

A TECHNICAL NOTE ON THE USE OF A COLORIMETRIC TECHNIQUE FOR EVALUATING MECHANICAL CORN KERNEL DAMAGE

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The colorimetric technique of corn kernel damage evaluation developed by Chowdhury and Buchele (1976) was used to measure kernels damaged both artificially and by passage through a laboratory cylinder-concave apparatus. The technique consists of staining the damaged parts of the kernels in a Fast Green FCF dye, rinsing, leaching the dye from the damaged kernels using dilute NaOH, and measuring the absorbance of the leachate. The greater the area of exposed inner kernel tissue, the greater the amount of dye in the leachate which makes the absorbance of the leachate a measure of the damage. Use of the technique on artificially damaged kernels demonstrated a high degree of repeatability. The technique indicated increased levels of damage as kernels passed along the combine shelling crescent. The method was quick, easy and straightforward with results more consistent than those from visual observation.

INTRODUCTION

Until recently, researchers reporting corn kernel damage levels, from field or laboratory threshing studies, have expressed the damage levels as a percentage by weight. The amount of damaged corn was evaluated by sieving, visual sorting of the damaged kernels, or a combination of both. These methods can be time consuming and do not accurately account for the fact that kernel damage may occur on a continuous scale.

A colorimetric technique has been developed by Chowdhury and Buchele (1976) and Chowdhury et al. (1976). The technique consists of staining a sample of corn kernels with Fast Green FCF dye; the dye reacts only with the exposed internal tissue of the corn kernel. Excess dye is rinsed off with distilled water and the sample is then placed in a mild sodium hydroxide solution which dissolves the dye adhering to the damaged kernels. The percentage transmittance or absorbance of the solution is then measured using a colorimeter. Clearly, the greater the damage levels in a sample, the greater the dye concentration in the NaOH solution and therefore the greater the absorbance. Chowdhury (1978) discussed the development of a scale to report kernel damage evaluated using the colorimetric technique. One may create a scale or 'calibration curve' by evaluating artificially damaged samples. The artificially damaged samples may be produced by cutting hand-shelled kernels along their longitudinal axis and then adding the 'damaged' kernels to sound hand-shelled kernels to make up samples of known percentage damage (by weight). But this is an arbitrary method; the simplest manner of reporting results

appears to be the use of percent absorbance readings. In this manner a higher numerical value indicates higher levels of corn kernel damage.

The objectives of the study were: (1) to reaffirm that observer error in visual damage inspection of combine harvested corn is unacceptably large; (2) to demonstrate the repeatability of the colorimetric technique for evaluating mechanical corn kernel damage; (3) to demonstrate the usefulness of the colorimetric technique for evaluating mechanical corn kernel damage in an experimental situation.

VISUAL DAMAGE INSPECTION

Schmidt et al (1968) report a study in which the precision of estimating mechanical damage in samples of corn was investigated. Results of their experiments showed considerable variation among mechanical damage observations on the samples. Main sources of variation in sample damage estimates were observer differences, sampling differences and the inability of observers to repeat their determination of damage.

The problem of observer error was reaffirmed in a small experiment in which five observers evaluated three 50-g samples of corn for damaged kernels. The results are shown in Table I. Clearly, there is an unacceptably wide range of reported damage levels.

THE COLORIMETRIC TECHNIQUE

To investigate the repeatability of the colorimetric technique, 10 artificially damaged samples of 15% (by weight) damage were created. Each sample weighed 100 g. A 0.1% Fast Green FCF dye solution followed by 0.05 N NaOH solution was used;

the time for soaking, rinsing and bleaching was 30 s in each case. The percent absorbance (100 minus percent transmittance) was determined with a "Spectronic 20" colorimeter. The readings were made at 610 nm. The colorimeter was calibrated for zero absorbance with 0.05 N NaOH. The results (Table II) show acceptable consistency; the small differences can be attributed to the differences in samples. Since the kernels that were cut were not all exactly the same size, some kernels present more internal tissue than others and thereby indicate greater damage levels.

