**Advanced Studies in Biology, Vol. 15, 2023, no. 1, 55 – 60**
**HIKARI Ltd, www.m-hikari.com**
**https://doi.org/10.12988/asb.2023.91623**

# Quality and Sustainability in Dehydration Processes

**Peppe Luigi [*], Peppe Mario [*] and Peppe Luca**

[*] Millenium S.r.l.- Via Piemonte, 1 - 04022 Fondi (LT), Italy



**Abstract**

The general objective of this project was the identification of applicable pre-treatments on fruit and vegetable products in order to reduce the loss of nutritional components during the dehydration process and, at the same time, to reduce the residence time of the product during the process itself. Through the study carried out, it was possible to define a prototype of a smart dehydrator. In the future, this prototype will have to be further implemented in order to make it usable on an industrial level.

Specific objectives of this experimentation are the monitoring and consequent optimization of the hot air flow dehydration process, considering organic carrots as products (cv. Romance and Carvejo). In order to achieve the intended purpose, the effects of some pre-treatments (thermal, dipping and vacuum impregnations techniques) aimed at reducing the dehydration time and improving the final quality of the plant matrices subjected to the process were investigated. The analytical techniques used for the analysis were: the peroxidase enzymatic activity assay (POD), the colorimetric analysis, the determination of the total phenol content, the extraction and quantification of carotenoids, the analysis of the rehydration and determination of the dry matter content. The monitoring of chemical-physical changes of the products (e.g. moisture content, water activity, soluble solids, titratable acidity, phenolic content, carotenoid content, consistency and color changes) was conducted taking into account the operational parameters that influence dehydration (temperature, air speed and relative humidity). In addition, four mathematical models were employed to describe the kinetics of dehydration. The ultimate goal of the design activity is the transfer of the monitoring and control system to a dryer prototype...

**Keywords:** sustainability, monitoring, quality, dehydrator

## 1. Introduction

To meet the new needs of the food sector, which is increasingly expanding, such as the demand for greater safety and the need to extend food storage times, or the need to facilitate transport, dehydration processes have proved to be a valid proposal. These processes make use of dynamic and non-linear characteristics, influenced by the food matrix of reference and by the operational and environmental properties to which one operates. Obviously, these factors have an impact on the qualitative and organoleptic, nutritional and functional characteristics and, consequently, have an impact on the final judgment made by consumers. Furthermore, the dehydration process requires a significant amount of energy, inevitably causing a contribution to climate change. For this reason, more and more scholars are trying to find valid solutions that can minimize the energy demand by the process, without affecting its normal operating conditions. "Innovation smart drying" is an emerging dehydration technique, which aims precisely to mitigate the problem of the conspicuous energy demand of classic dehydration, through the use of sensors and non-destructive technologies, which aim to improve the efficiency of the process itself. The project aims to implement "smart" systems for monitoring and controlling the dehydration parameters (temperature, air speed and relative humidity) and product quality during the process, based on the use of non-destructive technologies such as 'image analysis and Vis-NIR spectroscopy (point and hyperspectral). This approach will be applied to the dehydration of some fruit and vegetables of organic origin. The aim will be to optimize the dehydration process, reducing energy consumption and maximizing the quality of the finished product. For this purpose, [1] specific product pre-treatments will be identified to stabilize the product during the process and [2] the chemical, physical and physical chemical changes of the product will be monitored (moisture content, water activity, soluble solids, titratable acidity, phenolic content, antioxidant activity, consistency and color changes) during the process, depending on the selected pre-treatments and the process parameters adopted (temperature, air speed and relative humidity). The design activity will also deal with the transfer of the monitoring and control system to a dryer prototype.

## 2. Materials and methods

Innovation is a key factor for the success of organizations.
The implementation of an innovation offers various benefits to an organization; in particular:
- favors growth, revenue and profit deriving from innovations.
- brings new ways of thinking and new value to the organization.
- Proactively intercepts value from a better understanding of future market needs and possibilities.
- helps to identify and mitigate risks.
- draws on the organization's collective creativity and intelligence.
- intercepts the value of collaboration with innovation partners;
- motivates the involvement of employees within the organization and promotes

