

Project Number 78-L2
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Project Title: Concealed Damage and
Almond Quality

Concealed Damage

78-L2

This report describes two years' work (1977 and 1978) on the problem of concealed damage (CD) in almonds. CD is characterized by an internal discoloration (browning) of the kernel and is sometimes accompanied by off flavors.

Objectives

Informal observations suggested that CD increased with increased stockpiling of in-hull almonds. Initially, therefore, the study was aimed at defining the conditions which lead to the appearance of CD. The work in 1978 was based on 1977 results and attempted to more precisely define the conditions of kernel moisture and storage temperature which lead to CD. Tests were also carried out to develop a means to avoid CD in wetted almonds.

Interpretive Summary

In order for CD to appear dry almonds must be wetted. Following wetting the almonds must be exposed to elevated temperatures. Presumably the heating could take place during in-hull storage (which was tested) or during processing. Nuts that are well-soaked (14% water and up) develop CD when held at temperatures of 120°F and higher. Temperatures of this magnitude are often experienced by almonds stacked in exposed areas. Dry almonds (8% water, and less) did not show CD when held at 135°F for up to three weeks.

CD can be avoided if wet almonds are dried at low temperatures (less than 100°F) prior to storage.

Experimental Procedures

Informal observations had suggested that CD occurred primarily in stacks containing wet almonds. Therefore, in 1977, the influence of moisture and temperature on the induction of CD in stacked almonds was tested. A sample of dry, in-hull Nonpareils was divided in half. One half was subjected to a simulated rainfall from an oscillating sprinkler. The wet and dry batches of almonds were halved again and four small almond stacks were created--one wet and one dry placed in direct sunlight and duplicates of these in the shade. The stacks were fumigated with phostoxin (three days) and then uncovered. Temperatures were determined twice daily at three positions in each stack. Almond samples were taken every two weeks. Samples were tested for CD (both before and after roasting in oil), for the ability to germinate, and for content of water and sugars.

The results of 1977 indicated that moisture and heat interact to produce CD in almond kernels. In 1978 an attempt was made to designate "dangerous" levels of kernel moisture and storage temperature. A sample of field dry Nonpareils was shelled and split into four groups. Three of these groups were immersed in water for different lengths of time so that they could imbibe varying amounts of water. Each of the four groups was then subdivided four ways. Four samples each (one for each initial moisture level) were then placed in incubators at 90, 105, 120 and 138^oF. Samples spent approximately 12 hours of each day in the incubator and the rest of the day at 85^oF to simulate diurnal temperature fluctuations. Subsamples were removed from each treatment after 3, 9 and 15 days. These were evaluated for CD and, in some cases, analyzed for various biochemical constituents.

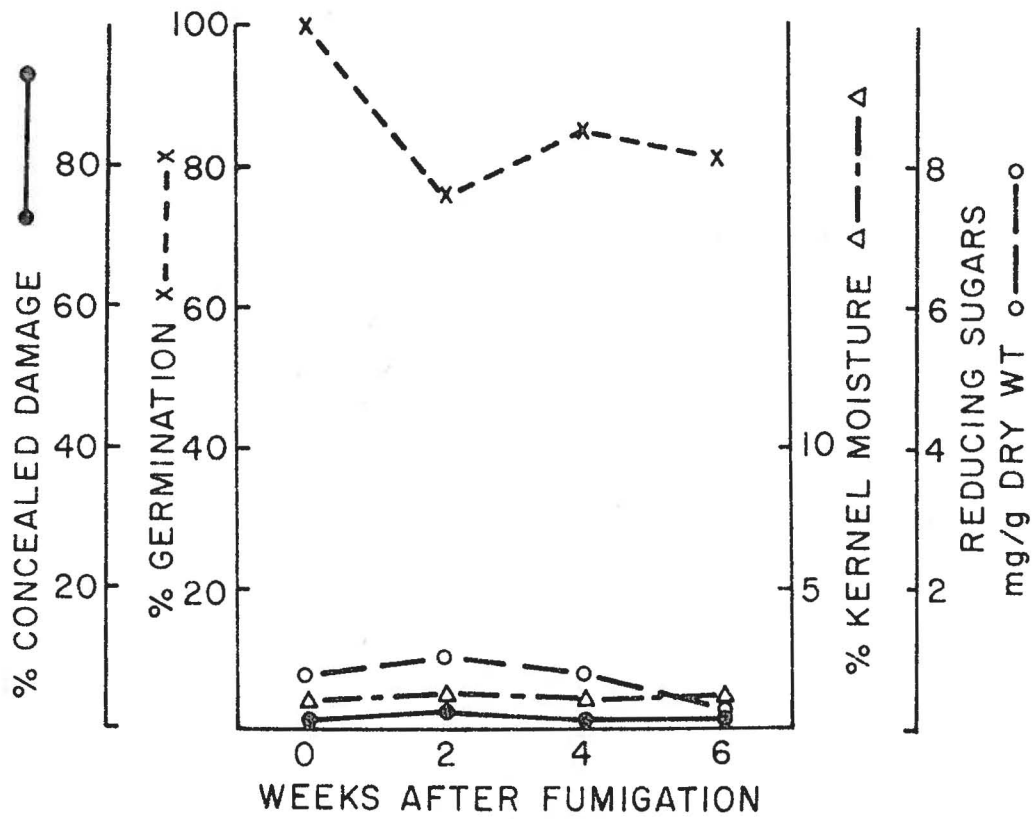


Figure 1. Analysis of samples of Nonpareils withdrawn from the south-facing side of a stack of dry almonds placed in direct exposure to the sun.

