STATISTICAL CORRELATION BETWEEN CONSUMER REACTION AND ORGANOLEPTIC ANALYSIS OF FEED FLAVORED MILK

by

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INTRODUCTION

The consumption of a food or beverage is regulated more by its flavor than by any other factor. It has been reported that 75 percent of the customer complaints about off-flavors in milk are caused by feeds that are consumed by the cow (9,17,22). This importance of off-flavors in milk caused by feeds, focused attention on the need for an objective study of consumer reaction and organoleptic analysis of milk produced and handled under controlled conditions.

Feed flavors can enter milk two ways: by absorption, and through the body of the cow. Milk left in an open container may absorb certain feed and other abnormal flavors. According to Babcock (3), absorbed odors as a source of off-flavors in milk probably have been overemphasized. Warm milk absorbs odors more readily than cold milk, but milk cartons or bottles left unclosed or only partially closed in the home refrigerator can become tainted if held for an extended period of time in an atmosphere saturated with odors.

The most important source of feed-flavors is through the body of the cow. This occurs when the cow inhales the odors and they are transmitted from the lungs through the blood and into the mammary system. Off-flavor compounds also come from feeds eaten by the cow. From the digestive tract, they are transmitted through the blood and into the mammary system. This origin of feed flavors in milk will be dealt with in this study.

Trout (57) reported that too many milk processors and distributors become aware of objectionable flavor in their milk by consumer complaint. Good business principles would seem to dictate routine product flavor examination to eliminate products containing "objectionable flavors" before they are allowed to reach the consumer.

Research has been conducted to find ways to reduce the intensity of feed flavors by both good management practices on the part of producers and flavor standardization by processors. The ability to utilize feeds, responsible for objectionable flavors in milk, to maximum advantage, would be of economic benefit to the dairy industry.

Work has been done to determine the value of consumer preference panels (2,13,23,25,27,39,41,45) and "trained" or "experienced" panels (25,27,36,44). This author was unable to find any studies in which attempts were made to correlate panel judgment of milk to actual consumer reaction.

The objectives of this study were to establish:

1. How consumers would react to milk with various degrees of off-flavor produced from cows on sorghum silage and rye and brome pastures.

2. If an "experienced flavor panel" could consistently indicate consumer acceptance of the various degrees of these three flavors.

It is hoped this material will be of value to milk processors and distributors as well as a guide for future research in this field.

LITERATURE REVIEW

Development of Feed Flavor Research

One of the first reported references to off-flavors in milk was concerned with a feed flavor. Strobel (55) reported in a review of literature that in 1757, Bradley found milk from cows fed fresh turnip leaves and roots had a bitter flavor. He also observed that the milk would not be bitter if the leaves and roots were cut and held two or three days before feeding. Soon after, other observations (55) generally indicated that roughages have a more pronounced effect on the flavor of milk than grain concentrates. Reports from many organized sources concerning off flavors from feed imparted to milk began to appear in the 1890's and early 1900's.

Silage. Silage in general, and corn silage in particular, were the first feeds studied in relation to odors and flavors imparted to milk. King (29) demonstrated, in 1897, that corn silage fed shortly before milking gave a "sweetish" odor to the milk. In 1905, Knisely (30) reported taste comparisons of milk from silage-fed cows and nonsilage-fed cows. Of 372 comparisons, 60 percent of those tasting the milk favored the milk from nonsilage-fed cows, and 11 percent indicated no preference. He concluded that silage of good quality, when fed in reasonable quantities after milking, was one of the best feeds obtainable for dairy cows when pasture was not available.

Gambel and Kelly (21) found, in 1922, that silage which was fed one hour before milking was absorbed so quickly through the body of the cow that its taint was discernible in the milk. When a full ration of corn silage was fed and the feed was withheld during the five-hour interval before milking, Roadhouse and Henderson (47), in 1935, observed that objectionable feed flavors and odors were eliminated.

In 1956, Owen et al. (42) found stronger feed flavors in the milk when cows were fed from crowded openings in a trench silo rather than from an open manger. More recently, McCormick reported several significant factors concerning transmission of silage flavors to milk. Results of his experiment showed that flavor scores dropped off almost as much when cows merely breathed the odors as when they ate the feed. Furthermore, it was hypothesized that the only reason eating the silage is worse than breathing it, is because of a double odor. This second odor comes when the cow brings the feed past her air intake as she chews her cud. During this natural process, the cow breathes the odors a second time.

Other important factors relating to the strength of off-flavors in milk due to silage are the moisture content of the silage and the ventilation in the proximity of the silage being consumed (46). McCormick (36) stated "the greater the moisture content (of silage), the stronger the flavor." The logical explanation for this would seem to be generally poorer quality with greater possibility of spoilage and mold growth in high moisture silage. Better quality silage in which this moisture has been converted to proper acid levels would tend to inhibit spoilage. Feeding inside closed buildings allows odors to permeate and saturate the atmosphere so they are breathed continually, while feeding silage outside or in well-ventilated buildings lessens flavors from these surrounding odors (37).

Rye. Conflicting views have been reported in connection with off-flavors in milk due to consumption of rye pasture. Babcock (4) as early as 1925, found that when dairy cows ate 15 pounds of green rye one hour before milking, slight abnormal odors and flavors could be detected in the milk. If the quantity of rye consumed was increased to 30 pounds, the off-flavors and odors were increased slightly. He also reported that feeding 30 pounds of green rye immediately after milking had no effect on the flavor of the milk produced at the next milking.

In 1944, Trout and Harwood (58) published results of an experiment comparing odor of milk from June grass pasture, with Balboa rye and common rye pastures. The average feed odor of the milk resulting from the June grass pasture was negligible; that from Balboa rye was slight to distinct and that from the common rye was distinct to very pronounced. Characteristic differences, aside from intensity, in the odors of milk from cows on Balboa rye pasture were not offensive, but might be described as "grassy," very similar to that resulting from early bluegrass pasture. However, milk from cows on common rye was decidedly offensive, suggesting sodium hydroxide, soap, or even, when very intense, a fish odor. A summary of the results by Trout and Harwood (58) indicates that Balboa rye pasture does not have as adverse an effect on the odor of the milk as common rye.

In 1944, Herman and Garrison (26) at the Missouri Experiment Station, reported a method of grazing Balboa rye and Missouri Early Beardless barley which did not produce objectionable flavors in milk. Cows were grazed on the Balboa rye three to four hours daily and the milk was sampled one to two hours after the cows were removed from the pasture. The milk produced showed slightly different, but not objectionable flavor, when analyzed organoleptically on 18 successive days. The relative flavor score of the milk produced was high and it was concluded that neither the Balboa rye nor the Beardless Winter barley produced undesirable flavors in milk.