"Focus groups" on the choice of ideas and innovations.
Thin-layer drying generally refers to the dehydration of a thin layer of chopped or thinly sliced products where the drying temperature can be assumed uniform. Mathematical thin-layer drying models have been shown to be very useful for simulating and estimating the behavior of various types of products during dehydration. This is thanks to the use of mathematical equations, used to predict the kinetics of dehydration (dehydration curves) of many types of porous materials, food and non-food. Thin-layer drying models that describe the dehydration process of agri-food products fall mainly into three categories: theoretical, semi-theoretical and empirical.
• Theoretical models: take into account both external and internal resistances to the transfer of humidity. They involve the geometry of the material, its mass diffusivity and the conductivity of the material (Cihan and Ece 2001). In thin-layer dehydration of food products, the analysis of the dehydration process is calculated using a diffusion model based on Fick's second law (Duc et al, 2011).
• Semi-theoretical models: they are generally derived from Fick's second law (theoretical models) and from modifications of its simplified forms, or from analogies with Newton's law of cooling. Factors that can determine the application of these models include drying temperature, drying air velocity, material thickness, initial moisture content, and relative humidity (Panchariya and others, 2002; Erbay and Icer , 2010). These models, unlike the theoretical ones, take into account only the external resistances to the transfer of moisture between the product and the dehydration air.
• Empirical models: provide a direct relationship between the average moisture content and the dehydration time. The main limitation to the application of empirical models in thin-layer dehydration is that they neglect the fundamental principles of the dehydration process; their parameters have no physical interpretation, and their applications are specific to the dehydration conditions of the experiments. However, due to the complex nature of the diffusion of moisture within agri-food products, empirical models are still widely used to describe the dehydration characteristics of these products.

## 4. Results and Conclusion

The impact generated by this project within Millenium S.r.l. can be considered high. The potential in terms of an expansion of the market to which the company addresses is not negligible.
From the data obtained from the analyzes carried out, it was possible to draw the following conclusions. Blanching in water hothas proved to be a valid method in inactivating by combining time and temperature in such a way that it does not rapportage organoleptic modifications to the treated product.
The dehydration of the samples were carried out at 40°C for 8 hours. From content analysis of moisture, free water, total soluble solids and carotenoids were not found obvious differences between control (product eightnot subjected to any pretreatment) and pretreatment with blanching, although it is possible to assume

that the product treated with bleaching is subject to more rapid dehydration The impact in terms of professional growth of the staff employed in research is also positive and can be used in the provision of specific services.

## References

[1] Aghbashlo, M., Hosseinpour, S., Mujumdar, A.S., Application of artificial neural networks (ANNs) in drying technology: a comprehensive review, *Dry. Technol.*, **33** (2015), 1397-1462. https://doi.org/10.1080/07373937.2015.1036288

[2] Aghilinategh, N., Rafiee, S., Hosseinpour, S., Omid, M., Mohtasebi, S.S., Realtime color change monitoring of apple slices using image processing during intermittent microwave convective drying, *Food Science and Technology International*, **22** (2016), 634- 646. https://doi.org/10.1177/1082013216636263

[3] Akpinar, E.K., Bicer, Y., Yildiz, C., Thin layer drying of red pepper, *J. Food Eng.*, **59** (2003), 99-104. https://doi.org/10.1016/s0260-8774(02)00425-9

[4] Ambrose, A., Lohumi, S., Lee, W.H., Cho, B.K., Comparative nondestructive measurement of corn seed viability using Fourier transform near-infrared (FTNIR) and Raman spectroscopy, *Sensors Actuators B: Chemical*, **224** (2016), 500-506. https://doi.org/10.1016/j.snb.2015.10.082

[5] Awad, T.S., Moharram, H.A., Shaltout, O.E., Asker, D., Youssef, M.M., Applications of ultrasound in analysis, processing and quality control of food: a review, *Food Res. Int.*, **48** (2012), 410-427. https://doi.org/10.1016/j.foodres.2012.05.004

[6] Awuah, G.B., Ramaswamy, H.S., Economides, A., Thermal processing and quality: principles and overview, *Chem. Eng. Process.: Process Intensif.*, **46** (2007), 584-602. https://doi.org/10.1016/j.cep.2006.08.004

[7] Benlloch-Tinoco, M., Igual, M., Rodrigo, D., Martínez-Navarrete, N., Comparison of microwaves and conventional thermal treatment on enzymes activity and antioxidant capacity of kiwifruit puree, *Innov. Food Sci. Emerg. Technol.*, **19** (2013), 166-172. https://doi.org/10.1016/j.ifset.2013.05.007

[8] Boysworth, M.K., Booksh, K.S., Aspects of multivariate calibration applied to near-infrared spectroscopy. In: Burns, D.A., Ciurczak, E.W. (Eds.), *Handbook of Near-Infrared Analysis*, CRC Press, New York, USA, 2008, 207-229.

