Skunkweed Flavor

In

Cream and Butter

By
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What Can Be Done About "Skunkweed Flavor"?

The research reported herein showed that the so-called "skunk-weed flavor" which develops in butter in some sections of Oklahoma during May and June is due to the eating of two weeds by cows. One is wild carrot, the other mule's tail (also called mare's tail).

The wild carrot alone sometimes produces the undesirable flavor in mild form; but in the Experiment Station's tests the skunkweed defect was never definite or strong except when the carrot was fed in combination with the mule's tail.

The defect cannot be avoided by removing cows from the affected pastures a few hours ahead of milking time. It was always found at least 12 hours after milking, and sometimes as much as 48 hours afterward.

Spraying pastures with 2,4-D to kill the carrot plants showed indication of being an effective control; but on the type of pasture most commonly affected it seems unlikely that the benefit obtained would repay the cost of spraying. On suitable land, some consideration might be given to the possibility of a general pasture improvement program to increase production as well as remove weedy growths.

The only positive prevention of this butter defect apparently is to keep cows off of pasture containing wild carrot and mule's tail while those plants are growing rapidly. This usually would be through May and June, but could be earlier or later, depending on seasonal conditions.

The skunkweed flavor does not appear in fresh milk or cream. It does develop in cheese as well as in butter manufactured from milk produced by cows grazing on pastures containing wild carrot and mule's tail.

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SKUNKWEED FLAVOR IN CREAM AND BUTTER

A Study of Its Cause and Prevention

By H. C. OLSON, R. F. BEACHBOARD, R. E. ANDERSON, AND L. F. EDMONDSON*

For several years, butter plants in the southwest section of Oklahoma have encountered a defect in butter which is commonly called "skunkweed flavor." The defect usually is prevalent during the months of May and June in the butter churned from cream produced in the "black jack" areas characterized by hilly terrain, sandy soil, and the predominance of black jack oak** among the trees in the area. The defect was apparently due to the consumption by the cows of some weeds or brush, because the defect was seasonal and was present only in the cream produced from the "black jack" pastures.

Operators of Oklahoma butter plants replying to a questionnaire estimated the annual loss at from $10,000 to $60,000, depending on the prevalence of the defect in different years.

At the request of the dairy industry of Oklahoma, and with the cooperation of the Oklahoma State Department of Agriculture, the Oklahoma Agricultural Experiment Station undertook research aimed at finding the cause of the defect and methods of eliminating it.

The research followed three principal lines: (1) Feeding trials made to identify the plant or plants causing the defect; (2) butter manufacturing trials, made in search of a treatment which would eliminate the defect from affected cream; and (3) experiments aimed at devising a test for identifying affected cream prior to churning.

Before experimental work was started, a questionnaire was sent to all butter-making plants in Oklahoma to determine the extent of the defect, time of occurrence, and the losses that had been suffered.

Nature and Extent of the Defect

CHARACTERISTICS

The so-called "skunkweed flavor" is an odor which develops in butter. It is very similar to the odor emitted by the common skunk (*Mephitis mephitis*). The defect cannot be detected in the fresh milk, fresh cream, or fresh butter.

No reference to this defect could be found in the literature. Claydon and Hammer*** isolated from butter an organism with a skunk-like odor, but this organism produced the odor in milk and cream as well as in butter.

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**Shrub and weed species mentioned in the text by their common names are identified by their scientific names in the Appendix, page 22.

***T. J. Claydon and B. W. Hammer, "A skunklike odor of bacterial origin in butter," **Jour. Bact.**, 37:251-258 (1939).

The defect generally becomes evident in the butter within 24 to 48 hours after churning, and it increases in intensity for several days thereafter. There apparently is no decrease in intensity during extended storage.

Milk and cream which will produce butter having the defect have an off-flavor characterized as "weedy," but this flavor defect is unlike that which develops in the butter. Experienced buttermakers can grade out some of the defective cream, but the latent nature of the defect makes accurate grading impossible.

The authors have never detected the defect in old cream, although some creamery operators believe it is occasionally present to a slight degree.

The urine from cows producing milk with skunkweed defect has a slight odor suggesting that of the common skunk.

GEOGRAPHIC EXTENT

Of 43 butter plants which replied to a questionnaire, 20 reported having had trouble with skunkweed flavor, and 23 reported no trouble. Most of the skunkweed cream appeared to come from Caddo, Washita, Kiowa and Comanche counties in the southwest section of Oklahoma (Figure 1). A few reports of cream having this defect came from adjacent areas and from scattered points elsewhere in the state.

Replies to the questionnaire indicated that skunkweed flavor in butter was first noticed about 1934, and the majority of the plant operators believed that the defect was becoming more common in the affected areas.

No reports of this defect in butter had been received from outside Oklahoma until late in 1952, when a sample of butter with a rather typical skunkweed defect was received from a butter grader in Canada. This butter was manufactured in a country creamery near Edmonton, Alberta.

