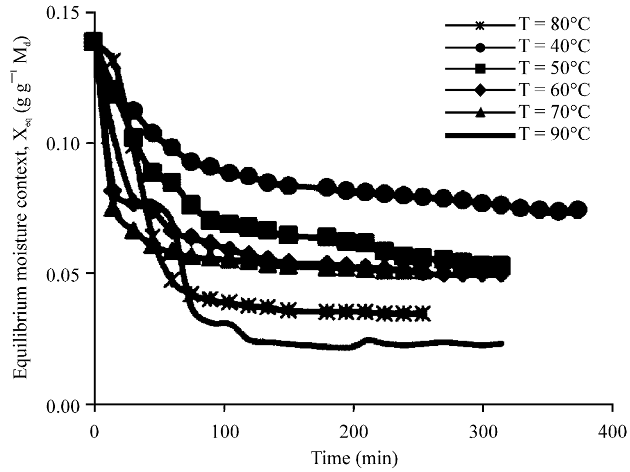

Fig. 4: Influence of drying air temperature on the evolution of water content as a function of time

This decrease is explained by the fact that at the beginning of drying, evaporation of water from the surface of the product does not require a lot of energy, against the diffusion of water from the interior part of product to the surface requires much time.

Influence of humidity of air: The initial water content of the product is equal to 0.23 g g^{-1} of dry mass sample. In this study, we present the results obtained at T = 70°C for the other temperatures show no special behavior to that obtained at 70°C.

Figure 5 shows the evolution of water content during drying to the relative humidities used. This Fig. 5 demonstrates the presence of the declining phase during the drying process. These results are consistent with other work (Chou and Chua, 2001).

Determination of extraction efficiency and quality of essential oil: The quality of essential oils was followed by determining their chemical composition using gas chromatography coupled with mass spectrometry (GC/MS).

Extraction efficiency of essential oil: The *Myrtus communis* was submitted to hydrodistillation with a Clevenger-type apparatus according to the European Pharmacopoeia and extracted with water for three hours until no more essential oil was obtained (Aliyu *et al.*, 2011; May and Perre, 2002; Everette and Islam, 2012).

Vapor condensation obtained by hydrodistillation led to two phases:

- An aqueous phase also called aromatic water
- An organic phase which is added sodium sulfate Na_2SO_4 to remove traces of water. This phase is called essential oil

The extraction yields of essential oils are defined as follows:

$$\eta_{org}(\%) = \frac{\text{Mass of essential oils in the organic phase}}{\text{Dry masses of sample}} \times 100 \quad (2)$$

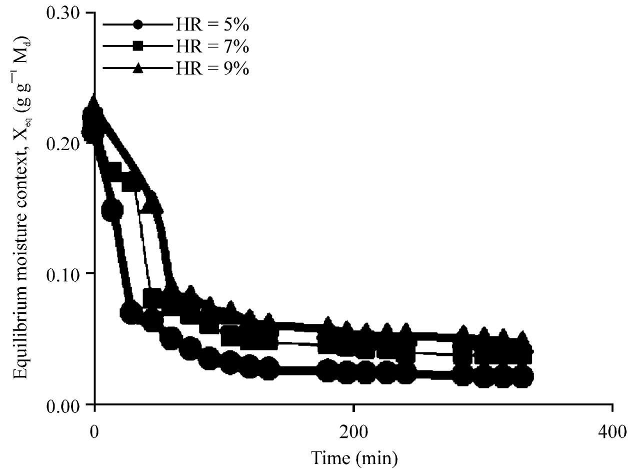

Fig. 5: Influence of drying air humidity on the evolution of water content as a function of time

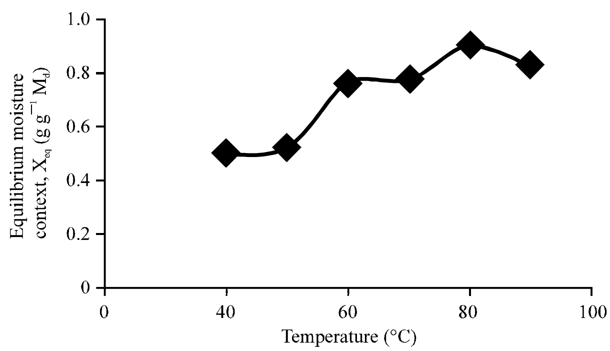

Fig. 6: Influence of drying temperature on extraction efficiency of essential oils of myrtle

$$\eta_{aq}(\%) = \frac{\text{Mass of essential oils in the aqueous phase}}{\text{Dry masses of sample}} \times 100 \quad (3)$$

$$\%\ \eta_{Tot} = \%\eta_{aq} + \%\eta_{org} \quad (4)$$

$\%\ \eta_{org}$: Efficiency of essential oils organic phase
$\%\ \eta_{aq}$: Efficiency of essential oils aqueous phase
$\%\ \eta_{Tot}$: Total efficiency of essential oils

The results obtained show that the extraction efficiency varies considerably with temperature drying in the tunnel; it seems that the best efficiency was obtained at a temperature of 80°C (Fig. 6). These results can be explained by the fact that for too high temperature, it can cause evaporation of some volatile compounds of essential oils from Myrtle so reducing the extraction efficiency. The drying tunnel is a very effective method for drying products: we noticed the speed and very good extraction efficiency for an optimum temperature equal to 80°C.

Quality of essential oils: The essential oil is generally in the form of a complex mixture of many compounds in varying proportions. In present study, the qualitative analysis of essential oil was made by method of gas chromatography coupled with mass (GC-MS) (Ismail *et al.*, 2011; Rashid *et al.*, 2012; Lopez *et al.*, 2000).

