MOISTURE–SORPTION CAPACITY OF WALNUT KERNEL, SHELL AND MEMBRANE SEPTUM (JUGLANS REGIA L)

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Abstract: The knowledge of water sorption Isotherm gives information about water activity of foods; to investigate chemical reactions during drying and storage [4].

This study therefore, was to determine the sorption properties of walnut kernel, walnut shell and walnut membrane septum samples during storage at ambient temperature. The sorption properties of walnuts were studied at 25±2°C over a range of water activity, 0.16 – 1.00 using the standard static, gravimetric method. The walnut membrane septum had the highest equilibrium moisture content, followed by walnut shell. Due to its lipid content which have the capacity of preventing the water adsorption the walnut kernel registered the lowest equilibrium moisture.

Keywords: walnuts; sorption isotherm; walnut kernel; walnut shell; membrane septum; moisture content.

Introduction

Walnuts are rich source of a number of important nutrients that have a very positive effect on the human health [2].

The Moldovan walnut sector has seen rapid growth, from a very low base, in recent years, founded on three factors: the comparative advantage in production, the presence of a low cost labour force which is able to extract manually for the confectionary market with a much higher extraction rate of unbroken kernels than mechanised methods, and preferential access to the EU market with no tariff duties. [3]

The most popular varieties of walnuts in Moldova are – Chişinău, Kogâlniceanu, Călăraşi, Costiujeni, Schinoasa, Criuleni, Corjeuţi and others, some of them of a great perspective. [5]

According to position of this product in the country economy, important are the suitable preservation and storage conditions to prevent spoilage and damage it.

There is the problem of protecting the quality of the walnuts after harvest and during storage. Duration and conditions prevailing during storage have a significant impact on the quality of the walnuts. Usually walnut shelf life is one year from harvest to harvest.

During walnuts storage over 2–3 months, there are some change in their quality both in terms of the sensory (the skin discoloration, stains, taste perversion, etc.) as well as the physico–chemical.

Walnuts are characterized by a moisture content of 5–6%, during storage – after water sorption increase the amount of moisture increases to 7–10%, this process promotes irreversible changes of nutritional and sensory properties of walnuts.

From this point of view it is obvious that humidity is an important factor influencing the quality changes of walnuts.

Moisture sorption isotherms describe the relationship between water activity (aw) and an equilibrium moisture content of the system at a given temperature and pressure. Both water activity and moisture sorption isotherms are important for new product development, ingredient research, shelf–life estimation, and to fully understanding the moisture within a product [6, 7, 8].

Therefore the aim of this study was to research the sorption capacity of the kernel, shell and membrane septum of walnuts.

II. Materials and methods

2.1. Materials

Performing research was used were used qualitative nuts collected in 2013 year which corresponds to the GOST 16833–71 demands. Walnuts were crushed and itwas separately selected the kernel, shell and membrane septum.

2.2. Methods

Adsorption characteristics of walnut kernel, walnut shell and membrane septum were determined at room temperature of 25±2C°C The equilibrium moisture content of walnut kernel, shell and membrane septum were determined by static gravimetric method as applied according to Oyelade et al. [9,10]. For the adsorption process, the samples were dehydrated in a hot air oven. Duplicate samples, 5.0±.001g each of kernel, shell and membrane septum were weighed into moisture pans in the desiccators. The concentrated sulphuric acid quantities used to make up a 200ml of desiccant with deionized water was prepared at room temperature of 25°C, corresponding water activity (aw) was dispensed into the desiccators. The desiccators were maintained at aw ranges 0.1–1.0. The desiccators were kept at room temperature (25±2°C). Each of the samples was being weighed at two days intervals using a digital balance until constant weight was obtained in three consecutive recordings, then the sample was assumed to beat equilibrium (±0.001g). The time to reach equilibrium ranged between 10 to 21days depending on the water activity in each of the desiccators.

Results

Walnuts are composed of several parts: kernel, shell and membrane septum which have different characters and different reactions to environmental conditions depending on the specific chemical content.

Previously this problem has been studied at the Department of Technology and Organisation of Catering by Ms Daniela Otel–Bernic in her article *Determination of moisture sorption isotherms of Moldavian walnuts* in 2008 [1].

The sorption curves obtained by her for the walnuts kernel, shell and membrane septum at 20°C are presented below.

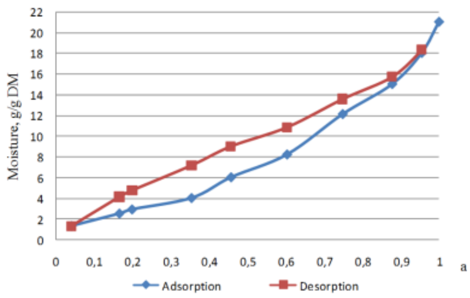

Fig. 1. Moisture–Sorption Isotherms for Walnut Shell at 20^{0}C

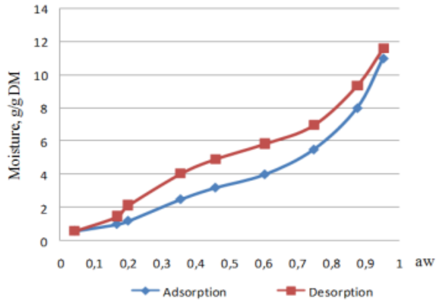

Fig. 2. Moisture–Sorption Isotherms for Walnut Kernel at 20^{0}C

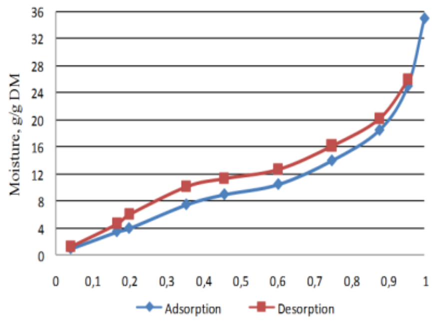

Fig. 3. Moisture–Sorption Isotherms for Walnut Membrane Septum

The effect of water activity on the sorption capacity of the researched samples is shown in Figure 4, 5 and 6.

