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MOISTURE ANALYSIS OF DRIED AGRICULTURAL PRODUCTS BY THE LUMINESCENCE METHOD

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A b s t r a c t s. A new non-destructive express--method has been proposed for moisture control of dried agricultural products by measuring their delayed luminescence. The method is based on the fundamental conception of the dynamical structure of a biological molecule and the changes of the latter in dependence of the moisture and temperature as well as on the luminescent properties of biological molecules. The method had been tested on a number of agricultural products (dried milk, grains, silk, wool, etc.) and enables one to measure the moisture within the range 2-20 % with the error of 0.1 % to 0.5 % depending of the product. The device for the realization of the method with the use of light-conducting fibres makes it possible to measure the moisture of dried agricultural products without their sampling, at remote control and in the mode of continuons technological process.

K e y w o r d s: delayed luminescence, moisture, dried milk, grains

INTRODUCTION

The moisture content of agricultural products is important factor for management decisions during harvesting, processing, and storage. Moisture measurments during processing of dried agricultural products must be done, to be usefull, rapidly and continuously on-line. The recent need for faster moisture assessment has caused a renewed search for new, express, low-cost methods of moisture measurments. The accuracy and the of responsibility of determination of moisture content by various physical methods is dependent on many factors such as: the pecularities of the same physical method, sampling techniques, variation of moisture within the bulk product, the size and the number of samples, etc. At present a number of modern physical methods for moisture analyses: infra-red spectroscopy, method based on measuring of dielectric properties, and NMR are used. But all above mentioned methods are featured by a common limitation. They measure parameters that are related to amount and state of water, whereas some important sample properties of agricultural products (especially the possibility of long-time storage) can be affected by other factors as well; such as amount and nature of ingredients and impurities, history and texture of preparation, etc. On the other hand, it is well known and at present much evidence is available suggesting that there is a correlation between particular type of molecular dynamics of various biological systems with correlation time $t<10^{-7}$ s and amplitude >0.2 A and their functional activity and stability [1,4-7]. In connection with these data we proposed to measure the intensity of molecular dynamics, as the integral molecular characteristics of agricultural products, that more directly determine, in great extend, their macroscopic properties. Figure 1 shows that the methods of molecular dynamics

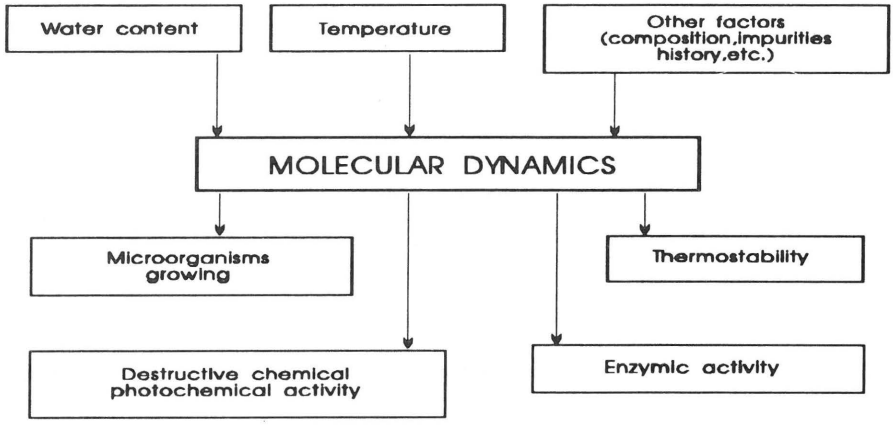

Fig. 1. Schematic representation of main factors affected on molecular dynamics and its effect on physicochemical properties of agricultural products.

measuring appear to be able to monitor properties of interest by more direct way than moisture analysers.

It is proposed a new approach for quantitative characterization of the molecular dynamics and water content of systems being tested based on luminescence technique. In our opinion the luminescent technique will be most perspective and convinient from view point of practice.