Reports from studies at the Kansas State Experiment Station (10,12,38) indicated a strong off-flavor was generally encountered in the milk when cows were pastured on Balboa rye until shortly before milking. This flavor was very objectionable and often described as "fishy." These flavors were less objectionable when the cows were removed from the pasture four hours before milking.

Bromegrass. Trout et al. (59), in 1940, found that milk from cows milked three times daily, which were on alfalfa-bromegrass pasture, had a very strong feed flavor, whereas cows on a comparatively mature sudangrass pasture had no feed flavor. In a second trial, cows were grazed on alfalfa-bromegrass pasture following the morning and noon milking and left in the barn after the night milking. The night milk had a more intense off-flavor which was offensive, nauseating, and suggestive of soda neutralizer; the noon milk showed a very strong feed flavor; and the morning milk had no feed flavor. These workers concluded that cows milked three times daily must graze within the "harmful five-hour period" prior to milking in order to obtain sufficient nutrients even when fed a grain mixture.

Observations regarding an unclean flavor in milk produced by feeding bromegrass were reported by Foreman et al. (19) in 1959. About ten percent of cows pastured on bromegrass developed an undesirable, unclean milk flavor to which customers objected. According to these workers the flavor does not always appear in the milk as it leaves the udder, but may develop after holding one or two days. After longer grazing, the flavor is strong and persistent. It is not reduced by pasteurization nor removed by "vacuumizing" or by condensing three to one. Dilution experiments suggest that as little as ten percent of the milk with the defect can cause a flavor intensity objectionable to the customer. The defect has been controlled by limited pasturing of bromegrass, supplemental hay feeding, and removing cows from the pasture at least four hours before milking.

Economic Importance of the Feed Flavor Problem

Competition for the consumer's food dollar is becoming more apparent with every passing day. There are two areas in which the economic importance of the feed flavor problem asserts itself.

First, the most efficient and economical production of milk depends largely upon the ability of the cow to utilize large amounts of roughage feeds which are generally responsible for objectionable feed flavors. Secondly, consumption of a product depends upon its acceptance by the public, and acceptance of a food or beverage depends to a large degree upon its flavor qualities.

Davies (15) showed production was not affected by removing cows from pasture at least three hours before the afternoon milking. He stated that this procedure is confidently recommended as the simplest and most efficient method of reducing feed flavors. Opinions expressed by men following this technique were that the herd milked better, the grade of cream was consistently higher, the cows were cool and quiet when being milked, and were always quite ready for milking.

In a recent survey, Dunkley (17) reported off-flavors in milk caused by feeds in 127 of 169 samples of pasteurized milk collected from eight widely separated cities with population of 100,000 or more. Lewis et al. (32) observed feed flavors in 69 percent of evening and 21 percent of morning milk samples when roughage was fed ad libitum to dairy cows.

Downs et al. (16) reported flavor criticisms of milk judged in collegiate student contests after World War II. These results showed feed as the only criticism in 15.7 percent and feed, in addition to some other criticism, in 24.3 percent of the samples. This is a total of 40 percent of the samples, which were collected throughout the country, showing feed flavor criticisms.

Babcock (3) claimed that flavor controls to a large extent the quantity of milk consumed. Public health officials and dietitians agree that per capita consumption of milk and milk products is lower than it should be from a public health standpoint. By improving the flavor of milk, we can, therefore, improve the health of our nation.

Trout (57) stated, "the dairy industry must pay more attention to the flavor of its products in order to protect itself against the potential competitor of other foods." People drink milk primarily because they like it. The secondary reasons are because they have the known assurance that it is nutritionally valuable and has been produced and handled in a hygienic manner.

Causes and Control of Feed Flavors

Much experimentation has been done and many articles published about various causes and methods of controlling feed flavors. It is not the purpose of this thesis to elaborate on this topic extensively. Therefore, an attempt will be made to relate only references which generally outline the effects of various treatments on milk flavor.

Basically, there is one cause of objectionable feed flavors in milk and two ways to control these flavors (1). The cause is the transmission of flavor and odor compounds from feeds to milk. The two control measures are: 1. Proper management of dairy herds to allow these feed flavor compounds to be eliminated from the system before the cows are milked, and 2. The use of flavor standardization equipment by processors.

Several authors (14,18,19) have reported that one can of "grassy" milk is sufficient to impart objectionable flavor and odor when mixed with 2,000 gallons of normal milk. Crowe (14) stated that the sudden change to a succulent roughage must be avoided. Flagg (18) listed these herd management practices to eliminate feed flavors:

1. Start a herd on early flush pastures no longer than one hour in the morning.
2. Take cows off pasture no less than five hours before milking.
3. Leave cows off pastures at night.

Gholson (22) advised that getting away from strong grassy flavors from fresh lush pastures by "break-in" periods of two to three hours for the first two to three days when changing from winter feeding. He also stated that after five hours, most off-flavors are practically gone.

Roberts (49) has classified flavor standardization equipment into three categories. Type I is a double chamber vacuum unit with plate heater and no steam injection. Type II uses a steam heater as well as a plate heater and two vacuum chambers. Type III permits use of excess steam injection as the pasteurizer (milk is heated with live steam to 194^{o} F. to satisfy minimum U.S.P.H.S. requirements for pasteurization).

Various degrees of effectiveness in removing objectionable flavors have been reported. These reports (6,7,10,11,48,49,52, 53,60) all agree that the amount of off-flavor removal is related to intensity of treatment as measured by temperature differentials and the amount of flash steam created. Roberts (49) concluded that vacuum treatment without the creation of considerable flash steam does not appear to remove the quantity of feed flavor desired by most plants during the off-flavor season. Smith et al. (53) reported vacuum treatment of milk is effective in producing a uniform fine-flavored milk. Such a product should increase sales and consumer acceptance of milk; however, flavor removal equipment should in no way be a substitute for quality control programs at the farm level.

Taste Panels and Consumer Acceptance

Roberts (48) proposed that the senses of taste and smell are valuable tools for testing flavor substances, but they often leave something to be desired in terms of objectivity. Research work may eventually produce chemical tests which will detect abnormal flavors in milk. This fact may lead to methods of measuring the intensity of abnormal flavors which will be much more accurate than can be obtained organoleptically. At the present time, however, objective chemical methods of flavor analysis are not refined enough to be of general use. For this reason, organoleptic analysis is still the best method of evaluating flavor in foods and beverages.

Bernard (5) observed that at top efficiency the olfactory mechanism can detect as little as two trillionths of a gram of a strong smelling chemical. No laboratory instrument can duplicate this. Peryam (44) established that most individuals are more sensitive when hungry. The nose has a remarkable talent for adaption. When an odor is strong, Bernard (5) states, "you automatically tune down the volume" by a process known as odor fatigue. The first scent is powerful, the second weaker, until eventually the odor cannot be detected. Unfortunately, this phenomenon of odor fatigue also reduces the awareness of odors that one is around continuously. Ishler et al. (27) suggested that fatigue seems prominent in tasting some types of food products, while it is practically negligible in others.