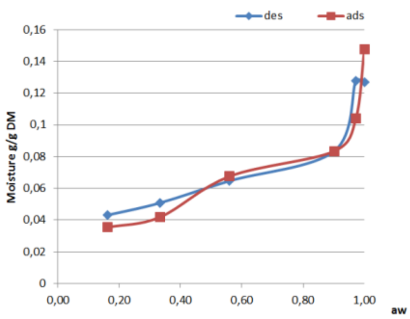

Fig. 4. Moisture–Sorption Isotherms for Walnut Kernel at 25^{0}C

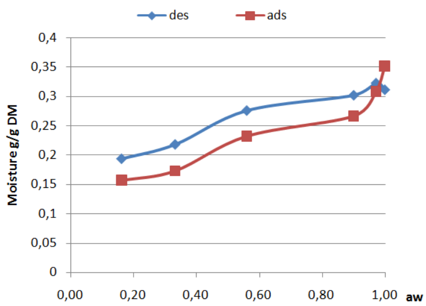

Fig. 5. Moisture–Sorption Isotherms for Walnut Shell at 25^{0}C

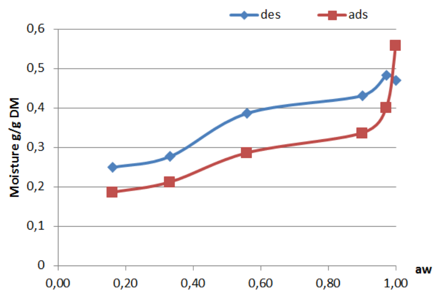

Fig. 6. Moisture–Sorption Isotherms for walnut Membrane Septum at 25^{0}C

Analysis of the figures shows that the sorption curves, both obtained in 2008 as well as the research of this study are sigmoid, and are of type II (characteristic for many molecular layer adsorptions) according to the Brunauer, Emmet and Teller (BET) classification [11].

Desorption isotherms show that water absorption is minimal when water activity is reduced and maximum when water activity is quite significant.

Walnut kernel (Fig.1) is characterized by an average wettability 14.78% DM for adsorption and 12.68% DM for desorption. But the shell and membrane are characterized by maximum wettability 35.19% and 31.11% DM for the shell and 55.9% DM and 47.0% DM for the membrane septum. This indicates that water adsorption is influenced by the chemical composition of absorbent; from here we can say that namely the kernel lipids which are hydrophilic prevent water adsorption. The other parts (shell and membrane septum) contain cellulose and hemicelluloses which easily bind water and are easier to dry under the influence of environmental temperature.

Placed in order of hygroscopicity increasing, samples form series: walnut kernel (14.78 % DM) → walnut shell (35.19 % DM) → walnut membrane septum (55.9 % DM).

All three sorption curves can be divided in three different zones which indicate different mechanisms for binding the water.

In region A, water is chemically bound and doesn't participate in none of the reactions. Since lipid oxidation in this area is minimal, it is an important indicator for the more effective and qualitative storage, which means minimizing the biological loss and training other adverse environments.

Region B characterizes both chemically bound water as well as physically, a larger segment of this zone is characteristic of membrane of walnuts (aw = 0.33 to 0.90) and a narrow one for kernel (aw = 0.44 to 0.90).

In region C the water is just about physically concentrated in large capillaries and available to participate in reactions as solvent. In region C all curves show a significant increase until equilibrium moisture. This section practically linear indicating the correlation between a_w and moisture content is related to sorption capacity of walnut shell. Thus, during storage of walnuts, the shell can be regarded both as a protective barrier, and water sorption object to the kernel.

Conclusions

Experimental isotherms obtained for walnut and its parts, as in the study conducted in 2008 [1] as in the present study research show that water absorption is minimal when water activity is reduced and maximum when water activity is quite significant.

The experimental isotherms obtained for the kernel, the shell and the membrane are sigmoidal, type II, characterized by a multimolecular adsorption.

Sorption curves for the kernel, shell and membrane of walnuts are characterized by three segments indicating the three water–binding mechanisms: chemical (A), physico–chemical (B) and physical (C).

The limit of the A zone, corresponding to the formation of the monomolecular film varies from 0.15 to 0.33 for the kernel, from 0.15–0.2 for the shell and 0.15 to 0.28 for membrane. In zone B, all curves are almost linear and characterizes both chemically bound water as well as physically, a larger segment of this zone is characteristic of membrane of walnuts (aw = 0.33 to 0.90) and a narrow one for kernel (aw = 0.44 to 0.90). In zone C all the curves rise steeply up to the maximum values of humidity balance.

Sorption curves of the walnuts shell represents a water binding mechanism more physical and physico–chemical where the water content is correlated with water activity.

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