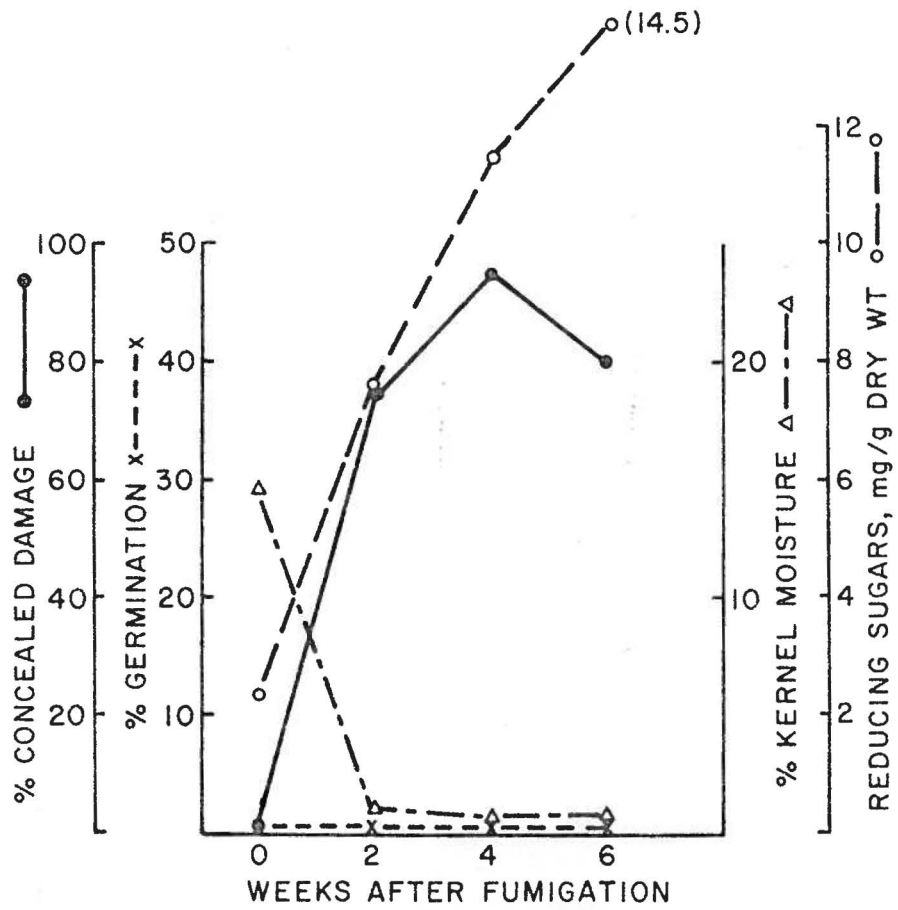


Figure 2. Analysis of samples of Nonpareils withdrawn from the south-facing side of a stack of wet almonds placed in direct exposure to the sun.

Results

The data in Figures 1 and 2 summarize the findings of the 1977 effort. Figure 1 shows the incidence of CD in dry nuts that were held in an exposed location for six weeks. The CD seen is minimal and the kernels are viable seeds (i.e. they germinate). Figure 2 shows the data for nuts that were wetted prior to stacking in an exposed location. After two weeks CD is high and the kernels will no longer germinate. In addition, the level of reducing sugars is greatly elevated (compare with Fig. 1). This pair of figures illustrates the role of moisture in causing CD. The need for an elevated temperature to make CD apparent is illustrated by data that are not shown. Wet almond stacked in the shade do not show CD.

If wet nuts are removed from the exposed stack immediately prior to fumigation (before CD is seen, see Fig. 2), dried (forced air at 85°F), and returned to an exposed stack, no CD is seen even after six weeks. This finding is the basis for our suggestion that CD can be avoided if wet almonds are carefully dried.

Holding Temp. (°F)	Initial Kernel Moisture (%)			
	4	8	14	21
90	OK	OK	Extensive Fungus Growth, (A. flavus) Aflatoxin Danger	
105	OK	OK		
120	OK	OK	20% CD After 15 d.	
138	OK	OK	100% CD in 9 d.	20% CD, in 9 d.

Figure 3. Incidence of CD in almonds of varying initial moisture content held at 90°, 105°, 120° and 138°F.

In 1978 an attempt was made to determine the limits of temperature and moisture which lead to CD. The data are shown in Figure 3. No CD was seen in dry (4 and 8% moisture) samples held for up to two weeks at 135°. However, considerable CD was seen in the wetter samples (14 and 21% moisture) that were held at 120 and 138°F. The lower figure for CD in nuts of 21% moisture held at 138°F (relative to 14% moisture at 138°) is due to the fact that the nuts were in such poor condition that measurement of actual CD was difficult.

Fungal growth made it impossible to measure CD in wet samples held at 90 and 105°F. This portion of the test must be repeated in 1979.

Discussion

Field tests indicate that the appearance of CD is linked to the wetting of kernels followed by exposure to high temperatures. Laboratory tests suggest that temperatures of 120°F (but perhaps not 105°F) are sufficient to lead to CD in dry nuts that have been wetted to 14% moisture. CD can be avoided if wet almonds are dried before stacking.

Some points, relevant to control of CD, require research attention. Can a cost-efficient means of drying wet almonds be developed? Since early harvesting may lead to stacking of green (somewhat wet) almonds, the susceptibility of green almonds to CD should be determined.

Publications

To date, no publications based on this work have been prepared.