Crist and Seaton (13) found great variance among consumers in the sensitivity of the senses. Scent shows itself to be less sensitive and even less accurately discriminative than taste. Two authors (13,40) reported that taste alone cannot be relied upon. Scent and taste together, however, increase sensitivity and repeatability.

Mitchell (39) outlined "inherent difficulties" in consumer reaction tests. In the laboratory or the home, the very fact that a test is being conducted presents difficulties. For example, in a test situation there is strong evidence that the subject is motivated to respond as he thinks he "ought to." The consumer is not always conscious of a sensation transference and many times will attempt to hide its existence by rationalizing his response. The most serious problems of sensory testing methods according to Hanson (23) concern people, since they are the measuring instruments. Individuals vary in the degree of difference they can distinguish, in their response at different times, and ability to identify a particular flavor in the presence of other flavors. Consumer preference tests determine whether there is a difference in consumer preference, the magnitude of preference, whether changes in flavor affect preference or acceptability, and whether an original preference is maintained after repeated tests.

Hedrick et al. (25) report that many factors are involved in the selection of panel members or organization and management of sensory panels to obtain reliable flavor data. Such factors as panel size and guidance, ability and personal habits of members, management of the samples, and proper analysis of the data all enter into the accuracy of the results obtained. These workers concluded that valuable information on consumer acceptance of foods including dairy products can be obtained from valid consumer acceptance panels.

General conditions necessary in consumer preference tests were outlined by Platt (45).

1. Must have representative sample of public concerned.
2. Study must be as unbiased as possible.
3. Must not know identity of the samples.
4. Must give independent opinions.

Special considerations for food preferences are:

1. Judgment should be made under natural conditions for consumption of the given food.
2. Remember there is a tendency for a stronger flavored product to predominate over a milder, more delicate flavor.

3. Guesses must be eliminated by proper statistical analysis.

Arnold (2) found a large, well-balanced advisory committee of housewives gave the most valuable results in consumer research. He stated, "any inclination for us to doubt the ability of a consumer group to express preferences and reasons therefore has ceased." He stressed the importance of a consumer preference group operating in their home under normal conditions.

Peryam (44) proposed that establishing food quality by "trained panel" judgment has value for two reasons: it gives better discrimination between items than do consumer preference tests, and it is easier to conduct since fewer people are required. Hanson (23) presented the advantage that a selected, trained panel is able to detect very small differences under ideal conditions; however, these differences must be considered in their proper perspective to be useful.

Methodology of sensory evaluation has been standardized to a limited extent, but is not routine. With trained or experienced panels it is possible to establish a routine method and improve repeatability of performance.

Flavor analysis experiments should be designed for appropriate statistical analysis. Differences may be expressed by scores, ranks, or by indicating which of three samples differs from the others. Hanson (23) found it easier and safer to use rank or the triangular difference tests than scores. Scores are used more frequently than the other method. Care must be taken, however, to interpret score results on a relative basis rather than on an absolute basis. Crist and Seaton (13) reported that rank correlation instead of linear correlation can often be better used to analyze taste panel results.

Overman and Jerome (41) suggested two methods of analysis. The first includes a preliminary study and evaluation of the tabulated data in which the range, number of duplicated judgments and the absolute deviations from means were used. The second was the use of the analysis of variance to measure the consistency of each judge. A high ability to detect differences, together with a low variability in duplicating judgments, are indications of good judging.

Harrison and Elder (24) discussed a number of applications of statistics to taste-testing. Correlation coefficients between a trained panel and a consumer panel are presented. Lillard and Day (33) obtained linear relationships and correlation coefficients when comparing objective chemical tests with flavor threshold values.

Mitchell (39) cautioned that there must be sound basic controls and psychological principles present to achieve validity in evaluating consumer reaction. The statistical interpretation technique does not automatically make a test or experiment valid.

EXPERIMENTAL PROCEDURE

Organizing the Consumer Group[1]

Forty multiple-quart customers from a commercial retail route which was supplied by the University Dairy were selected for the consumer group. Included among these customers were families of various sizes and age groups, and different social and economic classes. These customers were sent a letter requesting their participation in a milk flavor research study. A copy of this letter may be found as Exhibit 1 in the Appendix. A personal interview was conducted with each of these customers at his home to answer questions about the study shortly after the letters were sent out. Points stressed during this interview were:

1. During the study, all milk received by the customer would be in quart paper containers.
2. They would not receive experimental milk every day during the study period.
3. When they did receive experimental milk, it would be only part of their order for that day.
4. Cartons of milk that were in any way objectionable should be returned the next delivery day.
5. Any comments of customers were asked for by note or phone call.
6. All milk rejected would be gladly replaced with regular herd milk.

It was also explained that the customers were free to withdraw from the study at any time they wished. One customer withdrew before the end of the study for fear of upsetting a baby formula,

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[1] Referred to hereafter as consumers or customers.

but the other 39 completed the experiment.

The customers were divided into three groups of equal size and designated A, B, and C. During the study, two groups received experimental feed flavored milk as part of their order each delivery day and the third group served as the control. The order of control groups was altered so no pattern was evident.

Organizing the Trained Panel[1]

Milk was analyzed organoleptically by three experienced milk flavor analysts, according to the procedure of the National Collegiate Students Dairy Products Judging Contest. Milk scores range from 40 with no criticism to 30 with various types and intensities of off-flavors. Before the study, the following null hypothesis was proposed:

1. No significant complaints would be received from customers for milk scored from 37 to 40 by the panel.
2. Milk scored 34 to 35 would not be acceptable to half of the customers.
3. Milk scored 32 or below would be completely rejected.

The panel analyzed both control and experimental samples on the afternoon of the same day they were delivered to the consumer. Each day approximately five samples were tempered to 60° F. and presented to the panel for evaluation and scoring.

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[1] Referred to hereafter as the panel.

Obtaining Samples

Seven cows from the Kansas State University dairy herd, representing four breeds, were utilized in this study. The cows, two Holsteins, two Ayrshires, two Guernseys, and one Jersey were selected to eliminate the possible effect of different breeds reacting in a characteristic way to the feeds. The cows were in early to middle stages of lactation and all were producing over 35 pounds of milk per day. At no time during the two months of this study were either the consumers or the panel informed of what the cows were being fed.

The first feeding trial for the experimental cows involved sorghum silage. The silage employed was good quality sorghum silage preserved in a large trench silo with a concrete bottom. During this trial the experimental cows were kept in a dry lot about 50 feet downhill and generally downwind from the silo. The cows were fed all the silage they would eat two to three hours before the afternoon milking. They ate from an open manger in the dry lot. Silage was the only roughage fed during this part of the experiment.

Cows were separated from the rest of the herd and placed on the silage feeding trial Thursday morning, March 31. The first milk was collected from the Thursday afternoon milking. This milk was processed and bottled Friday. It was delivered to the consumers Monday morning and evaluated by the panel Monday afternoon.

