Quality in Frozen Lima Beans

effects of processing on table-quality of frozen Concentrated Fordhooks studied in series of tests

Clarence Sterling and Mildred M. Boggs

Concentrated Fordhook lima beans —subjected to experimental variations during processing, freezing, and subsequent cooking—were adversely affected by increased delay time after vining, decreased blanch time and temperature, increased freezing temperature, decreased cooking time, and increased calcium content of the processing and cooking water.

Present United States Standards for Grades of Frozen Lima Beans are largely based on ratings of color and on absence of defects, but in addition, there are requirements covering flavor, odor, and tenderness.

When the standards were established, varieties of lima beans were commonly used that gradually lose their green color as their physiological maturity advances, becoming white when fully mature. In recent years, new varieties have been developed, many of which retain their green color at all stages of maturity. This situation has made it increasingly difficult to determine quickly and accurately the quality of frozen lima beans under United States Standards.

One phase of a recent study—conducted in co-operation with the Western Utilization Research Branch of the United States Department of Agriculture under a contract supervised by the Agricultural Marketing Service—was to evaluate a number of objective tests with the aim of finding one which could replace or supplement the color and the tenderness ratings in the present United States Standards for Grades.

Samples of Concentrated Fordhook lima beans—with about 10% white—were vined, size-graded, washed, brine-floated, washed again, and cooled at a commercial processing plant. These were then placed in 32° F storage and processed in successive experiments. The total elapsed time from vining to blanching of the last sample was 48 hours. Subsequently, the beans were made more homogeneous by separating in sugar solutions; those floating in 25% sugar and sinking in 18% sugar were used after removal of those that were white or pale green.

Processing Treatments

In the standard procedure, the beans were blanched—scalded—in steam at 212° F for 180 seconds, cooled 30 seconds in soft tap water, sealed in No. 2 cans, frozen, and stored for seven months in circulating air at −10° F. In each experiment, only one of the above processing conditions was varied. Before taste-testing, all samples were cooked for 12 minutes in distilled water.

One series of beans was given three different blanching temperatures—190° F, 200° F, and 212° F. Another series underwent different periods of blanching—0, 90, 180, 270, 360 seconds. A third series was cooled in water of varying calcium concentrations of 0, 50, 100, 200, 500 ppm—parts per million—and subsequently cooked in water of the same concentrations for tasting and analysis. A fourth series was frozen and stored for seven months in still air at temperatures of −30° F, −20° F, −10° F, and +10° F. The fifth series was subjected to different periods of delay at room temperature—0, 1.25, 3.0, 5.5, and 7.5 hours—before blanching and further processing. The sixth and final series was cooked for different periods of time—four, six, nine, 13, and 18 minutes—before tasting and physicochemical analysis.

From the data obtained by the tests, it was apparent that variations in the processing and cooking of frozen lima beans may markedly influence the textural quality of the product. Also, the effects of the experimental variations were readily detectable to the members of the taste panel. However, of the objective tests applied, only the tenderometer value of the cooked beans reflected the changes in eating quality at the 1% level of probability. The tenderometer value appeared to be particularly sensitive to toughening due to calcium in the cooking water.

The tests for alcohol-insoluble solids—AIS—and for per-cent moisture had values closely correlated, but neither appeared to be correlated with cotyledon —embryo—texture scores. This indicates that these two tests did not clearly reflect differences in textural quality introduced by the variations in the handling, processing, and cooking conditions investigated in this study. The correlation between starch content and AIS value is significant at the 5% level of probability. While AIS and moisture determinations have been well established as indices of the physiological maturity of lima beans, they do not measure the textural quality of the cooked frozen product under the conditions of the present study. The United States Department of Agriculture color scores remain at an unvaried level which is not significantly related to any of the factors employed.

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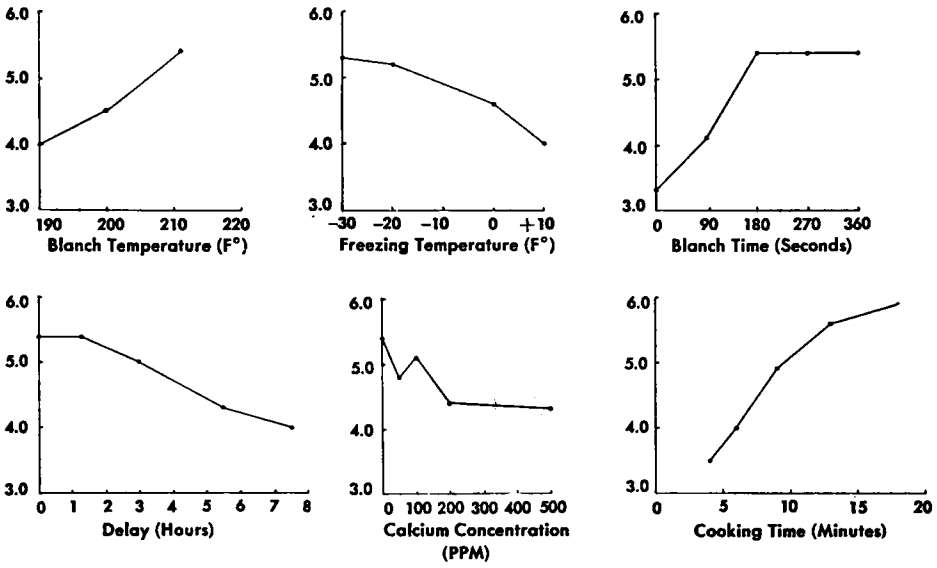
Organoleptic texture scores for frozen lima beans undergoing variation in processing.