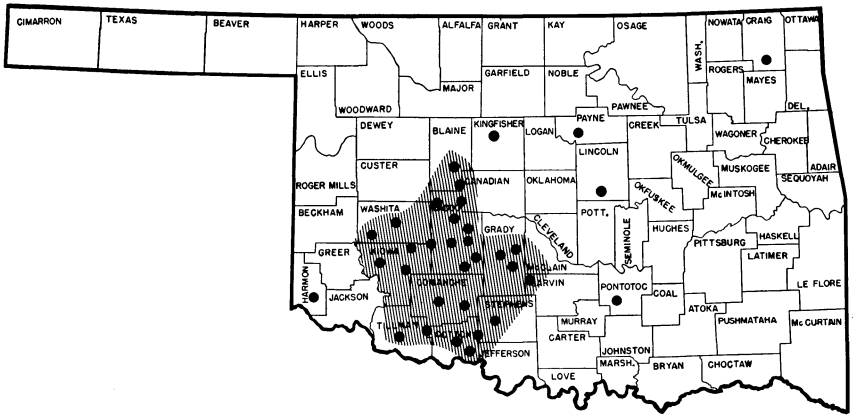


Figure 1.—The shaded portion of this map of Oklahoma shows the portion of the state where the skunkweed flavor defect in butter apparently was most prevalent at the time these studies were made. The dots indicate location of butter plants which reported in 1944 that they had difficulty with this defect in 1943 or prior years.

SEASONAL INCIDENCE

The majority of the plants which replied to the questionnaire expected the defect to appear about April 15 to May 1 each year, and to be most intense during the months of May and June. Some plants reported that the defect was present in their butter as early as April 1, and others reported it present as late as July 30.

TIME OF APPEARANCE IN BUTTER

A majority of the plant operators reported that the skunkweed flavor was present in butter to a slight degree one day after churning, and that it increased in intensity on holding. The opinions varied greatly, but the consensus was that the defect was distinct within 7 days and pronounced within 10 days.

Test for Identifying Affected Cream

The need of a test for detecting cream which would produce the skunkweed defect after churning was evident. Therefore search for such a test was immediately undertaken. Samples of cream known to produce butter having this defect were mixed with various acids, alkalis, oxidizing agents, reducing agents, etc., in an effort to find something which would produce an odor or other reaction indicating presence of the defect.

It was found that one part of concentrated nitric acid mixed with four parts of cream caused a skunk-like odor to develop in about 15 minutes. This nitric acid test was thereafter used in selecting herds of cows for experimental work, and for determining the prevalence of the defect in different areas. It is also available for use in butter plants to sort out shipments of cream containing the defect, in order to avoid mixing it with other cream and thereby contaminating the entire batch.

Source of the Defect

GENERAL EXPERIMENTAL PROCEDURE

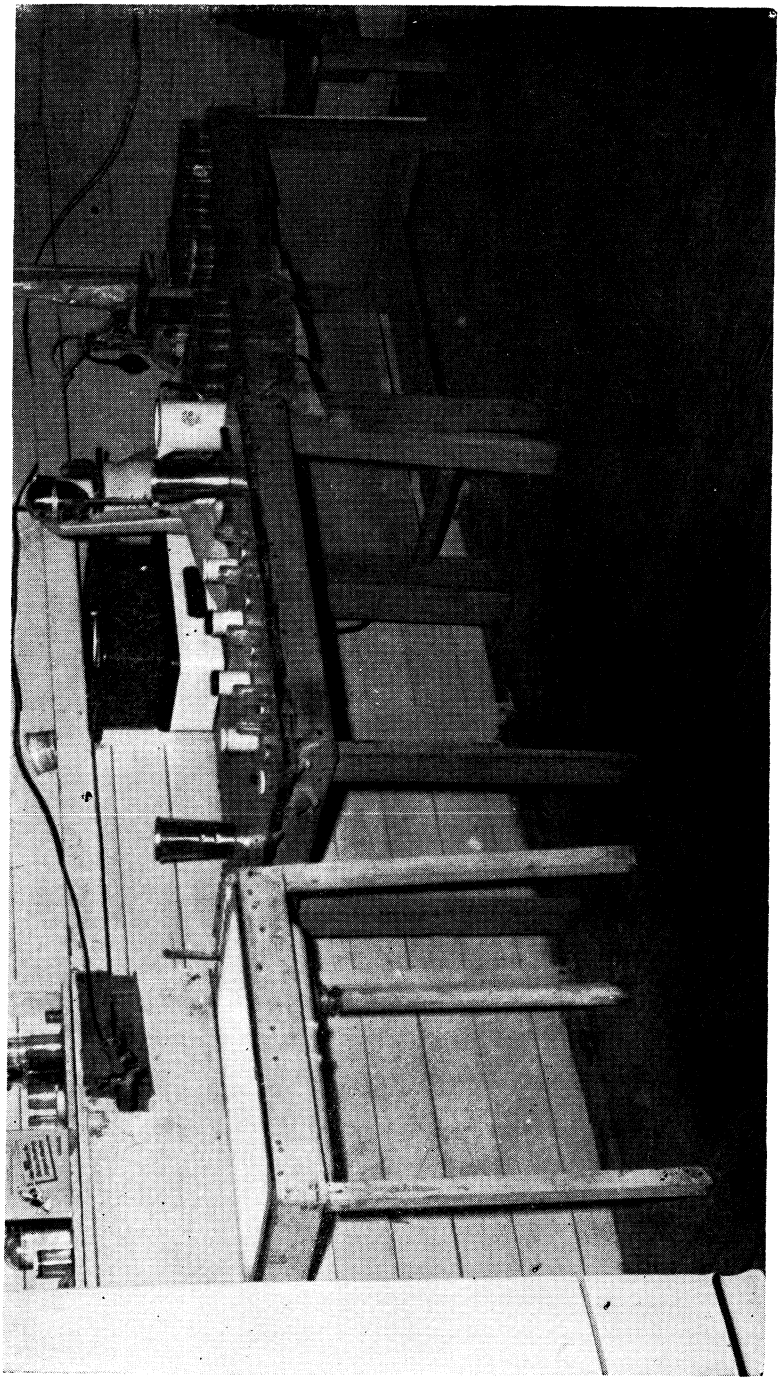
The feeding trials were conducted on farms in the vicinity of Anadarko, Okla., using cows from herds producing milk which carried the skunkweed defect. A temporary laboratory with equipment for holding cream, churning small samples of butter, and holding butter samples for test, was set up each year as near as possible to the source of the milk.

