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INTERNAL DAMAGE IDENTIFICATION OF SEEDS

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A b s t r a c t. X-ray method to determine internal damage of seed, mainly its endosperm, was used. A roentgenogram obtained by this method was analysed manually only (at present time). Number of cracks, size and location was assessed for each kernel of sample. Kernels of wheat, barley and malt were used. An algorithm for analysis of biological damage of barley was used. In this case the surface of kernels of barley was damage. For quantification of the internal damage of seeds it is very important to obtain the clear roentgenograms for next semi-automatic processing. Current works are undertaken to computerize the analysis of the roentgenograms.

K e y w o r d s: stress cracks, internal damage, X-ray method, roentgenogram, kernel, biological damage

INTRODUCTION

Mechanical damage can be defined as a state of disturbance of the natural continuity of particular tissues of kernels and caused by the destructive effect of external forces (harvest, transport, handling) as well as internal stresses (which may be) caused for example by the gradient of moisture in the process of intensive wetting or drying of grain. Many authors referred about these reasons of damage [4,5,11].

Research on grain quality has shown a correlation between visually detectable stress cracks in corn kernels and subsequent breakage during handling [1,10]. Stress cracks in grain are one type of mechanical damage only but very important one. Grain inspection facilities have to rely on human vision to classify damage characteristics of a sample but visual stress cracks, which also limit usefulness of a kernel in most processing operations are not examined. It this case, a computer vision system may provide an objective measure of stress cracks for example and other types of damage, respectively. The vision system provide good results when lighting and orientation of objects are suitable. Orientation of objects is also a very important consideration in computer vision applications as well as X-ray applications. Most of agricultural products have not simple shape. Lighting is the most important condition for obtaining a good image. Diffuse lighting is used very often. For a light contrast between the image object and its background a dark platform is very often used as well.

Mechanical damage can be classified as external or internal, according to its respect to the differentiation in the extent of cracks or cavities, as well as their location. External damage to grain, in the form of cracks in the involucre, extending to the endosperm can be identifed by means of direct visual inspection or by means of other, indirect methods of measurement applicable to damage of this kind. Internal damage of grain, located within the endosperm and usually not extending into the aleurone layer, can be identifed through X-ray detection. Some other methods are used but not very often and not for all cases. Therefore applicable methods of grain damage assessment can be divided mainly in two basic categories: direct and indirect methods.

Direct methods are based on visual assessment of the surface condition of the object under study, or its picture or image, can be burdened with a considerable subjective error. In the case of X-ray method, included in to this group, the subjective character of the assessment can be limited.

Indirect methods, more objective in character, allow the extent of damage to be assessed on the basis of the values of the parameters measured and related to the extent of damage. This group of methods includes methods based on biotests, as well as methods based on the absorption of water or colouring solutions, to use their optical or fluorescent properties. In this group of methods the colorimetric method deserves the closest attention because is faster than the methods based on biotests [3]. Selection of method primarily depends on the requirements of the researcher.

MATERIALS, METHODS AND RESULTS

X-ray method was used for identification of an internal damage of grains (stress cracks, cracks and splits). During the last ten years this method has found extensive application in studies on damage of grain and other materials [9,12].

Internal damage of grains was detected by means of compact short-focus Russian apparaturs (Fig. 1), which provides images with a good geometrical definition. Kernels used for determination (usualy 100 kernels

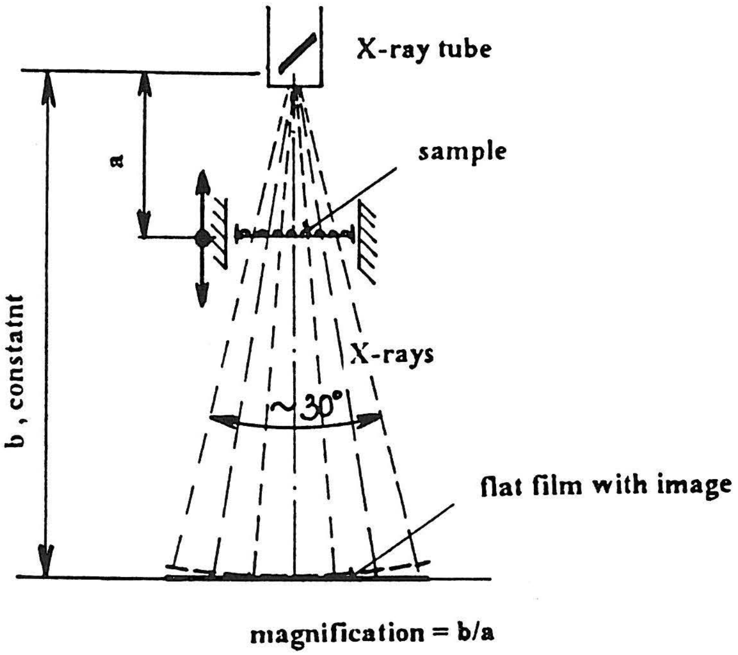

Fig. 1. A scheme of X-ray apparatus. Maximum of magnification is ten times. A distance 'a' is variable. For various magnification the position of sample must be changed. The magnification can be adjustament in steps only, no continuously.

