Relation of the Use of Tygon Plastic Tubing to the Incidence of Solar Activated Flavor in Milk Products

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Introduccion

Most of the common off-flavors in milk are acquired in one or more of the following ways:

1. Substances absorbed by milk from the surroundings.
2. Substances contained in the feed of the cow which are secreted with the milk.
3. Bacterial action in milk.
4. Variations in the chemical composition of milk.
5. Chemical changes occurring in milk.

The Oxidized Flavors

Of the flavors produced by chemical changes in milk, the ones due to oxidation are the most common and troublesome. Oxidized flavors in milk, also referred to as "cappy", "carboard", "oily", "talowy", "metallic", and "burnt", have been considered to be one of the most objectionable and serious defects in fluid milk.

The factors causing the oxidized flavors in milk can be divided into three groups: Metal contamination, solar activation, and spontaneous factors.

The off-flavors results from chemical changes due to oxidation. This reaction is catalysed by metals such as copper and iron, and by direct and diffused daylight.

The Tygon Plastic Tubing

Tygon B44-4 is a transparent flexible plastic tubing especially developed for the handling of milk and milk products. Its use in the dairy industry is relatively recent, and has been found to be very practical and highly adaptable to the different phases of dairy processing plant operations. Because of its transparency, it transmits light, which produces off-flavors in milk and milk products.

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The purpose of this investigation was to determine the influence of tygon plastic tubing in the production of solar activated flavor in milk products.

Review of Literature

The Oxidized Flavors

Most investigators agree in the causative factors of oxidized flavors in dairy products. Nelson and Dahle (11) state that oxidized flavor may be caused by light, metal catalyst, and spontaneous factors (direct from the cow). Brown and Thurston (1), after reviewing the literature, concluded that an oxidized flavor can be developed in dairy products due to copper, sunlight and the presence of oxygen. Several other factors, such as, season, temperature, and feed, were found to be involved in the production or inhibition of the flavor.

A pronounced oxidized flavor is produced in milk and dairy products, due to metal contamination specially copper and iron. Foster (6) stated that oxidized flavor is produced in milk, by copper contamination, and subsequent temperature. Dunkley (4) attributed the development of an oxidized flavor to a mild oxidation of lipid materials in milk, particularly the phospholipids.

The Action of Sunlight

Stull (12) states that light from either, natural or artificial sources, causes chemical changes in a minor whey protein constituent of milk. These changes give rise to the development of an off-flavor commonly referred to as activated flavor. Henderson and Roadhouse (9) concluded that by exposing cream to direct sunlight, diffuse light, or to the action of copper, the susceptibility of milk fat to oxidation is increased. Hammer and Cordes (8) state that sunlight has a pronounced effect on the flavor of milk and cream, and that with sufficient exposure a definite tallowy flavor was produced and with less exposure a distint "off" flavor developed. They observed that "off" flavors developed in samples of milk after an exposure of only 10 minutes, and definite tallowy flavors after exposures of 45 minutes. Frazier (7) concluded that a "carboard" taste and "linseed oil" odor develops in whole milk exposed to diffuse daylight for 8 hours, at about freezing temperature. The light apparently acts as a catalyst in the oxidation of the milk fat.

Tracy and Ruehs (13) concluded that two flavor defects resulted from the exposure of milk to sunlight, one a tallowy and the other a burnt flavor. The burnt flavor seemed to be due to an action upon the milk serum rather than the fat, since the effect was stronger in skim milk than in whole milk. Flake, Weckel, and Jackson, (5) state that evidence is found that if milk bottles can be devised which will eliminate the wave length of light less than 4600 A, the activated flavor caused by exposure of milk to sunlight will not develop. Daan and Myers (3) state that the burnt flavor caused by sunlight apparently

is due to an effect on the casein-free and albumin-free serum of milk. Chilson (2) states that when milk in clear glass bottles is exposed to direct sunlight, even for a short time, the flavor will change sufficiently to affect the palatability of the product.

Kende (10) was the first to report that oxidized flavor was caused by an enzyme system present in milk. Chilson (2) suggested that an enzyme was present in skim milk which catalyses the oxidation of the fat, since the oxidized flavor did not develop in milk prepared from skimmilk which had been heated to 170° F for 30 min. and then mixed with unheated cream.