To illustrate the strength of the colorimetric technique, results of a small experiment investigating the distribution of the corn kernel damage along the concave of a grain combine are presented graphically in Fig. 1. Hand-picked ears of corn were threshed in a stationary laboratory thresher constructed from Massey Ferguson 300 combine parts. A cylinder speed of 575 rpm and cylinder-concave clearance of 25 mm front, 16 mm rear were used. The material from each test run was collected in five boxes. The first four boxes divided the concave into four equal zones, the fifth box collected all material passing over and through the transition grate. Samples were taken from each box for damage determination. The increase in corn kernel damage with distance along the concave is not linear, as reported by Mahmoud and Buchele (1975). It is believed that the difference may be attributed to the method of damage evaluation. Chowdhury and Buchele (1978) reported that of the damaged kernels passing through the concave, the percentage suffering severe damage decreased with distance along the concave. This means that more of the kernels

TABLE I. CORN KERNEL DAMAGE, ASSESSED BY VISUAL DAMAGE INSPECTION (EACH VALUE IS THE AVERAGE OF THREE DETERMINATIONS)

Observer	1	2	3	4	5
% damage	47.7	42.9	30.6	20.9	20.5
	a	a	b	c	c

a-c Means with the same letter are not significantly different at the 5% level.

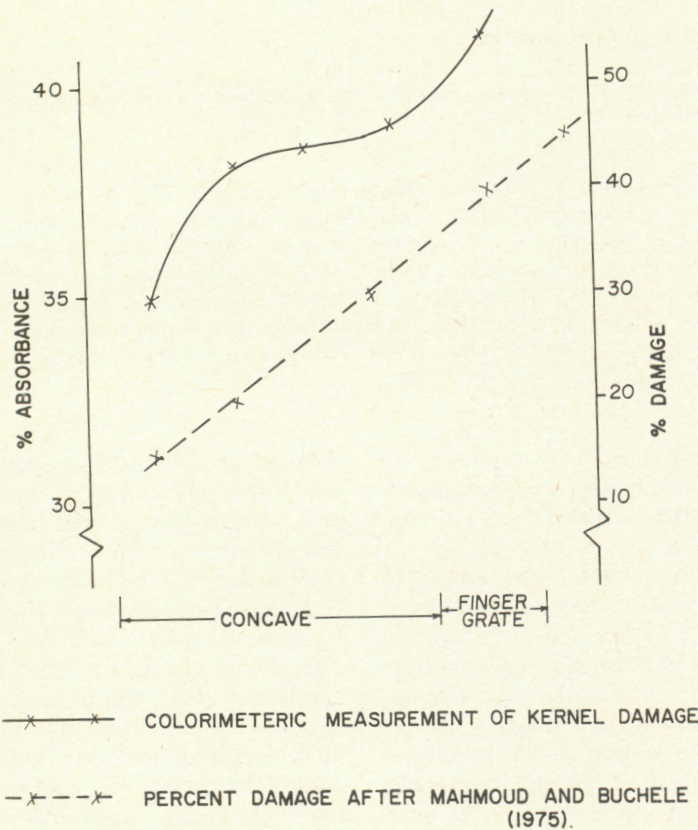


Fig. 1. Distribution of kernel damage along the concave.

TABLE II. REPEATABILITY OF THE COLORIMETRIC TECHNIQUE FOR EVALUATING CORN KERNEL DAMAGE

Sample	% absorbency
1	32.0
2	31.0
3	32.0
4	31.5
5	34.0
6	30.5
7	32.0
8	31.0
9	30.0
10	29.0
Mean	31.3
SD	1.4

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are suffering minor cracking or chipping. The method of weighing all damaged kernels to express kernel damage as a percentage by weight ignores this change in the nature of the kernel damage; the colorimetric technique takes the change into account. This might account for the flat portion of the curve for the colorimetric technique. The low value of kernel damage obtained from the colorimetric technique at the concave entrance may be due to the fact that these kernels were threshed by the first impact of the cylinder. Those kernels threshed first would not have been

in contact with the cylinder bar or concave bar (Halyk 1968; Johnson et al. 1969) and, therefore, are less likely to have sustained major damage. The increase in damage after the beater can be attributed to the impact of the kernels with the beater.

SUMMARY

The colorimetric technique has been found to be quick (4-5 min per sample), easy and straightforward. It is capable of accounting for the continuous nature of corn kernel damage, and gives repeatable results.