Feeding and Handling Cows

Weeds being fed experimentally to cows in dry lot were freshly pulled or cut just prior to being fed. Some weeds were unpalatable and were eaten rather sparingly. In such cases, the cow was given all of the weed she would consume and the weed was then mixed with good quality alfalfa hay or freshly cut grass to induce her to eat more of it.

In comparisons involving pasture, cows were confined to the desired area by electric fences or by tethering.

A small amount of dairy feed was given each cow at each milking to maintain body weight and milk flow.



A portion of the field laboratory and equipment used at Anadarko, Okla., in studying skunkweed flavor in cream and butter. Additional laboratory work was done in the Station dairy products laboratory at Stillwater.

One of the herds of dairy cows used in the feeding trials, grazing in a skunkweed pasture.

Churning and Testing Butter

The cows were milked twice daily and the cream separated on the farm. After the milk from each cow was separated, the separator bowl was emptied and flushed with warm water to prevent mixing of cream from different cows. In the 1949 and 1950 trials, cream samples were (with a few exceptions) obtained after each milking.

The cream samples were usually held cold over night in a household refrigerator and then churned in an electric malt mixer. During the churning enough water was added at intervals to keep the cream circulating. Ice water was used with samples of fresh cream or uncooled cream to insure a firm body on the butter. After draining the buttermilk, the butter granules were washed by adding cold water and mixing for a few seconds and then draining. The butter was worked by placing it on a piece of wet butter parchment paper and kneading by hand to expel the excess water. In case salt was to be added, the required amount was weighed out and worked into the butter after the excess water had been worked out. The samples were packed in 2-ounce aluminum-capped cream sample bottles, or in parchment paper, stored in a household refrigerator, and observed at intervals (usually daily) for evidence of the skunkweed odor. The intensity of the defect was observed by smelling and tasting.

Variations reported in intensity of the defect while cows were on skunkweed pasture may have been due to variations in the amount of weeds consumed by the cows, or perhaps by variations in evaluation of intensity by the persons doing the scoring.

PRELIMINARY TRIALS

With Woody Plants

Since cream with the skunkweed defect was invariably produced by cows feeding on pastures having a variety of trees and shrubs, it was at first thought that the defect was caused by the consumption of the leaves and sprouts of one or more of these woody plants. However, dry-lot feeding of leaves from various shrubs, including skunk brush, western buckeye, black jack oak sprouts, and hop tree, failed to produce the defect. Subsequently, cows were confined to pasture areas free from trees and shrubs; these cows continued to produce cream having the skunkweed defect.

