JOURNAL OF DAIRY SCIENCE

Contents

Vol. XXV, No. 6, June, 1942

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION

PART 1 . . . Duraglas

Duraglas is a registered trade-mark, but it needn't be. For without painstaking research, special equipment, and our unapproached skill in glassmaking, the tough, strong, lightweight Duraglas container cannot be duplicated.

PART 2 . . . Reason for Shape of Handi-Quart

Milk, all liquid—even molten glass—when poured forms a "tear-drop." That's Nature's way of evenly distributing liquid mass, of insuring best distribution of thickness and weight. The Handi-Quart is a natural "tear-drop"—modified to traditional milk bottle shape.

PART 3 . . . Resultant Economies of Handi-Quart

Bear in mind that these amazing economies—extended to the approximately 12 billion glass containers of milk delivered yearly in America—would save 1,595,000 tons weight alone. More, since 100 Handi-Quarts can be made from the same amount of glass needed for 76 old-style quarts, much glass can be released for defense!

FOR DAIRYMEN . . . The O-I Handi-Quart provides: 1. Substantially lower bottle costs. 2. Maximum capping economies because the Handi-Quart is ideal for small finishes. 3. Savings in load-weight—less weight for route and plant men. 4. Minimum of production "change-over" cost. 5. A distinct "merchandising" package—a *natural* for store trade.

FOR CONSUMERS . . . The O-I Handi-Quart is easier to hold and pour from—easier to slide into refrigerator shelves.

• • •

We are proud indeed of our part in pioneering the development of this distinctly economical and perfect container for milk.

OWENS-ILLINOIS *Complete Dairy Service*

TOLEDO, OHIO

WHERE QUALITY PREDOMINATES

Your advertisement is being read in every State and in 25 Foreign Countries

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION
Published at
NORTH QUEEN ST. AND MCGOVERN AVE., LANCASTER, PA.

The Journal of Dairy Science is issued monthly. Subscription is by the volume and one volume is issued per year.

Manuscripts should be typewritten and carefully revised before submission to T. S. Sutton, The Ohio State University, Columbus, Ohio. Twenty-five reprints will be furnished gratis to authors. Cost of additional reprints and reprint order blank will be submitted with proof.

The use of material published in the Journal is encouraged and a liberal policy will be followed concerning reproduction of articles with proper notation as to source.

Subscriptions. Price; $6.00 per volume in United States and Canada; $6.50 in all other countries. Prices are net, postpaid. New subscriptions and renewals are entered to begin with the first issue of the current volume. Renewals should be made promptly to avoid a break in the series. Subscriptions should be sent to R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Subscriptions for the British Isles and British Empire, except for Canada and Australia, should be ordered through our agents: Messrs. Bailliere, Tindall and Cox, 7 and 8 Henrietta Streets, Covent Garden, London, W. C. 2, England. Subscriptions for Australia should be sent to our agent: John H. Bryant, 19 Bridge Street, Sydney, Australia.

Advertising should be mailed direct to the Science Press Printing Company, N. Queen St. and McGovern Ave., Lancaster, Pennsylvania.

Correspondence regarding business policies of the Journal should be addressed to the Secretary-treasurer, R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Post Office Notices of undeliverable copies and changes of address should be sent to R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Entered as second-class matter April 13, 1934 at the postoffice at Lancaster, Pa., under the act of March 3, 1879.

JOURNAL OF DAIRY SCIENCE

VOLUME XXV JUNE, 1942 NUMBER 6

A STUDY OF THE COLIFORM GROUP IN ICE CREAM[1]

H. J. FOURNELLE[2] AND H. MACY

Dairy Bacteriology Laboratory, University of Minnesota, St. Paul

The purpose of these studies has been to ascertain the prevalence of members of the coliform group in typical commercial ice cream, and to determine the species or varieties present.

No attempt will be made to review the literature on this group as it is extensive and has been covered adequately in a number of recent papers.

EXPERIMENTAL METHODS

Factory-packed samples of ice cream were obtained from fourteen ice cream manufacturers located in Minnesota. Samples consisted of vanilla, chocolate, and strawberry ice cream, and sherbet (or ice), in pint-size packages and "Cheerios." These samples were collected at the plants and were packed in dry ice while being transported to the laboratory.

Scoop, or dipper samples of ice cream were obtained from thirty retail stores in the vicinity. These samples were collected in sterile pint fruit jars, using the dealer's scoop or dipper, and were carried in an iced sample case. These samples were purchased at drug store fountains, confectioneries, ice cream shops, etc.

Samples received from the plants were removed from the original package and placed in sterile pint fruit jars just prior to analysis. These samples and also the scoop samples were melted in a water bath, kept at 45° C. (113° F.), for 15 minutes (8). Occasional agitation of the sample during melting helped to expel the air.