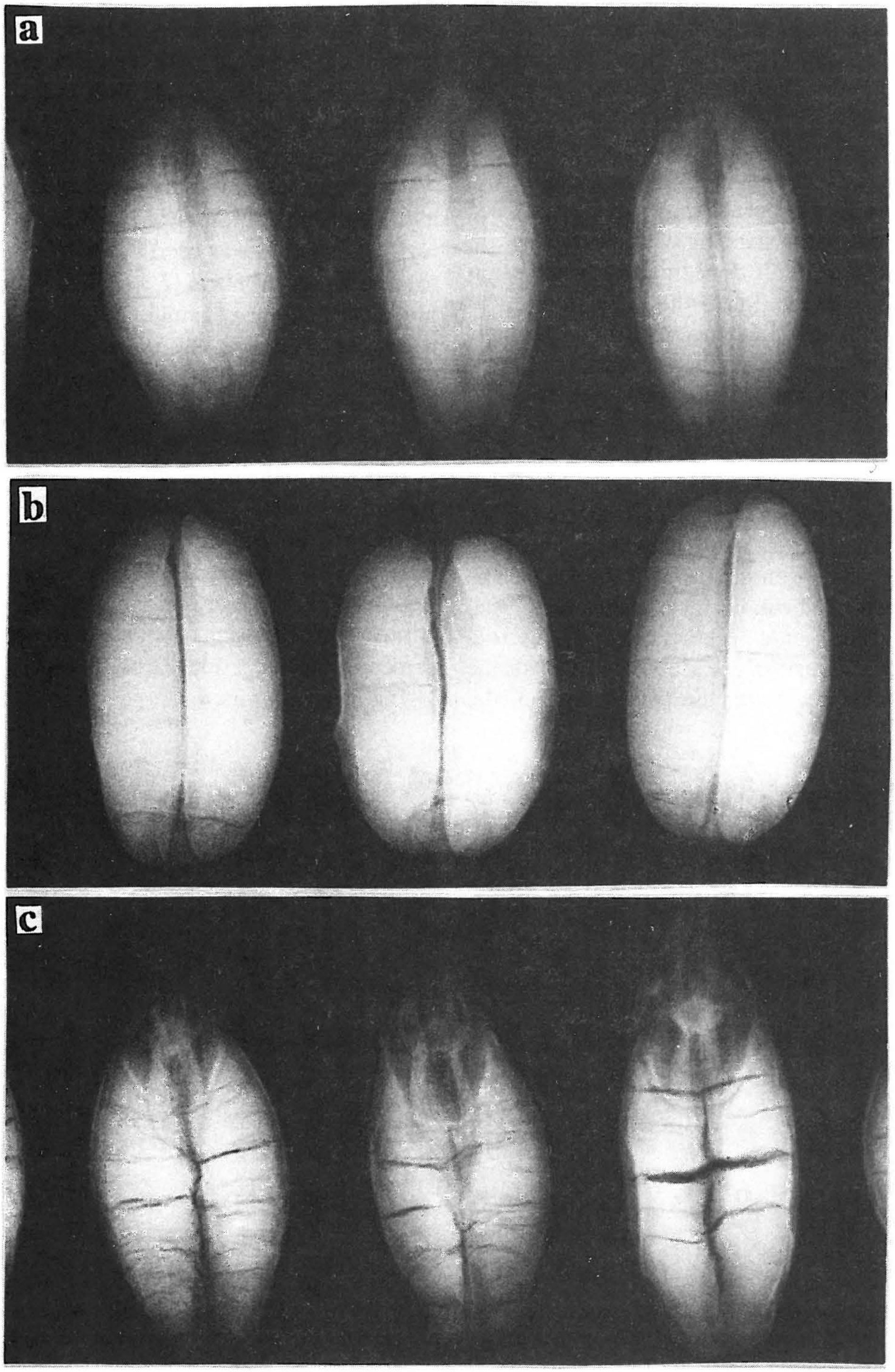

Fig. 2. Some results when using X-ray method. These images were scanned by camera and digitalized for next processing. In all pictures the cracks and splits are of black colour: kernels of spring barley (a), spring wheat (b) and malt - barley after processing for production of beer (c) (a,b,c - face views).

per one sample) are glued on a paper support plate and subjected to X-ray detection.

