farm and home

DAIRY INDUSTRIES NO. 5 4

FACT SHEET

HYDROLYTIC RANCIDITY--- CAUSE AND CONTROL

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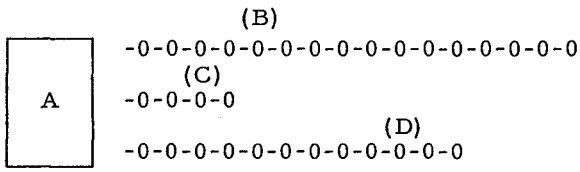
One of the most common off-flavors in dairy products is "slight bitter". Although the cause may vary, hydrolytic rancidity must be considered a prime cause. Both farm and dairy plant problems may lead to its development. Once an objectionable level is reached no processing technique will eliminate it.

Detection of slight hydrolytic rancidity by USDA butter graders demands an automatic B grade even though all other factors would allow an AA rating. Controlling this defect has important economic implications.

WHAT IS HYDROLYTIC RANCIDITY

Use of the word rancidity without qualification may cause confusion. Two entirely different defects are commonly referred to as rancidity. In both cases butterfat or butterfat-like compounds are the source. But in one case, hydrolytic, fat is severed into component parts. In the other, oxidative, a structural alteration takes place which results in a flavor change. "Tallowiness" is typical of this oxidative reaction.



Above is a schematic representation of a single butterfat unit, a molecule. In chemists' terms A is glycerol and B, C, and D, the three chains, are fatty acids. These chains vary in length from 4 links to 20 or more. Their position on A (top, middle, or bottom) is not fixed from unit to unit (B may be located at middle or bottom and C at top or bottom, etc.). Both chain length and position alter characteristics of butterfat. Vast numbers of unique molecules are conceivable.

Under suitable conditions, one of which may be the presence of butterfat units of specific properties, a milk component called "lipase" may sever some of these chains. When a given number of short ones are released the characteristic rancid flavor is detected. Because lipase is responsible for this breakdown many refer to the defect as "lipase." Prevalence of the off-flavor during winter months has prompted some to term hydrolytic rancidity "wintry" off-flavor.

CONDITIONS FAVORING OFF-FLAVOR DEVELOPMENT

Several conditions result in butterfat-lipase interaction. These are termed "activations." Like an electric motor activating machinery, these treatments activate or cause the rancidity reaction to take place. They are:

1. Agitation and foaming.
2. Cooling to refrigeration temperatures, rewarming to 60° to 90°F. and recooling to refrigeration temperatures. This is called "temperature" activation.
3. Homogenization.
4. Mixing raw and homogenized-pasteurized milk.
5. Presence of excessive residual detergents and/or sanitizers.

INFLUENCE OF PASTEURIZATION

Pasteurization destroys lipase capacity to break down butterfat. All treatments that cause rancidity require raw milk. Objectionable off-flavor developed prior to pasteurization will be present following heat treatment, but no further breakdown due to above factors occurs without raw milk contamination.

Some dairy products develop rancidity following pasteurization. In this case bacterial contamination is responsible. These bacteria, called "lipolytics," secrete a lipase that breaks down butterfat similarly to natural milk lipase.

SPONTANEOUS RANCIDITY DEVELOPMENT

Milk from some cows requires very little activation. Such milk is so susceptible that cooling alone causes rancidity. This kind of milk is not too common and few problems can be traced to this factor alone. In combination with other activations it may be significant.

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FACTORS RELATED TO PRODUCTION OF "SUSCEPTIBLE" MILK

Several conditions are thought to stimulate production of milk highly susceptible even to mild activation treatments and/or "spontaneous" milk. These are:

1. Advanced lactation. Breeding schedules that allow most of the herd to come into late lactation at the same time pose a potentially serious rancidity problem.
2. Mastitis.
3. Dry winter feed. This is one reason why the defect often occurs in the winter. Milk from cows on pasture generally is less susceptible to rancidity.
4. "Heat" period may cause an increase in susceptibility, but this is of short duration.
5. Any illness that results in a sudden drop in production may be followed by rancidity problems.

CONTROL MEASURES . . . FARM

Whether or not factors in items 1 through 5 above are present to encourage rancidity development, controls must be continuously applied:

1. Use only inflations that are in good condition. Cracks or holes permit entrance of air that can cause turbulence. Agitation and foaming result.
2. When installing pipeline milkers keep the pipeline as close to the cows as possible. Air entering at the "claw" and bubbling up the milk hose is potentially hazardous. Pipelines far above cows require long hoses and allow agitation to take place over a longer period of time.
3. If "in-line" strainers are used be sure joints on either side are airtight before milking. Lines "broken" at this point at each milking may not be properly tightened.
4. Keep pipeline joints on the vacuum side airtight. Any leak is a source of trouble.
5. Minimize the number of "risers" in the line. When milk is raised to a higher level turbulence and foaming occur when the line is not filled with milk. Risers in a "full" line will not be serious sources of activation.
6. Do not operate pumps and releaser systems continuously if a full head of milk is not available at all times. Automatic control systems can be installed to activate pumps or releasers only when the milk jar is full. After the jar is emptied the pump and releaser automatically shut off.
7. Minimize or eliminate splash as milk enters cans or bulk tanks.
8. Keep milk cold. The most common cause of rancidity is agitation and foaming; the reaction progresses much faster at warm temperatures. Milk coming from a cow at body temperature is highly reactive. Quick cooling is essential.
9. Feed adequate levels of good quality feed. Undernourished cows may produce susceptible milk.
10. Shut off vacuum while transferring milking machine to next cow. Keep sufficient vacuum to prevent milking machines from falling off cows.

CONTROL MEASURES . . . PLANT

1. Keep milk cold.
2. When separating milk at 80° to 90°F. avoid cooling cream and holding for long periods or holding cream at separation temperature. When cream is to be held prior to pasteurization and churning, 120°F. holding temperature may be advisable if the holding time is short.
3. Carefully check flow sequence when pasterurizers are shut down for repair or lack of milk. Don't recycle raw milk. In market milk operations prevent cycling homogenized-pasteurized milk into raw milk lines.
4. Never let pumps operate in a starved condition. Minimize raw milk pumping stations. Avoid "risers" in processing lines which may carry insufficient milk to fill the line.
5. Avoid air leaks in processing lines and equipment.

CHARACTERISTICS OF THE RANCIDITY REACTION

When milk is activated rancidity generally progresses to a level and then tapers off. If no further activation takes place the established level remains. Additional treatment will cause further reaction and a new, higher plateau.

The rate of reaction depends on type of activation, temperature, and susceptibility of milk. Homogenization can cause detectable rancidity in a few seconds; agitation and foaming may cause an off-flavor in a few minutes or a couple days, depending on milk susceptibility and severity of agitation. Temperature activation and "spontaneous" rancidity usually require 12 hours or more for detectable rancidity levels to occur.

If a milk supply, previously activated, is nearly at a detectable rancidity level further activation of any kind may cause off-flavor to quickly develop. The reaction must progress only for a short period of time before exceeding the critical level.

METHOD OF MEASURING RANCIDITY

A simple procedure for measuring rancidity has been developed by the University of Minnesota, Department of Dairy Industries. The procedure is sensitive enough to detect potential problems before objectionable off-flavor results, yet is simple enough to be run on a routine basis.

A copy of this procedure for determining acid degree value may be obtained upon request to the author, 136 Dairy Industries Building, University of Minnesota, St. Paul 1.

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