Throughout all three feeding trials only milk from the afternoon milkings was used in an attempt to get maximum flavor development. The silage feeding trial was continued for two weeks. The cows were then put on a dry feed and hay ration from April 14 to April 20. This was done to eliminate any possible flavor carry-over from one feed trial to the next.

The same seven cows were then placed on a Balboa rye pasture Wednesday morning, April 20. The first milk sample for this trial was collected Thursday afternoon and processed and bottled on Friday. Delivery to the consumers was started again the following Monday morning and the panel made their first evaluation of this feed trial Monday afternoon.

The Balboa rye pasture used for this experiment was from 6 to 12 inches tall. It had been pastured heavily just prior to this trial with dairy heifers. The pasture was almost free of weeds, so it was ideal for this specific feed flavor study. Weather conditions had been dry except for one light shower after heavy winter snows six weeks prior to this feed trial.

The rye feeding trial was also continued for two weeks. Again the cows were placed on a dry feed and hay ration from May 4 to May 9 before the next feed trial was started.

On Monday morning, May 9, the experimental cows were placed on Achenbach bromegrass pasture. For this trial, the first sample was collected that same afternoon. This milk was processed and bottled Tuesday, delivered to the consumers Wednesday morning, and analyzed organoleptically by the panel Wednesday afternoon.

The bromegrass feeding trial continued until May 26 to allow time to study the effect of some variations in the methods of producing and processing the milk. These treatments will be explained in detail in the following section.

The bromegrass pasture was on good upland soil near the rye pasture. It had not been pastured heavily just prior to the flavor study trial, so was dark green and 15 to 18 inches high. During the trial the bromegrass developed to the "boot stage," and some was "headed-out" before the trial was concluded.

Processing and Preparing Samples

All milk samples were processed and prepared for delivery to the consumers on Monday, Wednesday, and Friday mornings and organoleptically evaluated by the panel on those same afternoons.

To be ready for Monday delivery and evaluation, samples had to be collected Thursday afternoon and processed and bottled on Friday. Wednesday samples were collected on Monday afternoons, and processed and bottled on Tuesday. Friday samples were collected on Wednesday afternoons, and processed and bottled Thursday.

The experimental milk was collected at the barn in 10-gallon cans, brought immediately to the University Creamery and cooled over a surface cooler to 40° F. Each batch of experimental milk was vat pasteurized at 145° F. for 30 minutes except for two batches from the rye feeding trial and three batches from the bromegrass feeding trial which were subjected to special treatments which will be described later.

The milk was homogenized by a two-stage homogenizer to a total of 2500 pounds per square inch and again cooled to 40° F. It was then bottled into Pure-Pak quart cartons which were code dated for identification purposes. Neither the panel nor the consumers were aware of the dating system used, so they could not distinguish between quarts of control milk and experimental milk.

The control milk used throughout the experiment was the regular herd milk from the University Dairy Farm. Roughages fed were good-to-average alfalfa hay and sorghum silage. Both roughages were fed shortly after milking.

Two batches of experimental milk from the rye feeding trial were subjected to special treatment. Experimental milk evaluated by the consumers and the panel on May 4 had been processed in a DeLaval Vacu-Therm H.T.S.T. pasteurization unit.[1] This is the unit described as a Type I vacuum treatment pasteurizer in the Review of Literature. The degree of treatment employed was 22 inches of vacuum with a pasteurization temperature of 166° F. The flash cooling in the second chamber to 148° F. resulted in a temperature differential of 18° F.

The special treatment used for the experimental milk received by the consumer and the panel on May 6 was to remove the cows from the rye pasture four hours prior to milking. This milk was then pasteurized by the regular vat method.

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[1] Referred to hereafter as Vacu-Therm.

Three treatments were introduced to the bromegrass experimental milk. The first two were the same as were employed for the rye experiment (described above). A third treatment combined the two previous treatments. On the last trial, the experimental cows were removed from the pasture four hours before milking, and this milk was pasteurized with the Vacu-Therm equipment. This was done in an attempt to determine if objectionable flavors could be eliminated from milk produced on feeds known to transmit strong flavors.

Analysis

A detailed record of the total number of control and experimental quarts of milk delivered to each customer was kept in a regular retail route book. Records of the panel evaluations were also collected throughout the study. The data obtained were analyzed statistically for each feeding trial according to methods explained in detail by Snedecor (54).

EXPERIMENTAL RESULTS

Sorghum Silage Feeding Trial

Table 1 shows the mean flavor scores that the panel placed on milk from the experimental cows during the two weeks they were fed sorghum silage. As was outlined previously, the mean flavor scores shown as control for each day were from the regular processed herd milk. Exact flavor scores and criticisms of every sample of silage experimental and control milk analyzed by each

Table 1. Comparison of average flavor scores by the panel to percent milk returned by consumers for the sorghum silage feeding trial.

Date	Sample	Average panel flavor scores	Percent returned by consumers
April 4	Experimental	37.6	0
	Control	37.6	0
April 6	Experimental	37.3	0
	Control	37.8	0
April 8	Experimental	37.3	0
	Control	37.6	0
April 11	Experimental	37.2	0
	Control	37.7	0
April 13	Experimental	37.5	6.7
	Control	38.0	0
April 15	Experimental	37.3	0
	Control	37.6	0
Mean average	Experimental	37.4	1.1
	Control	37.7	0

of the three judges appear in Table 10 (Appendix). The data in Table 1 show that while the mean panel flavor scores for the experimental milks were consistently lower than those for the control milks, the average difference was only three tenths of one point. Both the mean experimental average of 37.4 and the mean control average of 37.7 are within the range of the postulate[1] of no significant complaints from consumers for milk scored 37 to 40 by the panel.

[1] See null hypothesis, pp. 15 and 16.

Reaction by the consumers to the silage experimental milk was negligible, with only two quarts being returned by one customer. Table 11 (Appendix) shows the number of experimental and control milks delivered each day during the two-week trial. Two returns from the 196 total quarts of experimental milk delivered were so insignificant that correlation and regression coefficients were not calculated from the results of this feeding trial.

The F-test in the analysis of variance in Table 2 shows no significant differences among judges in their scores. The differences between the experimental and control milks were also found to be nonsignificant.

Table 2. Analysis of variance of flavor scores among judges and between milks for the sorghum silage trial.

Source	D/F	Ms	F
Judges	2	0.105	1.91 ns
Milks	1	0.160	2.91 ns
Residual	2	0.055	
Total	5		

Balboa Rye Feeding Trial

Mean panel flavor scores and percent of milk returned by the consumers during the rye feeding trial are shown in Table 3. Data in this table indicate that the mean flavor scores for the rye experimental milks were consistently lower than the control

Table 3. Comparison of average flavor scores by the panel to percent milk returned by consumers for the rye feeding trial.

