The CO_2 influence on pears drying process using SHF energy

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Abstract

The most frequently used methods for food products processing with inert gases is anoxianabioza, which means inert gases use as bio-inhibit agents. This method consists of special conditions creation, which reduces more or less both vital processes and alterable factors, growing up the quality of final product. It was proposed to study the influence of CO2 and SHF field influence on pears, which contain a big number of properties and qualities.

Keywords: inert gas, SHF energy, drying process, pears, quality.

Rezumat

Cel mai des utilizate metode de procesare a produselor agro-alimentare cu gaze inerte, la conservarea prin deshidratare este anoxianabioza – utilizarea gazelor inerte ca agenți bioinhibanți, care constă în crearea unor condiții speciale care să reducă în măsura dorită, atât procesele vitale ale organismului, cât şi ale factorilor de alterare, astfel mărindu-se calitatea produsului finit. A fost propus studiul influenței mediului format din CO2în procesul de uscare cu microunde la păstrarea indicilor calitativi a perelor.

Cuvinte cheie: gaz inert, energie SHF, proces de uscare, pere, calitate.

1. Introduction

Pears, like other plants, have numerous beneficial element sfor human body. Besides water, fiber, lipids and chlorophyll, these fruits contain important components for human's health: mineral salts, calcium, phosphorus, potassium, iron and vitamins A, B and C.

This series of substances is complemented by the presence of sucrose, which make them easier to be digested by people with digestive system diseases and for diabetes. Therefore, a more qualitative pears' drying is very important, the ultimate goal being to obtain a high quality, preserving both colour and flavour, and chemical composition.

2. Materials and methods

One of effective methods to increase the duration of plant products' storage is their dehydration.

Pears are characterized by high moisture content (±80%) and soft tissue structure. In order to reduce the moisture content the yare subjected to thermal treatment processes, using different techniques, the most common being solar convective drying, convective drying, microwave drying (MW)and the use of infrared rays (IR).

In our view, the most advantageous method of drying is electromagnetic field (microwave) which has a number of advantages over others, namely:

– Processing velocity is enhanced;
– Uniform heating throughout the product;
– Dawn turned to outside temperature gradient favouring productive mass transfer in product. Temperature gradient is caused by loss of heat from a hot product to the less hot or even cold environment;
– High precision control of the drying process by providing the necessary heat quantity at desired temperature;
– Low inertia of thermal treatment process.

In many cases, the chemical reactions that occur in fruits while drying them, are stimulated by various inorganic catalysts (Fe, Cu, Zn), even in smaller quantities than the permissible dose. High temperature causes increased oxidation chemical reactions, corrosion, acid hydrolysis, condensation.

The processes of acid hydrolysis of sugars, lipids and proteins takes place under the action of acids and are favoured by increasing temperature.

Under the action of light rays and oxygen from the air, there take place photochemical reactions that lead to the destruction of valuable products items (destruction of vitamins), affecting its appearance (by changing colour) and total degradation.

The undesirable phenomena are also characteristic for microwave heat treatment, even if it occurs in a reduced period of time. In order to eliminate these short comings it is proposed to carry out the drying process using microwave power in medium of inert gas, which would exclude product's contact with oxygen during the stage of drying, while achieving the most advanced temperatures.

In thermal treatment processes nitrogen is used most often, which is quite expensive, requiring construction of various closed recirculating systems, leading to the need to create sophisticated and relatively expensive equipment.

When using CO_2, it can be used as semi-closed system, some gas and moisture extracted from the product being repressed in the atmosphere (Kudra and Poirier).

CO_2 drying advantages compared with N_2 drying are the following:

- CO_2 is much cheaper compared with N_2 (about 10 times), is widely used in alcoholic and soft beverages and does not require the mandatory use of sealed systems;
- CO_2 has higher density, providing a less volumetric flow rate at the same heat capacity;
- CO_2 requires additional expenses' reduction.

In the literature (Mujumdar, Menon), generalized drying curves have a constant region and the region in the fall.

If only radial diffusion is considered, neglecting the effect of temperature and total pressure, the moisture transfer during the drying process can be described using Fick's second law.

We admit that we have a product of thickness L, which is dried on both sides and the initial conditions are:

$$\mathbf{t = 0;\ 0 \leq x \leq L; \quad M(t) = M_0}$$

$$\mathbf{t > 0;\ x = 0, L; \quad M_t = M_{eq}}$$

where:

t is the drying time, in s or min.;

L – product layer's thickness, in mm;

M – moisture, %.

In the absence of external resistances, the solution proposed by Rao & Rizvi is obtained (Eq. 1).

Another widely used equation is Page's equation (3)

where:

K is the drying constant;

B – Page's parameter;

K – Lewis' parameter;

t – drying processes duration, in s;

D – effective diffusion

MR – moisture ratio.

