over 5°C (41°F) storage for the nectarines tested.

Following 0°C (32°F) storage, all susceptible varieties developed internal breakdown, but the expression of symptoms was delayed and less severe than in fruits stored at 2.2° or 5°C (36° or 41°F).

Transit after storage

Following storage, late nectarines are commonly shipped by rail with transit periods of seven days or more at temperatures near 5°C (41°F). To evaluate the development of internal breakdown under these conditions, weekly samples of five late season nectarine varieties (Le Grand, Regal Grand, Gold King, September Grand and Autumn Grand) were drawn from 0°C (32°F) storage and transferred to 5°C (41°F) for seven days before ripening. This treatment accelerated development of internal browning in all varieties and reduced market life by approximately one week, the period of exposure to the higher transit temperature. September Grand and Gold King were least affected; Le Grand was most affected.

Flesh firmness changes

Weekly measurements of flesh firmness were made on fruit from all lots at time of removal from storage. The rates of softening during storage differed markedly between fruit held at 2.2°C (36°F), or below, and fruit held at 5°C (41°F), or above (see graph). Data are shown only for the five late nectarine varieties because of the greater number of storage temperature treatments used. However, the same pattern was evident between 0°, 5°, and 10°C (32°, 41°, and 50°F) storage for all 15 test varieties of both nectarines and peaches.

Market life at 0°C

Based on accumulated data, the estimated market life for all test varieties held at 0°C (32°F) is as follows: Early Sun Grand—six weeks; Independence, Red Grand, Le Grand, and Gold King—five weeks; Red June, Regal Grand, September Grand, Fortyniner, and Fay Elberta—four weeks; Autumn Grand—three weeks; Suncrest and Fiesta—two weeks; and Pageant and Halloween—one week.

Effect of periodic warming

The value of periodic warming of fruit to interrupt constant low-temperature storage was explored. Warming fruit 20 to 25°C (68 to 77°F) had been reported to delay internal breakdown of peaches, but at the cost of rapid fruit softening. However, recent work suggests that fruit softening may be slowed at 40°C (104°F). In these tests, a weekly, 15-hour interruption of storage at either 20°C (68°F) or 40°C (104°F) slowed the development of internal browning. Fruit treated at 40°C (104°F) was judged firm enough to ship (6.6 to 8 lbs firmness), and some lots of fruit were classified as still juicy and flavorful at the end of the eight-week storage test. Fruit treated at 20°C (68°F) softened to less than 6 lbs firmness within two weeks. While these results provide a basis for further study, the commercial possibilities are uncertain.

Conclusions

Storage of any variety should be as near 0°C (32°F) as possible without danger of freezing the product. For all varieties, this low temperature is important in slowing the rate of flesh softening to obtain as long a market life as possible. For most varieties, this low temperature is essential in slowing the development of mealiness and browning during extended storage. Temperatures below 0°C (32°F) may be practical for high maturity, high-soluble-solids fruit of some varieties. Danger of fruit freezing is the only concern in lower temperature storage.

Storage at 2.2°C (36°F) to 5°C (41°F) should be avoided. Browning and mealiness develop quickly, and symptoms become extremely severe in this temperature range.

Extended transit at around 5°C (41°F) should be avoided. Ways of achieving low transit temperatures should be explored, particularly near the end of the storage life of a variety. Truck transport might be considered as a means of reducing transit time.

Varieties known to have a very short market life should not be stored. Their successful marketing will depend on rapid, thorough cooling to 0°C (32°F) and immediate distribution, preferably at a low transit temperature.

In the absence of adequate data, rapid and thorough cooling should be considered as essential for all varieties. All fruit used in tests reported here were cooled to storage temperature within 24 hours of harvest.

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ENERGY

D. L. BATH

High feed prices last year caused many dairymen to feed their herds poor quality roughages and to reduce both the quantity and quality of concentrates. The result was much lower milk production in many herds all over the state. In some cases, reduced milk production due to poor feeding practices resulted in less income above feed cost than if the feeding program had remained the same (in spite of high feed prices).

Although there is a continuing trend toward increased feeding of corn silage, oat silage, and other forages to dairy cows in California, alfalfa hay remains the predominant forage fed to dairy cows. About five million tons of alfalfa hay are fed to dairy cattle in California each year, which was about 70% of the seven-million-ton alfalfa hay crop in 1973. Good quality alfalfa hay is an ex- excellent forage for dairy cattle. Its availability in the past has been one of the primary reasons that California dairy cows have the highest average milk production in the United States.

Fiber and energy

There is a very close relationship between the fiber and energy content of alfalfa hay. As the alfalfa plant matures, it becomes more fibrous and contains less energy per unit of dry matter. Dairymen know that hay with lower crude fiber content results in higher milk production. This is partially due to the higher energy content of the low-fiber hay, and partially due to the fact that cows like it better and eat more. Additionally, low-fiber hay is higher in protein, minerals, and vitamins. This makes it possible to feed a less expensive concentrate mix without sacrificing milk production.

Even high-quality roughages limit milk production by filling the rumen to capacity before all nutrient needs are met. Energy in the form of grains and other concentrates must be provided to realize the full potential of high-producing cows. They cannot consume enough roughage to fulfill their energy needs for high milk production.

