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MINNESOTA DAIRY PRODUCTS PROCESSOR

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Old problems continue to give us new fits. Certainly, hydrolytic rancidity falls in that category. Thus it was interesting to note a couple of articles that recently appeared in the Journal of Dairy Science. The research in this case was done by Canadian workers (see J. Dairy Science 63:1213-1223) who evaluated test methods and causes of rancidity on dairy farms.

RANCIDITY--WHAT IS IT?

It is always necessary to define precisely what we mean by the term rancidity, because two different forms exist. In both cases, milkfat becomes the source of the off-flavor. Think of milkfat as looking like a block E. The arms are fatty acids. Some of these fatty acids are more or less unsaturated. That is, there is a weakness in the arms where oxygen can attack them. When this happens, the fat goes oxidized. That's one kind of rancidity. But the kind we will focus on in this discussion is hydrolytic rancidity. In this off-flavor problem, the entire fatty acid--the whole arm--is snipped off by an enzyme called lipase.

Oxidized milk occurs most often as a result of contamination of the milk with minute amounts of copper or iron.

Hydrolytic rancidity develops when raw milk undergoes (1) agitation and foaming, (2) cooling (to refrigeration temperature), re-warming (to 65-95° F), and re-cooling, and (3) homogenization. This kind of rancidity may also be caused by excessive amounts of residual detergent or surface active sanitizers in milk. Or mixing raw milk with homogenized-pasteurized milk will do it. Generally speaking, the most common cause of hydrolytic rancidity on the farm is agitation and foaming. And the temperature at which milk is most susceptible is at near the body temperature of the cow--at which point much of the fat is in the liquid state.

THE ONTARIO STUDY

The Ontario study focused on several different systems for transferring milk to the bulk tank: (1) bucket milkers and carrying pails, (2) bucket milkers and "sputnicks" (36-gallon tanks on wheels), (3) transfer systems with dumping stations, vacuum movement of milk, (4) around-the-barn pipeline systems (all high-lines), (5) milking parlor systems (three low-line, one high-line) with weigh jars, and (6) milking parlors without weigh jars.

All the pipelines were equipped with probe-activated centrifugal pumps for transfer of milk from the milk jar to the bulk tank. Samples were taken from the bulk tank after the final (4th) milking and after five minutes of

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agitation. Rancidity measurements were made initially, and after 24, 48, and 72 hours of cold storage. Sampling was conducted over an extended period of time.

In addition to samples taken of bulk milk, drip samples were taken from the milk hose just prior to the weigh jars. Each sample represented the entire milkings of five to seven cows. More than that, however, these samples showed how weigh jars influence rancidity development.

FINDINGS

As you might guess, differences in rancidity levels were found. Statistically evaluated, the differences were found to be significant. Lowest rancidity levels occurred in the bucket milker systems in which milk was carried to the bulk tank by pail. Next lowest levels were achieved in transfer systems with dumping stations. Then came sputnick systems and, at highest overall rancidity level, pipeline milker systems. But the pipeline systems did not all influence rancidity equally. Highest rancidity levels came from parlor pipeline milkers with weigh jars. Next highest were around-the-barn installations, and best overall were parlor systems without weigh jars.

These last findings bring up an interesting point. Weigh jars in the line appeared to boost rancidity in parlor systems to a higher level than around-the-barn milkers. And this happened despite the fact that three of the four parlor systems with weigh jars were <u>low-line</u> systems--considered generally to be less abusive to milk than high-line systems. All of the around-the-barn installations were of the high-line type. But take the weigh jar out of the picture and milking parlors with high pipelines showed lower rancidity than around-the-barn installations. Thus weigh jars loom as critical elements in the process by which agitation and foaming cause rancidity in pipeline milkers.

And when weigh jars were put to test and samples taken ahead of and also from the weigh jar, the latter had significantly higher rancidity values after 24 hours of storage.

WEIGH JARS--A POTENTIAL PROBLEM

Evidence from this study throws a heavy burden on weigh jars as a significant factor in development of rancidity. This is not to say that all weigh jars would induce similar responses. Design of weigh jars varies; principle of operation varies. Some weigh jars might very well be more abusive to milk than others. Milk meters, too, have been found to induce agitation and foaming and, thereby, rancidity. The authors of this study make all the above observations. They also suggest--and it would seem most appropriate--<u>that weigh jars be disconnected from pipeline systems whenever they are not being used to make weighings or to segregate abnormal milk</u>.

METHODS OF DETERMINING RANCIDITY

Several methods have been devised for measuring rancidity in milk. Only two or three are used routinely. A method frequently used in this area is one devised by E. L. Thomas, A. J. Neilsen, and J. C. Olson (<u>Am. Milk Rev</u>. 17:50).

A somewhat faster method has been designed around the procedure developed by California scientists E. M. Frankel and N. P. Tarassuk (J. Dairy Science 38:751). However, the latter method is only significantly faster if you know the percentage of fat in the milk. Otherwise, a fat test must be made. The modified Californian procedure, as worked out by Canadian scientists (J. Dairy Sci. 63:1213), goes like this:

1. Take a 4 ml sample of milk and place in a screw-capped culture tube.
2. Add 4 ml of 95% ethanol.
3. Mix 15 seconds on a Vortex mixer previously set at a speed rating of 5.
4. Add 6 ml of a solvent mixture consisting of 40% diethyl ether and 60% petroleum ether.
5. Mix 30 seconds on a Vortex mixer set at a speed rating of 9.
6. Centrifuge 3 minutes at 1500 rpm (516 x g).
7. Extract 4 ml of solvent layer and mix with 12 ml of neutralized 95% ethanol.
8. Titrate with 0.01 N alcoholic KOH, using phenolphthalein as indicator.
9. Calculate Acid Degree Value: $\text{ADV} = \frac{T \times 1.5 \times 100}{4 \times 1.028 \times \%\ \text{fat}}$, where T = titration volume - blank

While the results are expressed as Acid Degree Value (ADV), they are not directly comparable to ADV's measured by the method of Thomas et al. In the latter, off-flavors in milk are usually detected at ADV levels of 1.2-2.0. In the former, the threshold of off-flavor detection runs to ADV's of 2.6-4.45.

CONVERTING ADV's

As a matter of interest and possible usefulness, you can convert ADV's as measured by the modified California method to ADV's of the Minnesota method. You can do it, with a fair degree of accuracy, by calculation. All you have to do is plug in appropriate values in a formula. The formula is: $y = 0.64065 + 1.8245\,x$, where y = ADV by the modified California method and x = ADV by the method of Thomas et al.

Suppose you have an ADV of 2.0 by the method of Thomas et al. What might you expect the ADV to be by the modified California method? Calculate:

$$y = 0.64065 + 1.8245\,x$$

$$y = 0.64065 + (1.8245 \times 2.0)$$

$$= 0.64065 + 3.649$$

$$= 4.3 \text{ (rounding off)}$$

Or you can reverse the question. Suppose you have a modified California ADV of 4.3. What is the comparable ADV by the method of Thomas et al.?

The formula now becomes:

$$x = \frac{y - 0.64065}{1.8245}$$

$$x = \frac{4.3 - 0.64065}{1.8245}$$

$$= \frac{3.659}{1.8245}$$

$$= 2.0$$

Controlling rancidity is a major problem that requires constant attention and exercise of quality control measures.

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