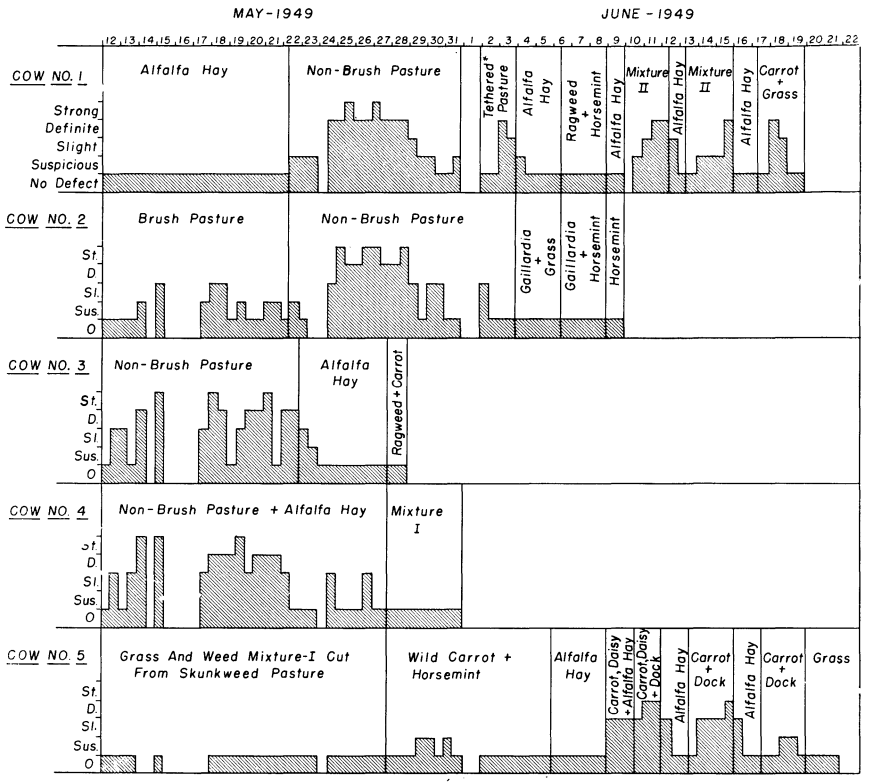
With Weeds

Various weeds found growing in the pastures were pulled by hand and fed to the cows in dry lot.

Many of the weeds were apparently unpalatable, and even after all other feed was withheld for 12 hours or more the cows ate them rather sparingly. These unpalatable weeds were also observed to be avoided by the cows grazing in the pastures. They include dotted horse mint, perennial ragweed, capitate croton, showy gaillardia, and wild alfalfa.

Weeds eaten more readily included western daisy, wild carrot, field sorrel, curly dock, peppergrass, mule's tail, hairy sunflower and Pursh's plantain. None

View of a portion of a skunkweed pasture showing some of the great variety of weeds growing in the skunkweed areas. The predominance of other weeds in this picture makes it impossible to distinguish the weeds (mule's tail and wild carrots) which cause skunkweed flavor.



*Tethered in non-brush pasture.

Chart I.—Relation of plants fed to dairy cows to development of skunkweed defect in their butter, 1949. Degrees of the defect are: 1, none; 2, suspicious; 3, slight; 4, definite; and 5, strong. A complete break in the line for no defect indicates no sample was taken at that milking.

of these weeds when fed singly or in combination with alfalfa hay or grass produced the skunkweed defect in cream.

EXPERIMENTS IN 1949

Five cows were used in trials made in 1949. Chart I shows, for each animal, the feed used and the intensity of the skunkweed defect.

Brush vs. Non-Brush Pasture

The pastures grazed by Cows Nos. 2 and 3 from May 12 to May 22 were adjacent. All shrubs and trees were removed from the non-brush pasture grazed by Cow No. 3.