Date	Sample	Average panel flavor scores	Percent returned by consumers
April 25	Experimental	32.8	31.0
	Control	38.0	0
April 27	Experimental	34.4	60.7
	Control	37.5	3.7
April 29	Experimental	32.5	50.0
	Control	38.3	4.2
May 2	Experimental	33.0	60.7
	Control	36.6	6.3
May 4	Experimental[a]	33.5	48.1
	Control	37.8	1.6
May 6	Experimental[b]	33.0	28.6
	Control	37.5	0
Mean average	Experimental	33.2	46.5
	Control	37.6	2.6

[a] Denotes that milk was processed by a Vacu-Therm pasteurization unit.

[b] Denotes that cows were taken off pasture four hours before milking.

milks. The range of these differences varied from 3.6 points on May 2 to 5.8 points on April 29. The control milks showed an average difference 4.4 points higher than the rye experimental milks.

The postulate that half of the consumers would not accept milk with a flavor score of 34 to 35 was incorrect on two days of the rye feeding trial and approximately correct on four days of this trial. Consumer reaction range from 28.6 percent of delivered quarts returned on April 25 to 60.7 percent returned on both April 27 and May 2.

Table 12 (Appendix) presents flavor scores and criticisms for each milk by each judge during the rye pasture study. Consumer reactions to these milks are presented in Table 13 (Appendix). A transformation was made from percent of milk returned to logarithmic values, because consumer reaction to flavor, when related to organoleptic scores, more closely follows a logarithmic rather than arithmetic relationship.

The sample correlation coefficient, r, between the panel flavor scores and the log percent of quarts returned by the consumers was 0.44. For the six comparisons in this trial, r must be 0.81 or greater to show a significant correlation.

The sample regression coefficient, b, between the panel scores and log percent of experimental milk returned by the consumers, was only 0.09. The regression coefficient of the null hypothesis gives so large a deviation that there is no linear relationship between panel scores and consumer acceptance of the experimental milk for this rye feeding trial.

The analysis of variance in Table 4 shows no significant differences among the three judges' scores of the experimental and the control milks. The differences among the four milks, however, were significant even at the one percent level.

Table 4. Analysis of variance of flavor scores among judges and milks for the rye trial.

Source	D/F	Ms	F
Judges	2	0.135	0.11 ns
Milks	3	15.020	12.11 **
Residual	6	1.240	
Total	11		

The results of an LSD test at the five percent level in Table 5 show a significant difference between the control and all three experimental milks, but no significant differences among the three experimental milks.

Table 5. Least significant differences (LSD)* of flavor scores among the four milks in the rye trial.

Ordered array of milk samples	Sum of mean panel scores	Differences and their significance		
		Exp.[a] LSD	Exp. LSD	Exp.[b] LSD
Control	113.2	12.7 *	13.2 *	14.2 *
Experimental[a]	100.5		0.5 ns	1.5 ns
Experimental	100.0			1.0 ns
Experimental[b]	99.0			

Achenbach Bromegrass Feeding Trial

Data in Table 6 show that the mean panel flavor scores for all the bromegrass experimental milk were lower than scores for the control milk. These differences range from 0.3 point on the

Table 6. Comparison of average flavor scores by panel to percent of milk returned by consumers for the bromegrass feeding trial.

Date	Sample	Average panel flavor scores	Percent returned by consumers
May 11	Experimental	37.4	14.3
	Control	37.7	0
May 13	Experimental	33.9	12.5
	Control	37.9	0
May 16	Experimental	33.7	33.3
	Control	37.5	1.6
May 18	Experimental	33.0	33.3
	Control	38.3	0
May 20	Experimental	32.9	26.7
	Control	38.3	1.5
May 23	Experimental[b]	35.0	17.8
	Control	37.8	4.3
May 25	Experimental[a]	32.0	16.7
	Control	37.0	0
May 27	Experimental[c]	33.7	7.1
	Control	37.5	0
Mean average	Experimental	33.9	20.0
	Control	37.7	0.9

[c] Denotes that cows were taken off pasture four hours prior to milking and Vacu-Therm pasteurization of that milk.

first day of the bromegrass feeding trial to 5.4 points on May 20. The average difference between all the experimental milks and the control milks was 3.8 points. Consumer reaction ranged from 7.1 percent of milk returned on May 27 when special management of cows and treatment of the milk was followed, to 33.0

percent returned on May 16 and May 18.

A surprising result occurred on May 25 when the mean panel score was 32.0 (lower than at any other time during the experiment) and the percent of consumer returns was only 16.7. This deviates greatly from the hypothesis postulate of complete consumer rejection of milk scored 32 or below by the panel.

Table 14 (Appendix) may be referred to for complete daily results of flavor scores and criticisms by all three panel members for every sample of milk analyzed during the bromegrass feeding trial. A complete record showing number of quarts of control and experimental milks delivered to and returned by the consumer during this feed trial is presented in Table 15 (Appendix).

The sample correlation coefficient, r, between the panel flavor scores and the log percent of quarts returned by consumers for the bromegrass feeding trial was 0.26. For the eight comparisons in this trial, r must be 0.71 or greater to show a significant correlation.

The sample regression coefficient, b, between the panel scores and the log percent of consumer returns was 0.04. This deviates so greatly from the null hypothesis regression coefficient that no significant linear relationship exists between the panel flavor scores and consumer acceptance of the bromegrass flavored milk in this study.

The analysis of variance in Table 7 shows no significant differences among the judges' mean scores of the milk samples.

Table 7. Analysis of variance of flavor scores among judges and milks for the bromegrass trial.

Source	D/F	Ms	F
Judges	2	2.505	1.11 ns
Milks	4	14.04	6.43 *
Residual	8	2.183	
Total	14		

There was a significant difference at the five percent level detected among the five different milks.

LSD tests at the five percent level on the mean panel scores reveal significant differences between the control and all the experimental milks (Table 8). The experimental milk from the cows taken off pasture four hours before milking scored significantly higher than did the three other experimental milks. Experimental milk that was subjected to Vacu-Therm pasteurization after the cows had been removed from the pasture four hours prior to milking was not scored significantly higher than the experimental milk without special treatment. The milk that received no special treatment was, however, scored significantly higher than the bromegrass flavored milk that was subjected to the Vacu-Therm pasteurization unit.

Table 8. Least significant differences (LSD)* of flavor scores among the five milks in the bromegrass trial.

Ordered array of milk samples	Sum of mean panel scores	Differences and their significance			
		Exp.[b] LSD	Exp.[c] LSD	Exp. LSD	Exp.[a] LSD
Control	113.2	8.3 *	12.2 *	13.0 *	17.2 *
Experimental[b]	104.9		3.9 *	4.7 *	8.9 *
Experimental[c]	101.0			0.8 ns	5.0 *
Experimental	100.2				4.2 *
Experimental[a]	96.0				

While there were no significant differences among judges on the means of all the scores during the bromegrass feeding trial, this analysis of variance shows a significant F-test for differences among judges on the milk sample from one day. Judge A scored all the samples presented on this day significantly lower than the other two judges.