MATERIALS AND METHODS

The experiments were conducted with samples of wheat grains and dried milk prepared by following manner: samples were placed in atmosphere of saturated vapours of water-NaCl solutions for various times, then these samples were placed in quartz tubes and held at 23 °C to reach the equilibrium moisture content. The calibration of the luminescent home-made analyser is commonly done by air oven drying. Standard procedures, i.e. oven temperature and time, exist for various products. Weighing of samples was done by a scale with sensitivity 0.001 g. The preparation of samples of vaccine of New-Castle illness of birds and the callibrating measurments of moisture content in the experimental samples by Karl-Fisher technique was done in cooperation with the Institute of Biological Industry, Shelkovo, Russia.

RESULTS AND DISCUSSION

The proposed method is based on recording the delayed luminescence (DL) of agricultural products after pulsed illumination by UV or visible light. Characteristic parametrs of the intensity and life time depend strongly on the intensity of molecular dynamics in a medium. It is known [1,2,4-7] that the intensity of molecular dynamics correlates with moisture content in given agricultural products at constant temperature. Thus, measuring the intensity of delayed luminescence of agricultural products permit to analyse moisture content. For this purpose a home-made luminescence analyser was constructed. The scheme of the developed luminescence moisture analyser is shown in Fig. 2. After excitation by ligth

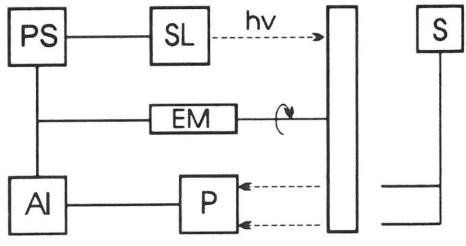

Fig. 2. Block-scheme of luminescent analyser. PS-power supply, SL-source of light, EM-electromechanical modulator, P- photomultiplier, AI - analog indicator, S-sample.

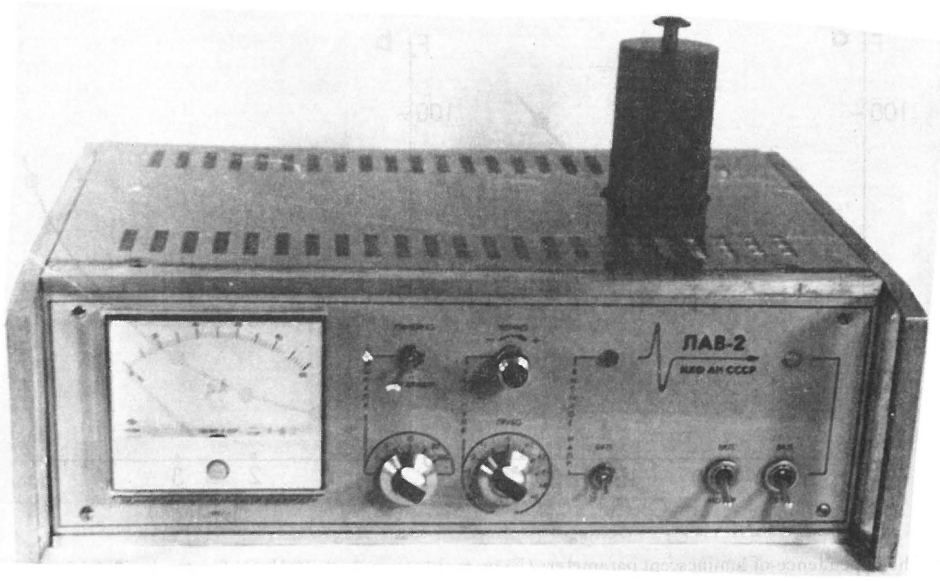

Fig. 3. Home-made luminescent analyser of moisture.