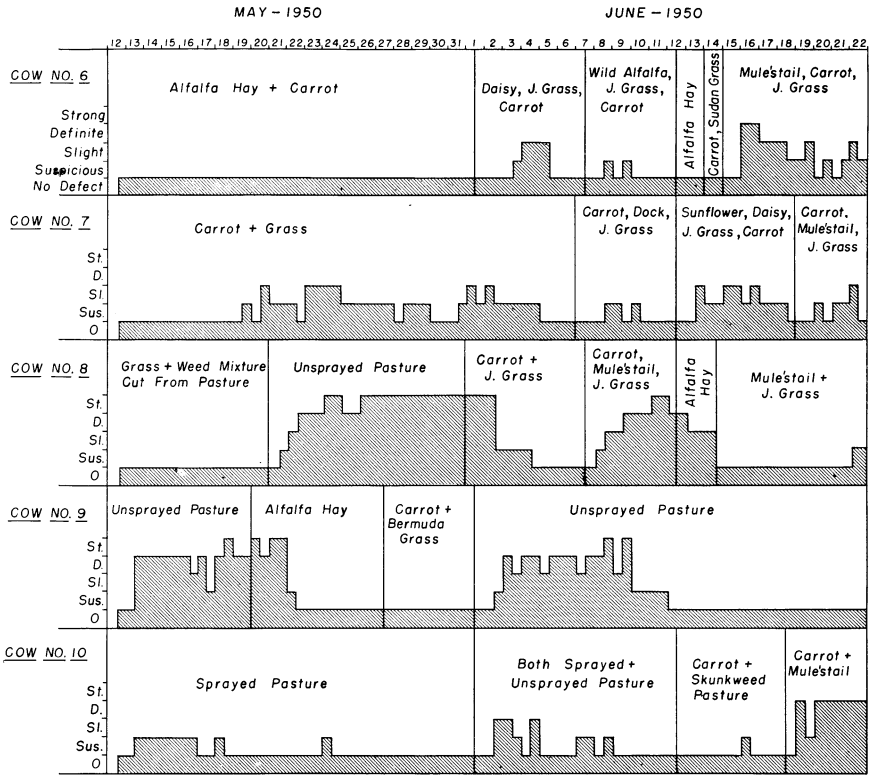


Chart II.—Relation of plants fed to dairy cows to development of skunkweed defect in their butter, 1950. Degrees of the defect are: 1, none; 2, suspicious; 3, slight; 4, definite; and 5, strong. A complete break in the line for no defect indicates no sample was taken at that milking.

Butter from both cows had the skunkweed defect, but the intensity was greater in that from Cow No. 3 on the non-brush pasture. When No. 2 was switched from the brush to the non-brush pasture on May 22, the intensity of the defect increased instead of diminishing.

Supplemental Feeding

Cow No. 4 was allowed free access to good quality alfalfa hay, in addition to the grain concentrate fed at milking time, and was also allowed free access to the non-brush pasture. She consumed some of the hay every day, but seemed to prefer obtaining part of her food requirement by grazing. The intensity of the defect remained high despite the supplemental feeding.

Cuttings from Skunkweed Pasture

An area of mixed grass and weeds in a skunkweed pasture was cut with a lawn mower and fed in dry lot to Cow No. 5 from May 12 to May 28. The

skunkweed defect did not appear. Nor did it appear in butter from Cow No. 4 when she was fed a similar mixture May 28 to 31. But June 10 to 12, and again June 13 to 15, a mixture cut from another pasture in the Anadarko area was fed to Cow No. 1; the defect appeared to a slight degree 12 hours after feeding and was definite 36 hours after feeding.

Mixtures of Weeds

Specific weeds in various combinations, or with grass, were fed as shown in Chart I. The only mixtures that gave any positive indication of skunkweed defect were the ones which included the wild carrot, but in no case was the defect as intense as that produced by cows on the non-brush pasture.

EXPERIMENTS IN 1950

Five cows were again used in the feeding trials in 1950. The sequence in which each animal received various feeds is shown in Chart II, together with the intensity of skunkweed flavor produced.

Combinations Including Wild Carrot

The effects of various weed and feed combinations are summarized in Table I. Some degree of the skunkweed defect developed in the butter in every combination which included wild carrot, except when Cow No. 6 was fed alfalfa hay in addition to the carrot (May 12 to June 1) and when No. 9 was fed Bermuda grass in addition (May 27 to June 1).

The skunkweed defect was produced in all combinations which included mule's tail with the wild carrot. When Cow No. 8 was fed wild carrot, mule's tail and Johnson grass, the intensity of the defect was as great as that produced by skunkweed pasture. The defect was not as intense in later trials, but those trials were made toward the end of the "skunkweed season," as indicated by the disappearance of the defect from the cream of Cow No. 9 about June 12 while she was on unsprayed pasture.

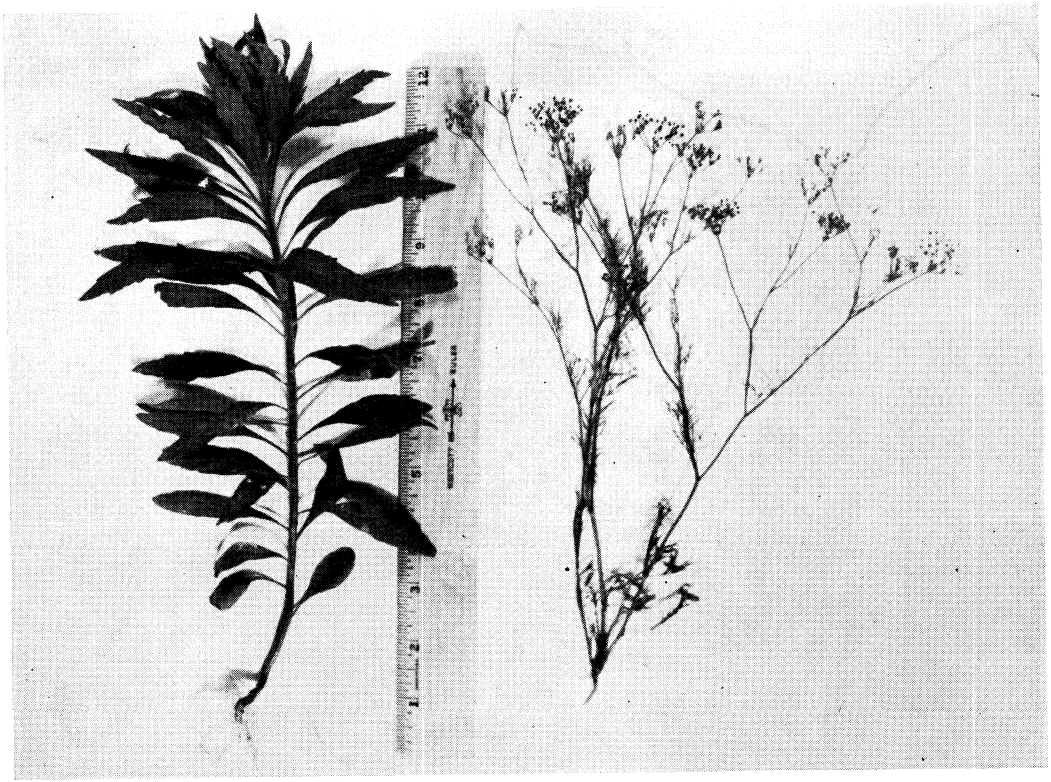
The defect disappeared when Cow No. 8 was fed mule's tail and Johnson grass June 15 to June 20, although it had been definite or strong a few days earlier when these two plants were being fed in combination with the wild carrot.