Defect in Limas for Freezing

wrinkled seed coat a new defect in green lima beans for freezing economically important in few areas only

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A seed-coat deformity in lima beans —responsible for lowering the grade of the frozen product—has appeared in some of the green lima bean areas of California during the last two years.

The deformity has received various names, including wrinkled, pebbled, blister, alligator hide, and brown spot.

Wrinkled beans have occurred in only a few areas—primarily in Santa Clara and Monterey counties. However, in certain fields, wrinkling has been so severe it was impossible to comply with the standards for U. S. Grade A frozen lima beans, which allow only 2% of wrinkled beans or about four per package. Cases are known where the economic loss to the freezing plant has been $30,000 to $45,000 per season for sorting alone. During 1954, this defect has caused the abandoning of about 200 acres in one area of the state. In other areas, wrinkled beans have caused but little economic loss.

Wrinkled seed coat was first observed in a field of Concentrated Fordhook—the only variety to exhibit an appreciable amount of the defect—that was suffering from a water shortage, as indicated by the appearance of the plants and the soil, as well as by the remarks of the grower.

It seems likely that the defect was caused by poor growing conditions during the last third of the growing season because it is found most frequently on plants somewhat stunted in growth.

Soil moisture is such an important factor in plant growth that a water shortage might well be the major causal agent of wrinkling. High temperatures have also been suggested as a cause. During such periods, soil moisture is likely to be a limiting factor. Early fields are more apt to have the defect, and usually wrinkling is more severe on the plants from the poorer areas of the field. In certain cases, 15% to 30% of the beans in one area of a field had wrinkled seed coats, while other areas of the same field were only slightly affected.

Because wrinkling cannot be detected from the appearance of the pod, it must be opened and the beans examined. Consequently, it is difficult for the processor's field men to identify affected areas within a field.

The defective area of the bean is usually wrinkled. When the seed coat is split, its inside surface appears cracked and is yellowish brown. The cracked condition affects the layers of cells near the green cotyledon but does not extend through the seed coat to the outer surface. After blanching, however, the affected area turns yellow-brown and the discoloration shows on the outside of the whole bean. The cotyledon of the bean—the green part within the seed coat—is not affected.

Occasionally, pods are opened whose cotyledons have burst the seed coat. In only a few cases has this defect been found near the hilum—the junction of seed and pod—and is generally more common near the outer circumference of

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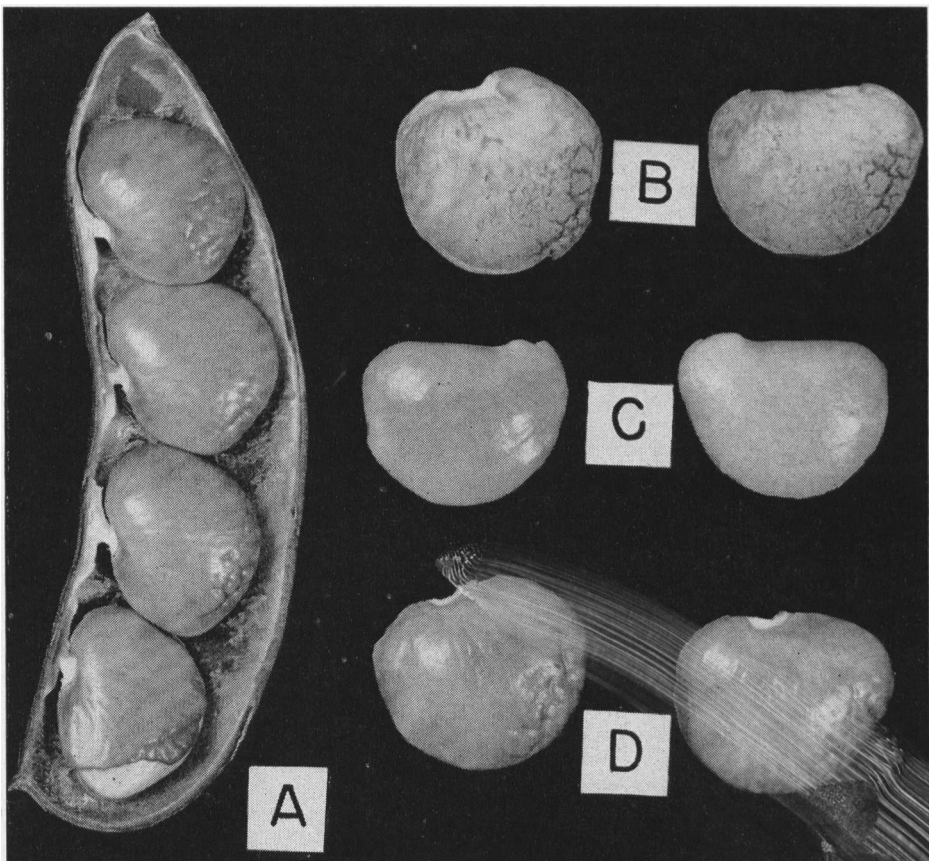
Wrinkled defect in green lima beans. *A*, Pod with beans showing wrinkled defect and a cotyledon which has burst the seed coat. *B*, The inside of the removed seed coat showing cracked condition caused by defect. *C*, Cotyledon removed from seed coat. *D*, Beans before removal of seed coat showing wrinkled defect on lower margin. *Photograph by W. B. Neuburg.*



QUALITY

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If textural quality is used to determine maturity, the complete history of the frozen beans must be kept uniform. Otherwise, grades and standards will lack equivalence. If physiological maturity—as indicated by alcohol-insoluble solids or moisture content—is used as a standard, variations in processing treatments will have a relatively minor influence in grade determination.

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