Table 9. Analysis of variance of flavor scores among judges and the five samples of milk on May 25.

Source	D/F	Ms	F
Judges	2	12.61	8.35 *
Milks	4	19.85	13.15 **
Residual	8	1.51	
Total	14		

DISCUSSION

The lack of an off-flavor in the silage experimental milk as shown by both the panel flavor scores and the consumer reaction was the characteristic factor of the sorghum silage feeding trial. Because the experimental milks were consistently scored lower by the panel even though by only three tenths of a point, one might suspect a difference was realized, but not discriminated against. The negligible consumer returns substantiated this theory. Reasons for the lack of silage off-flavor may have been due to the high quality silage that was fed and because it was consumed outside. Unknown or unexplained factors could also be reasons for the negligible off-flavors found.

Reactions by both the panel and the consumers indicated a distinct difference between control milks and rye experimental milks. The reactions of the consumers deviated much more from day to day than did the panel flavor scores.

It is felt that both groups realized differences, but the panel discriminated in a "trained" manner while reactions of the larger numbered consumer group indicated more nearly consumer acceptance of the various levels of off-flavor. The basis of this observation is the fact that the panel showed no increase in scores for the milk subjected to the treatments designed to lessen off-flavors, while the consumers did show greater acceptance of these treated milks.

The fact that the correlation coefficient and linear relationship were not significant was probably also partially due to the different degrees of discrimination of the off-flavors by the panel as compared to the consumers.

Differences between control milks and experimental milks from the bromegrass feeding trial were less than for the rye feeding trial according to reactions of both the panel and the consumers.

No significant correlation or linear relationship between panel flavor scores and consumer reaction was evident for the bromegrass feeding trial. The reason for this can be understood more clearly by comparing panel scores with percent of milk returned by consumers on two successive days, May 23 and May 25. On May 23 experimental milk was scored 35.0 by the panel and 17.8 percent of this milk was returned by the consumers, while on May 25 the panel scores averaged a much lower 32.0 and the consumer returns were only 16.7 percent.

If the panel results were viewed as a true evaluation of the bromegrass experimental milk, removing the cows from pasture four hours before milking improved the flavor, while the Vacu-Therm pasteurization was detrimental. Combining both treatments showed no improvement when it was compared to the experimental milk with no treatment.

On the other hand, consumer reactions to the bromegrass experimental milk indicated an improvement in milk flavor with the various treatments. Experimental milk with no treatment was less acceptable than either of the milks with the separate treatments, and these milks were less acceptable than the milk with the combined treatment (Table 15, Appendix).

Whether the dairy industry is able to produce the most desirable food products economically will determine whether it gains, remains equal, or loses in the competition for the food dollar. Trout (57) indicated that a regular routine product flavor analysis program is essential. Necessary factors in a flavor quality control program are:

1. Competent personnel as analysts.
2. Suitable facilities for judging the products.
3. Inclusion of competitors' products with identities unknown.
4. Make known the findings to those responsible for procurement and production.

The results of a trained panel can be most helpful if the problem of inherent bias from trained discrimination responses is realized. Advantages of a trained panel in comparison to a consumer are ease of availability and economy.

The importance of consumer preference tests is emphasized by the lack of correlation between the trained panel and consumer reaction shown by this study. Flavor is the determining factor in the acceptance of a food, and the consumer in the final analysis is the judge, so determining the consumer's flavor preferences is essential. Volume acceptance and sales of food products are, in turn, necessary for economical production.

The most important limitations to consumer preference studies are the expense involved, sampling and bias difficulties, and lack of routine procedures developed to determine results.

The results and limitations of this study make the need for further work in this area very evident. Suggestions to make future studies more meaningful are:

1. Obtain pronounced off-flavors.

2. Select and work closely with a consumer group consisting of 15 to 20 families, representing different age groups, socio-economic classes, and backgrounds.

3. Deliver products to be analyzed daily so as to obtain more data for each treatment or effect studied.

4. Use an analysis of variance of consumer reaction to determine significance of the various treatments.

5. Repeat the type of study described herein with a larger number of comparisons, to determine conclusively if a significant correlation and linear relationship between a trained panel and consumer reaction can be obtained.

CONCLUSIONS

Based on the results of the experiment, the following conclusions may be drawn:

1. Insufficient off-flavors were developed in milks from the sorghum silage so that neither the panel nor the consumers distinguished significant differences between control and experimental milks.

2. Reactions of both the panel and the consumers indicate a significant difference between control and Balboa rye experimental milks.

3. No significant differences of panel flavor scores were found among rye experimental milks when cows were removed from pasture four hours prior to milking, when it was pasteurized with the Vacu-Therm HTST pasteurization equipment or when it was pasteurized at 145° F. for 30 minutes.

4. Differences between control milks and Achenbach bromegrass experimental milks were found by both the panel and the consumers.

5. Bromegrass experimental milk from cows removed from pasture four hours prior to milking was scored significantly higher by the panel than experimental milks processed by either the Vacu-Therm unit or vat pasteurization when these milks were from cows left on the pasture until just before milking.

6. Consumer returns were least when a combination of removing the cows four hours prior to milking and Vacu-Therm pasteurization of this milk was the treatment used.

7. An accurate prediction for consumer acceptance of both rye and bromegrass flavored milks could not be made from the panel flavor scores.

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APPENDIX

Exhibit 1. Letter to customers selected from the Monday, Wednesday, Friday route of Standard Dairy, asking their cooperation in the study.

March 28, 1960

Dear Customer:

Standard Dairy is cooperating in a research study that has been organized in the Dairy Department at Kansas State University. The effect of various types of feeds that are normally fed to dairy cows will be evaluated.

We would like for you to help us with this study. Your part in this experiment would be to simply notify us when any milk which you receive is at all objectionable. This could be done by exchanging this milk with the routeman on the next delivery date.

You are among forty multiple-quart customers, selected for this experiment. The study will be conducted in such a manner that on certain days a portion of your milk order will be milk that is to be evaluated. This milk is in every way normal milk. The point that we are trying to establish is which feeds, if any, produce flavors that would not be acceptable to you, the consumer.

The study will begin immediately and will last for approximately two months. If at any time during this period you wish to withdraw from this survey, you need only to notify Mr. Suelter, your routeman.

One of our representatives will contact you some time this week to explain the program in more detail and answer any questions you might have.

For your cooperation in this study we would like to discount your milk bill by ten percent for the duration of the test period.

Sincerely yours,

Feed Flavor Study
Dairy Department

Table 10. Panel flavor scores and criticisms for milk from cows fed sorghum silage.