Effect of Herbicide Used on Pasture

A portion of the experimental pasture area was sprayed with 2,4-D on May 2. The spray killed many of the weeds; but some of the wild carrot plants, although twisted and stunted, survived and made enough growth to be consumed by cows to a limited extent. Butter from Cow No. 10 on the sprayed pasture never developed more than a slight skunkweed defect, while that from Cow No. 9 on an adjacent but unsprayed area showed the defect to a definite to strong degree.

Relationship of Feeding Time and Defect

The time required for appearance of the defect in the milk, and for its disappearance after a change in feed, is indicated in both Charts I and II.



The weeds which cause skunkweed flavor. Left, mule's tail or mare's tail; right, wild carrot. This picture, taken at the peak of the skunkweed season, shows mule's tail in an early stage of growth, while the wild carrot was beginning to develop seeds.

Table I.—Intensity of skunkweed flavor defect in butter as related to weeds and feeds consumed by cows, 1950. Summarized from Chart II.

Cow No.	Dates	Weeds and feeds fed	Maximum intensity of skunkweed defect
6	May 12-June 1	Wild carrot, and alfalfa hay	None
6	June 1-June 7	Wild carrot, Western daisy and Johnson grass	Slight
6	June 7-June 12	Wild carrot, wild alfalfa and Johnson grass	Very slight
6	June 15-June 22	Wild carrot, mule's tail and Johnson grass	Definite
7	May 12-June 6	Wild carrot and Bermuda grass	Slight
7	June 7-June 12	Wild carrot, curly dock and Johnson grass	Very slight
7	June 12-June 18	Wild carrot, hairy sunflower, Western daisy, and Johnson grass	Slight
7	June 19-June 22	Wild carrot, mule's tail and Johnson grass	Slight
8	May 12-May 20	Mixture of grass and weeds cut from skunkweed pasture	None
8	June 1-June 7	Wild carrot and Johnson grass	Very slight
8	June 7-June 12	Wild carrot, mule's tail and Johnson grass	Strong
8	June 14-June 22	Mule's tail, and Johnson grass	Very slight
9	May 27-June 1	Wild carrot, and Bermuda grass	None
10	June 12-June 18	Wild carrot, and pasture	Very slight
10	June 18-June 22	Wild carrot, and mule's tail	Definite

APPEARANCE AFTER FIRST FEEDING

When Cow No. 1 was shifted on the morning of May 22, 1949, from alfalfa hay in dry lot to grazing the non-brush pastures, butter samples were suspicious 12 hours afterward and definite by 60 hours afterward (Chart I). When No. 1 was fed a mixture of weeds and grass (evening of June 9 to noon June 12, 1949), the defect was present to a very slight degree in 24 hours and was definite in 48 hours.

When Cow No. 8 was put in the unsprayed pasture on May 21, 1950, the defect was very slight after 24 hours, slight after 36 hours, definite after 48 hours, and strong after 84 hours (Chart II). When No. 9 was placed in the unsprayed pasture on May 12, 1950, the defect was absent at the 12- and 24-hour intervals but was definite at the 36-hour interval.

DISAPPEARANCE AFTER LAST FEEDING

When Cow No. 3 was taken off non-brush pasture after the evening milking on May 22, 1949, intensity of the defect decreased to slight in 12 hours and to very slight in 24 hours (Chart I). Another indication that the defect persists for at least 12 hours may be seen in the record for Cow No. 1 when she was removed from pasture on June 3, 1949.

When Cow No. 8 was put on alfalfa hay in dry lot on June 12, 1950, the defect remained slight after 48 hours and did not entirely disappear until the 60-hour interval (Chart II). When No. 9 was put on alfalfa hay in dry lot on May 20, 1950, the defect was still strong at 48 hours, very slight at 60 hours, and did not disappear until the 72-hour interval.