Experiment set-up

Figure 1 presents the scheme of experiment set-up used for drying with inert gas.

$$MR = \left(\frac{M(t) - M_{eq}}{M_0 - M_{eq}}\right) = \frac{8}{\pi^2}\sum_{n=1}^{\infty}\frac{1}{(2n-1)^2}exp\left[-(2n-1)^2\pi^2\frac{Dt}{L^2}\right] \tag{1}$$

$$\ln(MR) = ln\left(\frac{M(t) - M_{eq}}{M_0 - M_{eq}}\right) = \ln\left(\frac{8}{\pi^2}\right) - \left(D\frac{\pi^2 t}{L^2}\right) \tag{2}$$

$$MR = \frac{X(t) - X_{eq}}{X_0 - X_{eq}} = exp(-Kt^B) \tag{3}$$

$$ln[-\ln(MR)] = lnK + Bln(t) \tag{4}$$

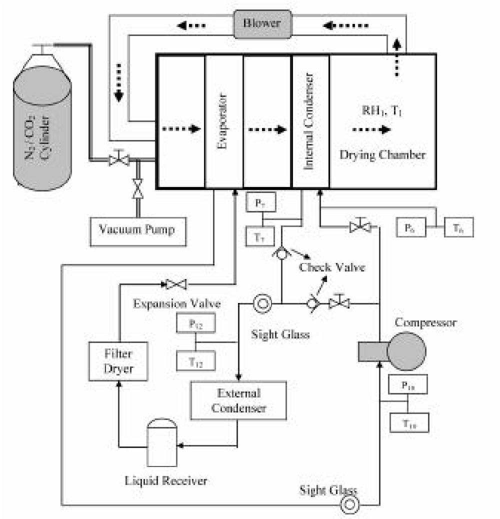

Figure 1. Schema of the experiment set-up used for drying with inert gas drying and recirculation

3. Results and discussion

The results show that using CO_2 experiences reflects on the quality and colour of dried pears, compared with air drying method.

4. Conclusions

Pears' drying using microwave power inpu tin medium of CO_2 gas reduces drying duration, energy consumption and chemical effects of products' oxidation.

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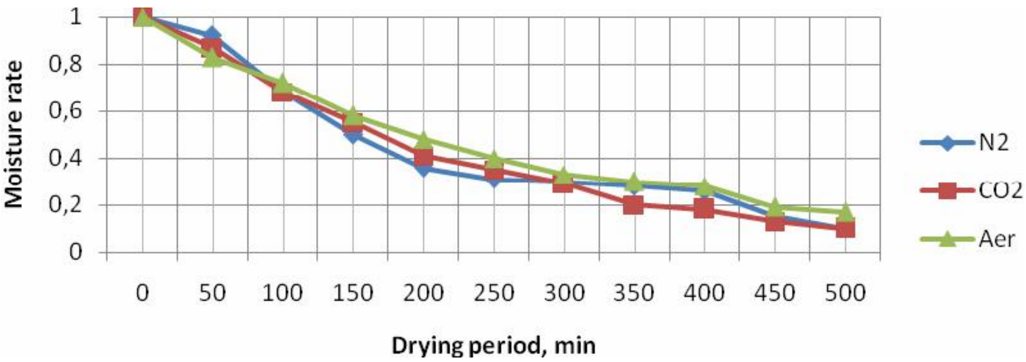

Figure 2. Effect of inert gas on pears' drying

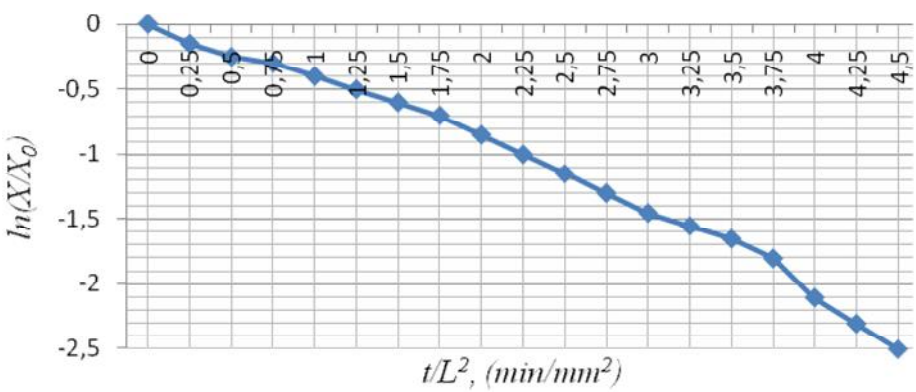

Figure 3. Variation of ln(MR) over t/L2

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