Sample	Judge A	Judge B	Judge C	Average score
	Score criticism[1]			
April 4				
1. Control	38.0 sC	38.0 CF	38.0 C	38.0
2. Control	38.0 sC	35.0 sR	38.0 dC	37.0
3. Experimental	38.0 sF	38.0 dCsF	39.0 sC	38.3
4. Control	38.0 sC	37.5 CF	37.5 sR	37.7
5. Experimental	37.0 CF	37.0 dF	36.5 dF	36.8
Experimental average				37.6
Control average				37.6
April 6				
1. Control	38.0 sC	37.0 CF	38.0 sC	37.8
2. Experimental	38.0 sC	37.0 CF	37.0 sS	37.3
3. Experimental	38.0 sC	37.0 CF	37.5 C	37.5
4. Experimental	38.0 sC	36.5 CdF	37.0 CsS	37.2
Experimental average				37.3
Control average				37.8
April 8				
1. Control	38.5 sC	38.0 CsF	36.5 dC	37.7
2. Experimental	37.0 F	37.0 CF	37.5 sF	37.2
3. Control	38.0 sC	37.5 CsF	37.0 sF	37.5
4. Experimental	37.0 F	37.0 CF	37.5 dC	37.3
5. Experimental	37.0 F	37.0 CF	37.0 F	37.0
Experimental average				37.3
Control average				37.6

[1] Criticisms are designated by the following symbols in this table and subsequent tables.

s-slight	F-feed	U-unclean	B-bitter
d-definite	C-cooked	S-salty	R-rancid
h-strong	O-oxidized	P-putrid	M-malty

Table 10 (concl.).

Sample	Judge A	Judge B	Judge C	Average score
	Score criticism			
April 11				
1. Experimental	37.0 CF	37.0 dCsF	37.0 CF	37.0
2. Control	38.0 C	38.0 C	37.0 F	37.7
3. Experimental	38.0 sC	38.0 sCsF	37.0 CF	37.7
4. Experimental	36.5 CF	37.5 CF	36.5 F	36.8
Experimental average				37.2
Control average				37.7
April 13				
1. Control	38.5 sC	38.0 CsF	37.5 C	38.0
2. Experimental	38.0 C	37.0 dCF	38.0 C	37.7
3. Control	38.0 C	38.0 CsF	38.0 sC	38.0
4. Experimental	37.0 F	37.5 CF	37.0 F	37.2
Experimental average				37.5
Control average				38.0
April 15				
1. Experimental	37.0 F		37.5 sF	37.3
2. Control	38.5 sC		36.5 dC	37.5
3. Control	38.0 sC		38.0 C	38.0
Experimental average				37.3
Control average				37.6

Table 11. Consumer reaction to milk from cows fed sorghum silage.

Sample	Quarts delivered	Quarts returned	Percent returned
April 4			
Experimental	34	0	0
Control	60	0	0
April 6			
Experimental	30	0	0
Control	54	0	0
April 8			
Experimental	38	0	0
Control	70	0	0
April 11			
Experimental	30	0	0
Control	46	0	0
April 13			
Experimental	30	2	6.7
Control	46	0	0
April 15			
Experimental	34	0	0
Control	68	0	0
Total			
Experimental	196	2	1.1
Control	344	0	0

Table 12. Panel flavor scores and criticisms for milk from cows on rye pasture.

Sample	Judge A	Judge B	Judge C	Average score
	Score criticism			
April 25				
1. Experimental	32.0 hF		32.0 P	32.0
2. Control	38.0 sC		38.0 sCsF	38.0
3. Experimental	32.0 hF		35.0 dCdF	33.5
4. Control	38.0 C		38.0 sCsF	38.0
Experimental average				32.8
Control average				38.0
April 27				
1. Control	38.0 CsF	37.0 CF	37.5 CF	37.5
2. Experimental	32.0 P	34.0 hF	35.5 dF	33.9
3. Experimental	32.0 P	36.5 CU	36.5 M	35.0
Experimental average				34.4
Control average				37.5
April 29				
1. Control	38.5 sC	37.5 CF	38.5 sC	38.2
2. Experimental	32.0 hF	32.0 hF	32.0 P	32.0
3. Experimental	32.0 hF	33.0 hF	34.0 sP	33.0
4. Control	38.0 sC	38.5 CsF	38.5 sC	38.3
Experimental average				32.5
Control average				38.3
May 2				
1. Experimental	32.0 hF		34.0 hF	33.0
2. Control	38.0 sC		38.5 sC	38.3
3. Control	35.0 hO		35.5 O	35.3
Experimental average				33.0
Control average				36.6

Table 12 (concl.).

Sample	Judge A	Judge B	Judge C	Average score
	Score criticism			
May 4				
1. Control	38.0 sC	38.0 hCsF	37.5 hC	37.8
2. Experimental[a]	34.0 hF	33.0 hF	32.0 hF	33.0
3. Control	37.5 sF	38.0 CsF	38.0 sC	37.8
4. Experimental[a]	34.0 hF	35.0 dF	33.0 hF	34.0
Experimental average				33.5
Control average				37.8
May 6				
1. Control	38.5 sF	36.0 F	38.0 CF	37.0
2. Experimental[b]	34.0 U	30.0 hF	35.0 dF	33.0
3. Experimental[b]	33.0 dF	33.0 dF	33.0 hF	33.0
4. Control	38.0 CsF	38.0 CsF	38.0 CF	38.0
Experimental average				33.0
Control average				37.5

[a] Denotes here and after that milk was processed by the Vacu-Therm pasteurization unit.

[b] Denotes here and after that cows were taken off pasture four hours prior to milking.

Table 13. Consumer reaction to milk from cows on rye pasture.

Sample	Quarts delivered	Quarts returned	Percent returned	Log percent returned
April 25				
Experimental	29	9	31.0	1.491
Control	45	0	0	
April 27				
Experimental	33	20	60.6	1.783
Control	55	2	3.7	
April 29				
Experimental	34	17	50.0	1.699
Control	71	3	4.2	
May 2				
Experimental	28	17	60.7	1.783
Control	48	3	6.3	
May 4				
Experimental[a]	27	13	48.1	1.682
Control	61	1	1.6	
May 6				
Experimental[b]	35	10	28.6	1.456
Control	82	0	0	
Total				
Experimental	124	63	50.8	
Experimental[a]	27	13	48.1	
Experimental[b]	35	10	28.6	
Control	362	9	2.5	

Table 14. Panel flavor scores and criticisms for milk from cows on brome pasture.