Obtained X-ray pictures, (roentgenograms) were analysed visually using a microfilm projector.

The internal mechanical damage detected within endosperm of the grains can be described, for example by means of indexes based on appropriate grinding of the image and on digital system of denoting the distribution on the damage [9]. In this time, quantification of internal damage of single kernels is made manually (number of cracks in endosperm of kernels, its size and location).

Current works are undertaken to computerize the analysis of the X-ray images, according to an algorithm comprising a determining system of coordinates, describing the location and extent of the cracks, recorded on the roentgenograms of the kernels. The kernels of wheat, barley and malt were used for experiments. Figure 2 shows internal damage image of various kernels (with the magnification about ten times). In fact, the smaller magnication is used more often (from two to five times) because the lines and outlines in the images are more clear. The kernels of the sample were analysed from two views. The second view is turned against the first view about 90 degrees to straight axis of kernel.

A computer image analysis was used for identification of biological damage of barley. This method was used by many authors to solve similar problems [2,6,7,10]. The samples with healthy and unhealthy kernels of barley were analysed by this method. The result of this procedure is shown in Fig. 3.

CONCLUSIONS

Internal mechanical damage was investigated in kernels of wheat, barley and malt. During the experiments various procedures were tested. Only X-ray method provides information about internal damage of each kernel. For processing of roentgenograms, in present form, very long time is necessary. Using the computer image analysis for

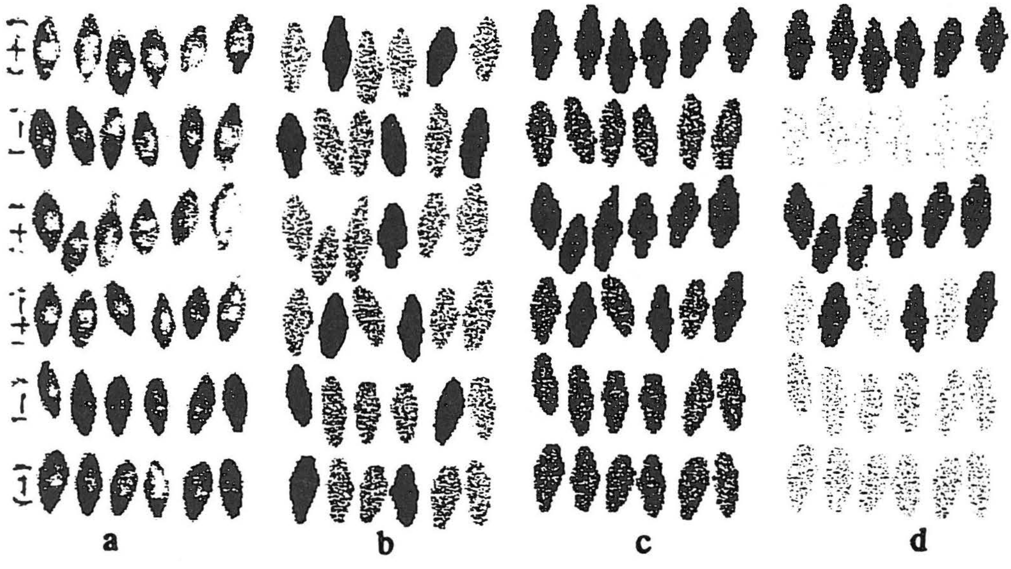

Fig. 3. An example of the result of computer image processing: a) There are six rows with kernels of barley. Any kernels are biologically damaged (having 'black tips'). The sample rows with healthy kernels are marked 'plus', the rows with unhealthy kernels are marked 'minus' and the rows with mixed kernels are marked 'plus minus'; b) and c) represent various steps during computer image processing of sample from Fig. 3a. Steps b) and c) represent 'recognition' in processing; d) Black color in image of kernels represents healthy kernels. Compare with a) All figures were made by 9-pin dot matrix printer. The sample of kernels was scanned by black and white vidicon camera.

processing of these roentgenograms is necessity.

Number, size and location of cracks in the single kernels can be expressed by a decimal fraction. On the other hand the colorimetric method can be used for evaluation of internal damage of grain as well as for the assessement of external damage. This method provides a mean value of whole sample. It can be disadvantage for some situations. So far the colorimetric method has not found any practical application. The computer image analysis seems to be the best solution of this problem. Having them, very clear endosperm images of kernels are necessity. In this case a device can work in a real time.

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