[9] Brosnan, T., Sun, D.W., Improving quality inspection of food products by computer vision - a review, *J. Food Eng.*, **61** (2004), 3-16. https://doi.org/10.1016/s0260-8774(03)00183-3

[10] Chen, Q., Zhang, C., Zhao, J., Ouyang, Q., Recent advances in emerging imaging techniques for non-destructive detection of food quality and safety, *TrAc Trends Anal. Chem.*, **52** (2013), 261-274.
https://doi.org/10.1016/j.trac.2013.09.007

[11] Chong, C.H., Figiel, A., Law, C.L., Wojdyło, A., Combined drying of apple cubes by using of heat pump, vacuum-microwave, and intermittent techniques, *Food Bioprocess Technology*, **7** (2014), 975-989.
https://doi.org/10.1007/s11947-013-1123-7

[12] Clarka, C.J., Hockings, P.D., Joyce, D.C., Mazucco, R.A., Application of magnetic resonance imaging to pre- and post-harvest studies of fruits and vegetables, *Postharvest Biol. Technology*, **11** (1997), 1-21.
https://doi.org/10.1016/s0925-5214(97)01413-0

[13] CRAN, Comprehensive R Archive Network, 2017. http://cran.r-project.org

[14] de Jong, S., SIMPLS: an alternative approach to partial least squares regression. Chemom, 1993.

[15] Intell. Lab. Syst. 18, 251e263CE, FMI, OCSE, ONU e Banca mondiale (2009), System of National Accounts, Nazioni Unite, New York.
https://unstats.un.org/unsd/nationalaccount/docs/sna2008.pdf

[16] Cfr. Bergman, E. & Haitani, R., Designing the PalmPilot: A Conversation with Rob Haitani, in E.Bergman, Information Appliances and Beyond, Morgan Kaufmann, 2000.

[17] Cfr. S.Houde, C.Hill, *What do Prototypes Prototype?* in *Handbook of Human - Computer Interaction* (2nd Ed.), M. Helander, T.E. Landauer, P. Prabhu (ed.), Elsevier Science, Amsterdam, 1997. Anche in
http://www.viktoria.se/fal/kurser/winograd-2004/Prototypes.pdf

[18] ICSU e UNESCO (2002), Science, traditional knowledge and sustainable development, ICSU Series on Science for Sustainable development, no. 4, UNESCO, Parigi.
http://unesdoc.UNESCO.org/images/0015/001505/150501eo.pdf

[19] Manuale di Frascati rev 2015.

[20] OCSE, *Handbook on Deriving Capital Measures of Intellectual Property Products*, Pubblicazione OCSE Parigi, 2009.
https://doi.org/10.1787/9789264079205-en

[21] OCSE, *Making Open Science a Reality*, OCSE publishing, Parigi, 2015.

[22] OCSE/Eurostat *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3rd edition, The Measurement of Scientific and Technological Activities, pubblicazione OCSE, Parigi, 2005.
https://doi.org/10.1787/9789264013100-en

[23] Shelf life degli alimenti, Meccanismi Valutazione Previsione (2008) Sebastiano Poretta; Chiriotti editori

[24] UNESCO (1978), Recommendation concerning the International Standardization of Statistics on Science and Technology, UNESCO, Parigi. http://portal.UNESCO.org/en/ev.php-URl_ID=13135&URl_DO=DO_TOPIC&URl_SECTION=201.html

[25] UNESCO (1984), *Guide to Statistics on Science and Technology*, division of Science and Technology – office of Statistics, ST/84/WS/19, UNESCO, Parigi. www.uis.UNESCO.org/library/Documents/STSManual84_en.pdf

[26] UNESCO-UIS (2014), *ISCED Fields of Education and Training 2013 (ISCED-F 2013)*, UNESCO, Parigi.
www.uis.UNESCO.org/Education/Documents/isced- elds-of-education-training-2013.pdf

**Received: February 1, 2023; Published: March 1, 2023**