

Transit from California (U. S. Dept of Agriculture Bulletin 505, 1936, p. 38).

C. W. Mann, E. A. Gorman, Jr., and W. V. Hukill: *Stage icing in the Refrigeration of Oranges in Transit from California* (U. S. Department of Agriculture Bulletin 857, September 1943).

W. F. Newhall and W. Grierson: A low cost self-polishing fungicidal water wax for citrus fruit (*Citrus Magazine*, March 1956).

R. V. Phillips and W. Grierson: Cost advantages of bulk handling citrus through the packing houses (*Proceedings, Florida State Horticultural Society*, Vol. 70, (in press) 1957).

D. S. Prosser, Jr., et al: *Bulk Handling of Fresh Citrus Fruit* (Florida Experiment Station Technical Bulletin No. 564, 1955).

D. H. Roe, H. T. Cook, and W. H. Redit: *Harvesting, Handling and Transportation of Citrus Fruits* (U. S. Department of Agriculture Bibliographical Bulletin No. 13, January 1951).

D. H. Rose, T. M. Whiteman, and R. C. Wright: *Storage of Fruits, Vegetables and Florists Stocks* (U. S. Department of Agriculture Circular 278, 1933 (now superseded by Handbook No. 66)).

Storage of Florida Oranges (USDA HT&S Office Report No. 219, 1949.)

J. S. Wiant, et al: *Storage Tests on Florida Oranges* (USDA HT&S Office Report No. 236, 1951).

STORAGE OF EGGS AND EGG PRODUCTS

Shell Eggs: Quality Factors, Commercial Grading, Keeping Quality, Control of Quality in Storage; Egg Products: Quality Factors, Processing, Freezing and Dehydration, Storage Life, Defrosting; Refrigeration Design Data

THE annual production of eggs in the United States now runs close to three billion dozens. A substantial proportion of these are produced during the spring months, particularly in the Midwest where farm flocks prevail. This production pattern gives rise to a surplus of eggs in the Spring. The surplus is mostly stored as shell eggs, although increasing quantities are being first processed and then stored as frozen and dried eggs.

SHELL EGGS

The bulk of the shell eggs moves into storage during February, March and April, and out of storage during August, September, October and November.

The long term storage of eggs is gradually decreasing as the production of eggs becomes more steady the year around. As this trend grows there will be more short term and less long term storage practiced. Thus, the warehousing of eggs is becoming a matter of backlogging stocks for handling and grading, and for adjusting supply to the current demand. The problems of handling eggs in warehouses are somewhat different today than a decade ago. It is in the latter setting that the handling of shell eggs in cold storage will be discussed.

QUALITY FACTORS

The following criteria are usually used in evaluating egg quality:

1. Appearance
2. Odor and flavor
3. Nutritive value
4. Culinary value
5. Microbiological condition

Most consumers think of *fresh-egg* quality in terms of appearance, odor, and flavor. An egg having a thick, gelatinous white completely surrounding an upstanding yolk is desired. The odor and taste should be normal (mild and eggy); there should be no defects present (cracks, dirt, blood spots, green whites, etc.). Generally eggs used for frying and poaching must meet the most exacting standards; those for cooking the least.

All fresh eggs are not of high quality. Most people are familiar with the fact that newly-laid eggs may have weak, cracked, or misshapen shells. These conditions arise due to poor genetic background of hens, faulty management, hen nutrition or even disease. It is not so well known that fresh eggs can and do occasionally contain foreign objects, particularly blood and meat spots. In addition, they may possess weak and watery whites and mottled yolks. These latter conditions are affected by the breeding behind the hen, her age, and disease history. Respiratory disorders are particularly damaging to egg quality.

The color of the shell is purely a matter of breeding. There is no difference in quality between brown and white eggs. Yolk color is entirely a question of the kind and amount of color in the feed of the hen. In commercial flocks close attention is

given to this point so as to produce a uniform, and generally, a light, yolk color.

The nutritive value of eggs is high; they class as one of our protective foods, being especially valued for their high quality protein and vitamin content. Nutritive value is very much affected by the feed of the hen, but hardly affected by handling or storage.

COMMERCIAL GRADING

Commercially, egg quality is determined by candling. This shows the interior quality and whether the egg meets the specifications of the *U. S. Standards for Quality of Individual Shell Eggs* with respect to albumen and yolk quality. Many states use the same or similar standards; some are obligatory; others are permissive. Weight classifications are also commonly used. These are usually divided into the following categories: jumbo, 30 os per doz; extra large, 27 os per doz; large, 24 os per doz; medium, 21 os per doz; small, 18 os per doz; and peewee, 15 os per doz.

In the past, eggs were candled and graded by hand. Increasingly, however, these operations are being mechanized, particularly handling and weighing.

KEEPING QUALITY

The use of refrigeration ranks highest of all controls which may be applied in the preservation of quality in shell eggs. Literally hundreds of methods for treating eggs have been devised for extending their edible life; none has surpassed the effectiveness of low temperatures. Clean, sound eggs, properly packed, promptly cooled and kept at 29 to 31 F retain their quality remarkably well for several months.

Recently the use of mechanical refrigeration in the cooling and holding of eggs on the farm has become more common. It is predicted that this practice will increase rapidly in commercial egg production areas. The recommended conditions are 50 to 60 F and 70 to 80 percent rh. Eggs handled under these conditions effectively prevent quality loss on the farm and still avoid the sweating problem when the eggs are removed and transported to the candling and grading plant.

Qualitatively there are three distinct kinds of deterioration in shell eggs: (1) changes brought about by chemical reactions, (2) decomposition by bacteria and molds, and (3) changes in flavor and odor brought about by absorption of foreign substances.

Some of the changes taking place during storage are brought about by chemical action and the effect of temperature. Cool temperatures have a beneficial effect on quality. If eggs are fertile, other and more serious changes will take place at temperatures above 68 F. Commercially produced market eggs are usually infertile, so this problem is not a serious matter. Unfortunately, many farm flock eggs are fertile and these can, and do, undergo serious changes. The more obvious effects are a flattening of the white and yolk which makes the eggs unsuitable for frying or poaching if it progresses far