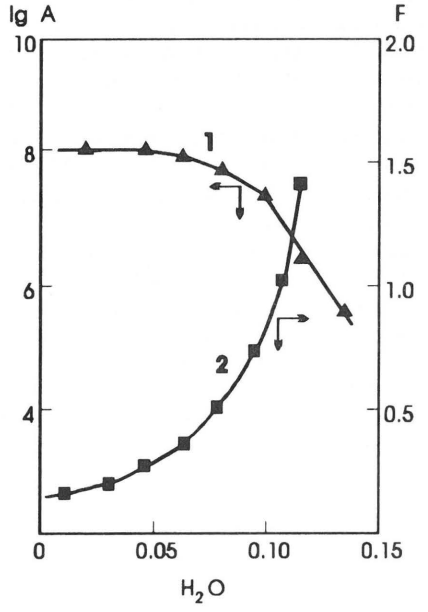

Fig. 4. The correlation between the water effect and biological activity for vaccine New Castle illness of birds at temperature 20 °C. 1 - A in relative units, 2 - F.

the luminescence signal from tested probe propagates through the optical fiber to specially constructed electromechanical modulator and then reached the photomultiplier. The construction of the modulator permits to registrate simultaneously by the same photomultiplier the intensity of fluorescence of samples and the intensity of delayed luminescence of the sample. The current signal from the photomultiplier is processed by a sinchronious current/voltage converter and a parameter F, function of $I(f)$ and $I(dl)$, is recorded by an analog indicator AI (where $I(f)$ is the intesity of fluorescence and $I(dl)$ is the intensity of delayed luminescence). Figure 3 shows the home-made luminescent analyser of moisture. The experimental dependences of luminescent parametrs F for various products are given in Figs 4 and 5. Such dependences can be used for moisture analysis of agricultural products. Now we have also preliminary results of moisture content measured by luminescent technique for other biomaterials (silk, wood, paper, etc.).

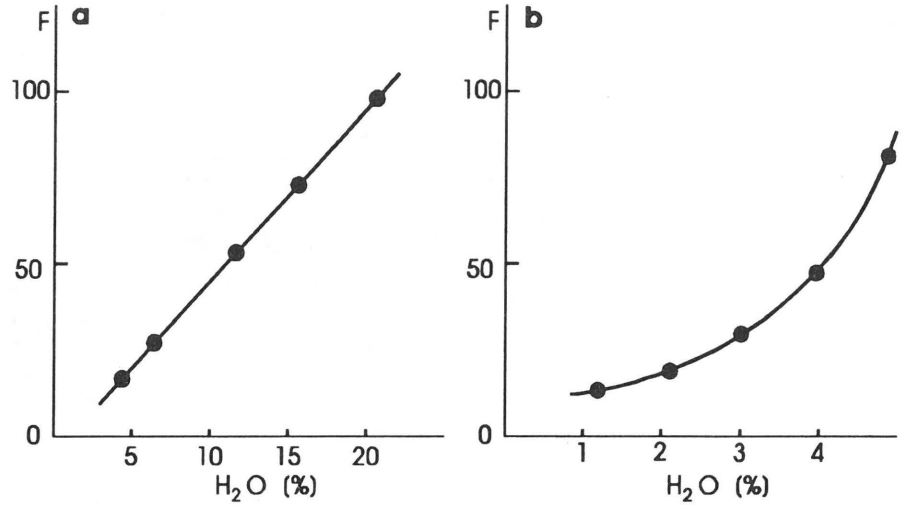

Fig. 5. The dependence of luminescent parameters (F) on moisture content (% H_2O) for dried milk (a), and grain (b). T= 23 °C.

CONCLUSION

The new luminescent technique for moisture content measurement has been developed. The main advantages of the proposed luminescent technique are the following:

- Ability to run an analysis without sampling, weighing, standartization and disturbance of integrity of the object;
- High speed of measuring (only few seconds);
- Remote control of production line;
- Examination of the products within transparent vessels and inclosed apparatus;
- Simplicity and low cost of construction.

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