Experiments With Manufacturing Processes

The butter industry employs several processes and practices to minimize or eliminate flavor defects in cream and butter. Several of these were tested for their effect upon the skunkweed defect.

NEUTRALIZATION

Sour cream known to possess the skunkweed defect was divided into five 400 gm. lots, placed in 8 oz. glass jars, and treated as follows:

Lot 1. Raw cream. No treatment.
Lot 2. Neutralized to 0.20% and pasteurized.
Lot 3. Neutralized to 0.10% and pasteurized.
Lot 4. Neutralized to 0.00% and pasteurized.
Lot 5. Neutralized to −0.10% and pasteurized.

The lots of cream, except Lot 1, were neutralized to .30% with caustic soda and then to the desired level of acidity (calculated as lactic acid) with sodium sesqui-carbonate. The cream tested 38% butterfat and had an initial acidity of .65% (calculated as lactic acid). The samples that were pasteurized were heated to 150° F. held for 30 minutes and cooled, using a water bath provided with

steam for heat and water for cooling. The samples were churned in a malted milk mixer, and the unsalted samples thus obtained were observed for skunkweed flavor at daily intervals for several days.

None of the treatments had any apparent influence on the intensity of the skunkweed defect. Pronounced neutralizer flavor in Lots 4 and 5 failed to mask the skunkweed flavor.

PASTEURIZATION

It was theorized that if enzymatic action were involved in producing the skunkweed defect, it might be reduced by pasteurization at higher temperatures or by immediate pasteurization of the fresh cream.

Milk from cows fed wild carrot and mule's tail was separated, and the fresh cream divided into three lots of approximately 300 grams each. Lot 1 was untreated, Lot 2 was pasteurized at 160° F. for 30 minutes, and Lot 3 pasteurized at 180° F. for the same length of time. The cream was churned as soon as it was sufficiently chilled, and the unsalted butter observed at daily intervals for several days. This experiment was repeated three times, using cream from successive milkings. All the samples developed the skunkweed defect, although it seemed to be slightly more intense in the butter from the cream pasteurized at 160 degrees than in the raw cream butter, or the butter from cream pasteurized at 180°.

VACUUM PASTEURIZATION

To test the effectiveness of vacuum pasteurization in removing the defect, about one gallon of sour, skunkweed cream was handled in a manner simulating vacuum pasteurization in a commercial butter plant. The cream was neutralized to 0.20% acid, heated to 170° F., and then drawn slowly by vacuum into a 5-gallon glass jug partially immersed in a water bath at 140° F. The cream struck at a tangent and flowed down the inside wall of the jug, to give maximum exposure to the vacuum. An aspirator maintained a vacuum of about 26 inches of mercury in the jug so that the cream boiled rather vigorously. The vacuum was maintained for about 30 minutes after all the cream had been drawn into the jug.

Butter churned from the vacuum-treated cream developed the skunkweed defect to about the same degree as did the butter from a portion of the cream that was pasteurized at 150° F. for 30 minutes but not vacuum treated. The discharge from the aspirator indicated some removal of odor from the cream, but the principles causing the skunkweed flavor apparently were not removed.

ADDITION OF OXIDANTS AND ANTI-OXIDANTS

If the skunkweed defect results from an oxidizing action, the addition of anti-oxidants should inhibit the development of the defect, and the addition of copper to catalyse the oxidizing reaction should speed up its development. Therefore fresh cream from cows fed mule's tail and wild carrot was divided into five 300-gram samples and treated as follows:

Lot 1. 400 ppm ascorbic acid added to raw cream.

Lot 2. 0.01% (of weight of fat) N.D.G.A. anti-oxidant, then pasteurized.

Lot 3. .5% oat flour added, then pasteurized.

Lot 4. 1 ppm copper (as $CuSO_4$) added.

Lot 5. 1 ppm copper (as $CuSO_4$) added, then pasteurized.

The pasteurized samples were heated to 150° F. for 30 minutes. After adequate chilling, the samples were churned and the butter wrapped in parchment and observed for the skunkweed defect at daily intervals for several days.

The test was replicated three times, using cream from three successive milkings.

None of the treatments had any apparent influencing in either increasi ıg or decreasing the intensity of the skunkweed defect.

Separation of Fat and Serum

Milk from cows fed wild carrot and mule's tail was separated, cooled, and churned within two or three hours after milking. Part of the freshly churned butter was heated to about 110° F. and the fat and serums of the melted butter separated in a separatory funnel. Samples of the serum and of the fat were observed for the skunkweed defect immediately after separation and at intervals later while in cold storage.

The skunkweed defect was principally present in the fat, and appeared to be as intense as in the butter from which it was obtained.

In another test, a portion of the fresh skunkweed cream was extracted with ethyl ether. After the ether was evaporated off, the fat was held at room temperature. This fat developed the skunkweed defect.