Sample	Judge A	Judge B	Judge C	Average score
	Score criticism			
May 11				
1. Control		38.0 CF	38.0 C	38.0
2. Experimental		36.5 dF	37.5 sF	37.0
3. Control		38.0 CF	37.5 dC	37.8
4. Control		37.0 dF	37.5 dF	37.3
5. Experimental		38.0 dCsF	37.5 sF	37.8
Experimental average				37.4
Control average				37.7
May 13				
1. Control	38.5 sC	38.0 CsF	38.0 sCsF	38.3
2. Experimental	34.0 dF	37.0 CF	34.0 CdF	35.0
3. Control	38.0 sC	38.0 CsF	37.0 sF	37.7
4. Experimental	30.0 hG	36.0 dF	32.0 P	32.7
5. Control	37.5 sCsF	37.5 CsF	38.0 sCsF	37.7
Experimental average				33.9
Control average				37.9
May 16				
1. Control	38.0 sF	37.5 dCsF	38.0 sCsF	37.8
2. Experimental	32.0 hF	33.0 hF	32.0 hP	32.3
3. Control	36.0 O	37.5 hC	37.0 C	36.8
4. Experimental	35.0 dF	36.0 dCdF	34.0 sP	35.0
5. Control	38.0 sF	38.0 CF	37.5 C	37.8
Experimental average				33.7
Control average				37.5
May 18				
1. Control	38.5 sC		38.0 sC	38.3
2. Control	38.0 sC		38.5 sC	38.3
3. Experimental	32.0 hF		34.0 dF	33.0
Experimental average				33.0
Control				38.3

Table 14 (concl.).

Sample	Judge A	Judge B	Judge C	Average score
	Score criticism			
May 20				
1. Control	39.0 sC	38.5 sC	38.5 sC	38.3
2. Control	38.0 sF	37.5 CF	38.0 C	37.8
3. Experimental	32.0 hG	35.0 dF	34.0 ChF	33.7
4. Experimental	30.0 hF	31.0 hF	34.0 hF	31.7
5. Experimental	32.0 hF	35.0 dF	33.0 ChF	33.3
Experimental average				32.9
Control average				38.3
May 23				
1. Control	38.0 sC	38.5 sC	38.5 sC	38.3
2. Experimental[b]	35.0 dF	38.0 sC	34.0 hF	35.7
3. Control	38.0 sC	38.0 sC	38.0 C	38.0
4. Experimental[b]	30.0 hF	38.0 sCF	34.5 CdF	34.2
5. Control	39.0 sC	38.0 sC	37.0 dC	37.0
Experimental average				35.0
Control average				37.8
May 25				
1. Control	36.0 F	38.5 sCsF	38.5 sCsF	37.7
2. Experimental[a]	30.0 hF	33.0 dF	34.0 U	32.3
3. Experimental[a]	30.0 hF	32.0 hF	33.0 hF	31.7
4. Control	33.0 O	38.0 C	38.0 C	36.3
5. Experimental[b]	35.0 dF	36.5 dF	34.0 CdF	35.2
Experimental average[a]				32.0
Experimental average[b]				35.2
Control average				37.0
May 27				
1. Control	36.0 sO	37.5 CF	38.0 sCsF	37.2
2. Control	37.0 dC	38.0 CF	38.0 sC	37.7
3. Experimental[c]	35.0 F	32.0 hF	34.0 U	33.7
Experimental average[c]				33.7
Control average				37.5

[c] Denotes here and after that cows were taken off pasture four hours prior to milking and Vacu-Therm pasteurization of that milk.

Table 15. Consumer reaction to milk from cows on brome pasture.

Sample	Quarts delivered	Quarts returned	Percent returned	Log percent returned
May 11				
Experimental	28	4	14.3	1.155
Control	44	0	0	
May 13				
Experimental	32	4	12.5	1.097
Control	66	0	0	
May 16				
Experimental	27	9	33.3	1.522
Control	62	1	1.6	
May 18				
Experimental	27	9	33.3	1.522
Control	50	0	0	
May 23				
Experimental[b]	23	4	17.8	1.250
Control	47	2	4.3	
May 25				
Experimental[a]	24	4	16.7	1.223
Control	55	0	0	
May 27				
Experimental[c]	28	2	7.1	0.851
Control	53	0	0	
Total				
Experimental	144	34	23.6	
Experimental[b]	23	4	17.8	
Experimental[a]	24	4	16.7	
Experimental[c]	28	2	7.1	
Control	442	4	0.9	

STATISTICAL CORRELATION BETWEEN CONSUMER REACTION AND ORGANOLEPTIC ANALYSIS OF FEED FLAVORED MILK

by

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A study was designed to determine, first, how consumers would react to milk flavored by three feeds: sorghum silage, and Balboa rye and Achenbach bromegrass pastures; second, if results of an "experienced flavor panel" could be used consistently to indicate consumer acceptance of various degrees of these off-flavors.

Milk was collected from seven cows representing four of the major dairy breeds during all feeding trials. The experimental samples were all vat pasteurized at 145^{o} F. for 30 minutes, except for samples (a) which were treated with a Vacu-Therm H.T.S.T. pasteurization unit and samples (c) described below. Treatment (b) consisted of removal of the cows from the pastures four hours prior to milking. Treatment (c) was a combination of treatments (a) and (b). The treatment effects (a, b, and c), of special management of the cows and processing of the experimental milks were studied with the rye and bromegrass feeding trials.

The control milk used throughout the study was the regular University herd milk. At this time the herd was being fed average quality hay and silage immediately after milking. The control milks were all processed through the Vacu-Therm flavor standardization equipment.

Both the control and the experimental milks were bottled into Pure-Pak quart cartons which were code dated for identification purposes during the study.

Thirty-nine multiple-quart customers from a commercial retail dairy route, supplied by the University Dairy, were used for the "consumer group." The customers received some of the coded experimental milk as a portion of their regular milk order at various times throughout the trial. Returned milk, by pre-arranged agreement, was used to measure consumer acceptance. Experimental and control milks were scored with respect to flavor by the panel the same day they were delivered to the consumers.

Neither the panel nor the consumers showed significant discrimination between the flavor of the silage experimental and control milks. Flavor differences between rye and bromegrass experimental milks and control milks were evidenced by low scores assessed by the panel and high percent of delivered experimental milk returned by the consumers.

Correlation coefficients between panel flavor scores and log percent of consumer returns were 0.44 for rye flavored milks and 0.26 for bromegrass flavored milks. These were not significant correlations for the number of comparisons in these trials. The data also revealed that the log percent of consumer returns gave no linear relationship with the panel scores for these two feeding trials.

Analysis of variance of the panel flavor scores indicated significant differences between control milks and bromegrass experimental milks at the five percent level and between control milks and rye experimental milks even at the one percent level. LSD tests at the five percent level on the mean panel flavor scores show no effects of the treatments outlined on the rye experimental milk. LSD tests at the five percent level on the mean panel scores of the bromegrass flavored milk show treatment (b) better than either treatment (a) or (c), and treatment (c) better than treatment (a).

Analysis of variance of flavor scores showed no significant differences among panel judges for any of the complete feeding trials. There was, however, a significant difference at the five percent level among judges for samples analyzed on a single day.