Experimental Procedure

For the determination of the minimum time required for the production of solar activated flavor in milk products, 250 ml samples were put into pieces of tygon plastic tubing, 12 inches long and 1.5 inches in diameter, and placed in strong sunlight. The sunlight exposure periods for pasteurized and homogenized milk were 15, 10, 5, 2, and 1 minutes; for pasteurized skim-milk 20, 15, 10, 5, 2, and 1 minutes; and for raw milk 30, 20, 15, 10, and 5 minutes. The samples were tasted immediately after exposure, kept under refrigeration at 45° F in darkness and retasted.

The off-flavor developed in the samples was scored according to the following numerical scale:

Very Strong	4
Strong	3
Distinct	2
Slight	1
None	0

Results and Discussion

Effect of Sunlight on the Flavor of Pasteurized and Homogenized Whole Milk.

The data in table 1 show that the minimum time to produce a noticeable solar activated flavor in pasteurized and homogenized whole milk is close to 10 minutes under strong sunlight. An exposture of 15 and 10 minutes produced a strong to very strong off-flavor, noticeable immediately after exposure.

TABLE 1.—Effect of Sunlight on the Production of Activated flavor in Pasteurized and Homogenized Whole Milk.

Exposure Time (min.)	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5	
	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later
15	3	—	4	—	3	—	4	—	3	—
10	3	—	4	—	3	—	3	—	3	—
5	0	3	0	4	0	4	1	4	0	4
2	0	3	0	3	0	3	0	3	0	4
1	0	1	0	1	0	0	0	1	0	0

An exposure of 5 and 2 minutes produced no off-flavor, but after 24 hours of cold storage in darkness all the samples tested showed strong to very strong off-flavors. One minute exposure produced no off-flavor in any of the samples, and after 24 hours of storage a slight off-flavor was detected in three of the samples.

The results of the test in table 2 show that the minimum exposure time to produce solar activated flavor in pasteurized skim-milk is between 15 to 20 minutes.

An exposure of 20 minutes produced a strong to very strong solar activated flavor in all the samples immediately after exposure to strong sunlight. An exposure time of 15 minutes produced a slight off-flavor in two of the five samples tested, and after 24 hours of storage all the samples were found to have a strong to very strong off-flavor. Exposures of 5, 2, and 1 minutes did not produce the solar activated flavor in skim-milk immediately, but after 24 hours of storage, samples exposed for 5 and 2 minutes had developed very strong to distinct off-flavor, while the samples exposed for 1 minute had a slight to distinct off-flavor.

Results in table 3 show that the minimum exposure time required to produce the solar activated flavor in raw milk is 20 minutes. All the samples developed a strong off-flavor immediately after an exposure of 30 minutes, while four of the five samples produced a slight off-flavor after an exposure of 20 minutes. Immediately after exposures of 15, 10, and 5 minutes none of the samples developed any off-flavor, but after 24 hours of storage, a distinct off-flavor was detected in most of the samples exposed for 15 and 10 minutes, and four of the five samples exposed for 5 minutes showed no off-flavor.

TABLE 2.—Effect of Sunlight on the Production of Activated Flavor in Pasteurized skim-milk.

Exposure Time (min.)	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5	
	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later
20	3	—	3	—	3	—	4	—	3	—
15	1	4	1	4	0	4	0	4	0	4
10	1	3	0	4	0	4	0	4	0	4
5	0	3	0	4	0	3	0	2	0	3
2	0	3	0	4	0	1	0	2	0	2
1	0	1	0	2	0	1	0	1	0	1

TABLE 3.—Effect of Sunlight on the Production of Activated Flavor in Raw Milk.

Exposure Time (min.)	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5	
	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later	After Expos.	24 Hrs Later
30	3	—	3	—	3	—	3	—	3	—
20	1	2	0	2	1	2	1	2	1	2
15	0	2	0	2	0	2	0	2	0	2
10	0	2	0	2	0	1	0	2	0	1
5	0	0	0	0	0	1	0	0	0	0

CONCLUSIONS

The minimum exposure time to produce the solar activated flavor in milk products varies with the product tested. The results of *this* investigation indicate that the minimum exposure time is between 5 and 10 minutes for pasteurized and homogenized whole milk, 15 to 20 minutes for pasteurized skim-milk, and 20 minutes for raw milk. Shorter exposures reduced the development of the solar activated flavor in all milk products.

The solar activated flavor was found to develop during storage in the dark in samples that did not have the off-flavor immediately after short exposure to strong sunlight. In all cases the intensity of the off-flavor was highly increased after storage.

The minimum exposure time to produce solar activated flavor after 24 hours of storage in the dark was found to be 1 minute for pasteurized and homogenized whole milk, and pasteurized skim-milk, and between 5 to 10 minutes for raw milk.

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