This analysis has shown that the major components of the essential oil are α-pinene, 1,8 cineole, limonene, para-cymene. But increasing the temperature of drying wind tunnel caused the decrease of the compounds detected. It further notes that the levels of compounds such as: α-pinene (major compound) and 1.8 cineole have experienced a decrease, respectively, 15.30 and 12.33%. However, the content of other compounds such as limonene disappeared.

So we can conclude that the optimum temperature for best quality of essential oils is 40°C.

CONCLUSION

Experimentally, we have studied for leaves of myrtle isotherms of adsorption and desorption by the static gravimetric method for different temperatures (30, 40 and 50°C). These curves can be prescient about the behavior of the product during (conservation and storage) to avoid changes in chemical and biological characteristics of essential oils.

The experimental study of the kinetics of drying of this product showed the influence of different parameters on the air drying process.

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REFERENCES

Ahmed, M., M.H. Laghari, I. Ahmed and K.M. Khokhar, 2002. Seasonal variation in rooting of leafy olive cuttings. Asian J. Plant Sci., 1: 228-229.

Ait Mohamed, L., M. Kouhila, S. Lahsasni, A. Jamali and A. Idlimam *et al.*, 2005. Equilibrium moisture content and heat of sorption of *Gelidium sesquipedale*. J. Stored Prod. Res., 41: 199-209.

Al-Muhtaseb, A.H., W.A.M. Mcminn and T.R.A. Magee, 2002. Moisture sorption isotherm characteristics of food products: A review. Food Bioprod. Process., 80: 118-128.

Aliyu, A.B., M.A. Ibrahim, A.M. Musa, T. Bulus and A.O. Ovewale, 2011. Phenolic content and antioxidant capacity of extracts and fractions of *Vernonia blumeoides* (Asteraceae). Int. J. Bio. Chem., 5: 352-359.

Bag, S.K., P.P. Srivastav and H.N. Mishra, 2009. Desorption and adsorption characteristics of bael (*Aegle marmelos*) pulp and powder. Int. Food Res. J., 16: 561-569.

Barbosa-Canovas, G. and H. Vega-Mercad, 1996. Dehydratation of Foods. Chapman and Hall, New York.

Chong, C.H., C.L. Law, M. Cloke, C.L. Hii, L.C. Abdullah and W.R.W. Daud, 2008. Drying kinetics and product quality of dried Chempedak. J. Food Eng., 88: 522-527.

Chou, S.K. and K.J. Chua, 2001. New hybrid drying technologies for heat sensitive foodstuffs. Trends Food Sci. Technol., 12: 359-369.

Dvin, S.R., E.G. Moghadam, E. Neyestani and A. Mokhtarian, 2011. Studies on rooting of azayesh apple cutting using indolebutyric acid and media. Asian J. Applied Sci., 4: 780-786.

Everette, J.D. and S. Islam, 2012. Effect of extraction procedures, genotypes and screening methods to measure the antioxidant potential and phenolic content of orange-fleshed sweetpotatoes (*Ipomoea batatas* L.). Am. J. Food Technol., 7: 50-61.

Ghribi, A. and M. Chlendi, 2011. Modeling of fixed bed adsorption: Application to the adsorption of an organic dye. Asian J. Textile, 1: 161-171.

Greenspan, L., 1977. Humidity fixed points of binary saturated aqueous solutions. J. Res. Natl. Bur. Stand. A: Phys. Chem., 81A: 89-96.

Hii, C.L., S.P. Ong and C.L. Law, 2011. Drying studies of tropical fruits cultivated in Malaysia: A review. J. Applied Sci., 11: 3815-3820.

Ismail, A., H. Lamia, H. Mohsen and J. Bassem, 2011. Chemical Composition of *Juniperus oxycedrus* L. subsp. *macrocarpa* essential oil and study of their herbicidal effects on germination and seedling growth of weeds. Asian J. Applied Sci., 4: 771-779.

Kouhila, M., N. Kechaou, M. Otmani, M. Fliyou and S. Lahsasni, 2002. Experimental study of sorption isotherms and drying kinetics of Moroccan *Eucalyptus globulus*. Dry. Technol., 20: 2027-2039.

Lahsasni, S., M. Kouhila, M. Mahrouz and N. Kechaou, 2002. Experimental study and modelling of adsorption and desorption isotherms of prickly pear peel (*Opuntia ficus indica*). J. Food Eng., 55: 201-207.

Lopez, A., A. Iguaz, A. Esnoz and P. Virseda, 2000. Thin layer drying behavior of vegetable wastes from wholesale market. Drying Technol., 18: 995-1006.

May, B.K. and P. Perre, 2002. The importance of considering exchange surface area reduction to exhibit a constant drying flux period in food stuffs. J. Food Eng., 54: 271-282.

Pfost, H.B., S.G. Maurer, D.S. Chung and G.A. Milliken, 1976. Summarizing and reporting equilibrium moisture data for grains. ASAE Paper No. 76-3520, St. Josaph, Michigan, USA.

Rashid, M.M., Hizbullah, N. Mohammad and M.J.H. Khan, 2012. Advanced control technique for substrate feed rate regulation of a fed batch fermentation. Asian J. Biochem., 7: 1-15.

Van den Berg, C. and S. Burin, 1981. Water activity and its Estimation in food Systems: Theoretical Aspects, In: Water Activity: Influences on Food Quality, Rockland, L.B. and G.F. Stewart (Eds.), Academic Press, New York, USA., pp: 1-61.

Yogananth, N., R. Bhakyaraj, A. Chanthuru and S. Palanivel, 2011. *In vitro* regeneration and conservation of rare medicinal plant *Dregea volubilis* Benth. J. Plant Sci., 6: 225-228.