It would seem that the more concentrates fed, the better it would be for the high-producing cow. However, it becomes eventually impossible to increase energy any further without lowering fiber con-

AND FIBER LEVELS
in dairy cow rations

RESPONSE TO VARYING LEVELS OF CONCENTRATES

Mix	Percent of energy requirement from concentrate mix				
	20	35	50	65	80
Concentrates (lb/day)	4.7	8.1	12.0	13.6	19.1
Hay cubes (lb/day)	29.1	29.3	25.8	20.4	17.2
Milk (lb/day)	30.5	32.1	36.0	31.4	37.0
Milk fat (%)	3.5	3.7	3.2	3.1	2.3
Crude fiber (% of DM)	19.8	18.9	17.2	15.9	14.1
Crude fiber (@ 90% DM)	17.8	17.0	15.5	14.3	12.7

tent below minimum levels required to prevent a depression in the fat content of the milk. A minimum amount of fiber in the ration is essential for normal ruminal function, health, and production of milk with normal milk fat content.

Acetate

Rations which contain high proportions of forages favor the production of acetate in the rumen. Acetate (CH_3COO^-) is the primary precursor of the fats found in milk. Feeding a ration high in concentrates tends to reduce the proportion of acetate and to increase propionate ($CH_3CH_2COO^-$). When the percentage of propionate is increased in proportion to the other ruminal volatile fatty acids, a depression in the percentage of milk fat occurs. This is accompanied by an increase in body weight as a result of the deposition of fat in the cow. Factors other than acetate:propionate ratios also affect the fat test, and more research is necessary before a complete understanding of this phenomenon is possible.

This trend toward a decreasing fat test, as concentrate amounts are increased, is illustrated by the results of a trial recently conducted at the University of California, Davis. First-lactation Holstein cows received 20, 35, 50, 65 or 80% of their estimated net energy (ENE) requirements from a concentrate mix for 36 weeks. Alfalfa hay cubes were fed free-choice to all cows. The primary purpose of the trial was to determine the decrease in voluntary intake of alfalfa cubes as concentrate amounts were increased. The results of the trial are shown in the table.

Alfalfa cubes

Voluntary intake of alfalfa cubes decreased an average of 0.8 lb for each added pound of concentrate fed. The range in average concentrate intake was from about 5 to 19 lb per day, while voluntary hay cube intake decreased from about 29 to 17 lb per day. Crude fiber content of the total ration dry matter decreased from 19.8% to 14.1% as concentrates increased in the ration. The effect on the average fat test varied from a high of 3.7% on the high-roughage rations to a low of 2.3% on the high-concentrate ration.

The ration with 80% of the energy requirement obtained from concentrates contained 14.1% crude fiber—which is above the 13% listed as a minimum requirement in the 1971 edition of the National Research Council publication "Nutrient Requirements of Dairy Cattle." The NRC minimum appears to be much too low to maintain normal milk fat tests, at least under the conditions of this trial.

A level of at least 17% crude fiber in the total ration dry matter would be indicated as a minimum according to trials at U.C. Davis, and other universities around the country. Even the 17% level does not appear to be adequate under some conditions. A level of 19% crude fiber probably is necessary for some rations, particularly if all or part of the ration is cubed.

Under practical dairying conditions, the crude fiber content of feed ingredients is more likely to be estimated from tables of feed values than actually determined by chemical analysis. The estimated values may be somewhat higher or lower than the actual values. If a dairy ration is calculated to have 17% crude fiber but actually has 18 or 19%, there probably will be very little effect on milk production or fat test results. However, if the ration actually contains only 14 or 15%, rather than the calculated 17%, the milk fat test could be severely depressed. Therefore, it seems reasonable to build in a safety factor to insure that fiber levels will be adequate under most ration formulation conditions. This is the rationale for suggesting a minimum level of 19% crude fiber in the dry matter of the total ration (17% @ 90% DM) under practical dairying conditions.

Not only is the level of fiber critical, but also the physical form of the roughage. Milk fat percentage is decreased by hay finely ground and/or pelleted before feeding, even though the fiber level may be adequate. Heating and pelleting of concentrates and high levels of unsaturated fats in the ration also reduce the acetate:propionate ratio, resulting in milk fat depression. There is also limited evidence that fat tests are lower when alfalfa cubes are the only roughage in the ration, although the effect is not nearly so drastic as the fat depression resulting from pelleted alfalfa fed as the only roughage.

In spite of the slightly lower fat tests observed with alfalfa cubes, there is increased interest in them due to their handling characteristics for mixing and feeding, reduced transportation costs, less storage space requirements, and other non-nutritional reasons. Furthermore, there has been some interest in combining concentrate ingredients with alfalfa to make a complete-ration cube.

Previous research and experience with complete rations composed of various combinations of chopped alfalfa hay or hay cubes, concentrates, and silages have demonstrated the feasibility of these types of rations under many conditions. However, it is very important to maintain quality control on complete rations, because cows have no opportunity to select ingredients. Each bite must contain the proper proportion of all essential nutrients, such as protein, minerals, vitamins, and net energy, as well as a minimum level of crude fiber.

To insure the proper form of fiber, minimum-roughage dry-matter levels should be at least 1.5% of the body weight of the cow. For a 1400-lb cow, this amounts to a minimum of 21 lb per day of dry hay, or its equivalent of other roughages which have not been finely ground. When this level of coarse roughage and the 19% crude fiber level in the total ration dry matter are maintained, incidences of depressed fat test are very rare.

Part of the problem with setting minimum fiber levels in dairy rations, and the reason for some of the disagreement on the subject, is that crude fiber is not a well-defined or distinct substance. It probably is not the best indicator of the adequacy of fiber levels for maintenance of fat tests. Work at Cornell University indicated that acid-detergent fiber (ADF) was superior to crude fiber when relating dietary fractions to the milk fat percentage. Although ADF probably is superior to crude fiber for estimating the quality of feedstuffs, and their ability to maintain a high fat test, this is a relatively new analytical procedure. Inadequate data for many feeds prevent it from completely replacing crude fiber analyses at present. When sufficient data are available, at switch to ADF would be desirable.

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