Trials Using Weed Extractives

Attempts were made to extract the skunkweed principle from several weeds. These included western daisy, horse mint, gaillardia, carrot, mule's tail, ragweed, sunflower, pepper grass and curly dock, as well as other weeds found in skunkweed pastures.

The freshly cut or pulled weeds were ground in a food grinder. A portion of each ground weed was steeped in normal, fresh cream for about 3 hours, the weeds strained out, and the cream then churned into butter. Another portion of each ground weed was extracted successively with water, ethyl alcohol, acetone and ethyl and petroleum ethers, the extracts combined and condensed to a small volume by subjecting to vacuum treatment at 145° F. The condensed extract was mixed with small portions of normal butter and the mixtures observed for skunkweed defect during cold storage. None of the samples developed any evidence of the skunkweed defect. No combinations of weeds or weed extracts were used in these trials.

Skunkweed Flavor in Cheese

A few reports of skunkweed flavor in cheese were received during the course of this research, and one sample of cheese with a slight skunkweed odor was submitted to the Station's dairy laboratory. To investigate this, wild carrots and mule's tail were fed to cows in dry lot until the nitric acid test showed the defect was present in the cream. Ten gallons of the milk was then obtained and transported to the laboratory at Stillwater, where it was pasteurized and made into cheddar cheese. The cheese was ripened at about 50° F. and observed at intervals for the skunkweed defect. The fresh cheese had a weedy flavor, and a typical skunkweed odor developed within a week. The defect increased with intensity on continued holding and was rather strong after one month of ripening. The cheese still had a strong skunkweed odor one year after manufacture and there apparently was no decrease in intensity of the defect during the extended ripening period.

Summary and Conclusions

A flavor defect commonly called "skunkweed flavor" develops within 24 to 48 hours after churning in butter made from cream produced in the sandy and hilly areas in southwestern Oklahoma during the months of May and June. The defect is not present in the milk or cream or freshly churned butter.

A test developed for skunkweed cream has proved useful in grading out cream with the defect.

Controlled grazing trials established that skunkweed cream is produced by cows feeding on both brush and non-brush pastures in the affected area, and that the intensity of the defect was greater when the cows were grazing on the non-brush pastures.

Experimental feeding established that the defect was due to consumption by the cows of two weeds common in the area: wild carrot (*Spermolepis echinata*) and mule's tail or mare's tail (*Erigeron canadensis*). The wild carrot when fed alone or in combination with weeds or feeds other than mule's tail occasionally resulted in the defect, indicating that the carrot is the key weed. However, a definite or strong skunkweed defect was not produced unless the carrot was fed in combination with mule's tail.

The defect developed in butter churned from cream produced 12 to 24 hours after feeding the causative weeds. It persisted in the milk for at least 12 hours to as long as 48 hours after the causative weeds were removed from the cows' ration.

Supplemental feeding of alfalfa hay to cows on skunkweed pastures did not minimize the intensity of the defect.

Spraying a skunkweed pasture with 2,4-D eliminated the defect, but the affected pastures are generally so poor that the benefits gained from better quality cream would probably be more than offset by the cost of spraying.

Cheddar cheese made from milk produced by cows fed wild carrot and mule's tail developed the skunkweed defect.

Various treatments which might be applied to the cream in the manufacturing plants failed to minimize or eliminate the defect. These included pasteurization of the cream immediately after separation, neutralization to different levels of churning acidity, variations in pasteurization exposures, vacuum treatment, addition of anti-oxidants, and addition of chemicals intended to neutralize the flavors.

Separation of the fat and serum fractions of skunkweed butter indicated that the odor was principally present in the fat.

Butter containing extracts prepared from various weeds did not develop the skunkweed defect.

Appendix

List of Weeds Used In Feeding Trials

Common Name	Scientific Name
Alfalfa, Wild	*Psoralea tenuiflora* Pursh
Buckeye, Western	*Aesculus arguta* Buckl.
Carrot, Wild (Bristly fruited spermolepis)	*Spermolepis echinata* (Nutt.) Heller
Croton, Capitate	*Croton capitatus* Michx.
Daisy, Western	*Bellis integrifolia* Michx.
Dock, Curly	*Rumex crispus* L.
Gaillardia, Showy (Indian blanket flower)	*Gaillardia pulchella* Foug.
Hop Tree (water ash)	*Ptelea trifoliata* L.
Horse Mint, Dotted	*Monarda punctata* L.
Mule's Tail (Mare's Tail)	*Erigeron canadensis* L.
Oak, Blackjack	*Quercus marilandica* Muenchh.
Peppergrass	*Lepidium apetalum* Willd.
Plantain, Pursh's (Poor Joe)	*Plantago purshii* R+S
Ragweed, Perennial	*Ambrosia psilostachya* D C
Skunkbrush (Ill-scented sumac)	*Rhus trilobata* Nutt.
Sorrel, Field	*Rumex acetosella* L.
Sunflower, Hairy	*Helianthus mollis* Lam.