The presumptive media used in this work consisted of brilliant green-lactose-peptone-bile 2 per cent and violet red-bile agar.

The brilliant green-lactose-bile broth was made up and employed according to the directions given in "Standard Methods" (2), with the exception that a dye concentration of 1:30,000 of brilliant green as recommended by McAuliffe and Farrell (15) for milk was used instead of 1:75,188.

Received for publication February 13, 1942.

[1] Paper No. 1962, Scientific Journal Series, Minnesota Agricultural Experiment Station.

[2] Now on active duty in Sanitary Corps Reserve, U. S. Army, on leave from the Division of Sanitation, Minnesota Department of Health, Minneapolis, Minnesota.

A buffered, brilliant green-lactose-bile medium containing 0.5 per cent of $K_2 HPO_4$, was also used for sherbets and ices.

An estimation of the number of coliform organisms was made by using the dilution technique of Halvorson and Ziegler (9). For factory-packed ice cream, six dilutions were made with 10 tubes inoculated in each dilution. Volumetric measurements of the melted ice cream samples were made throughout this work (7). The largest inoculum, consisting of 10 milliliters of the sample, was planted into 100 milliliters of the brilliant green-lactose-bile broth. The other inocula, one milliliter to 0.0001 milliliter, inclusive, were planted into 10 milliliter quantities of the medium. However, in the case of the buffered and unbuffered brilliant green-lactose-bile broths only four dilutions were made, the inocula being 10 milliliters to 0.01 milliliter, inclusive, where five tubes each of the buffered and unbuffered medium were used in each dilution. In the case of the "Cheerios" the 10-milliliter inoculum was not used, the others being one milliliter to 0.0001 milliliter, inclusive.

The range of dilutions of inocula of the scoop samples was between one milliliter and 0.000001 milliliter, inclusive, where 10 tubes were used for each dilution.

After 48 hours' incubation at 37° C. all tubes were examined for gas production. Halvorson and Ziegler's tables (11) giving the most probable number of bacteria per milliliter were used for interpreting the data.

Direct counts of coliform organisms were made on violet red-bile agar plates that had been incubated 18–24 hours at 37° C.

Levine's eosin-methylene blue (E.M.B.) agar plates were streaked from tubes of brilliant green-lactose-bile broth of the lowest and highest dilutions showing gas after 24 and 48 hours. (Usually two tubes of each of the two dilutions were taken.)

Coliform-like colonies were picked from positive violet red-bile agar (V.R.B.) plates and were transferred to nutrient agar slants and later the cultures were streaked on E.M.B. agar plates.

Representative, typical and atypical, coliform colonies and non-coliform colonies were picked from streaked E.M.B. agar plates and were transferred to nutrient agar slants. The differentiation of *Escherichia coli* and *Aerobacter aerogenes* was made according to the suggestion of Levine (12) on eosin-methylene blue agar.

For purification, light suspensions were made in tubes of sterile distilled water from cultures growing on nutrient agar slants, and inocula from these suspensions were streaked on E.M.B. agar. After incubation, 24–48 hours, representative colonies of different types were picked and transferred to nutrient agar slants. This process was repeated so that three E.M.B. agar plates were streaked and colonies were transferred to three agar slants.

Gram and flagella stains and determination of motility were made from

nutrient agar slant cultures that had been incubated for 18–22 hours at 37° C. Hucker's modification (18) of the Gram stain was used. The method of study of bacterial flagellation recommended by Conn and Wolfe (5) was used.

The following tests and reactions were used for determining the biochemical characteristics of the isolated cultures: fermentation of lactose, dextrose, sucrose, salicin, dulcitol, and glycerol; formation of indol from 1 per cent tryptone broth; utilization of citrate as a sole source of carbon; methyl red and Voges-Proskauer reactions; reduction of nitrate to nitrite; hydrogen sulfide production from peptone-iron agar; gelatin liquefaction, and action on litmus milk.

As far as possible the media used for the biochemical characterization of the cultures were selected from the Manual of Methods for Pure Culture Study of Bacteria (18).

The formation of indol was determined by the Gore modification (18) of the Ehrlich-Böhme technique, after 3 days at 37° C.

The medium used for the study of citrate utilization was that given in Standard Methods for the Examination of Water and Sewage, 8th Edition, 1936 (1).

The methyl red and Voges-Proskauer reactions were determined according to Werkman's modification (21) and Barritt's modification (3) further modified by Vaughn, Mitchell, and Levine (20). The tubes treated for the Voges-Proskauer reaction by the Werkman modification were allowed to stand a half day or overnight to permit development of color.

The reduction of nitrate to nitrite was determined by the method given in the Manual of Methods for Pure Culture Study of Bacteria, Leaflet V, p. 8, 1939 (18).

The iron-peptone medium was a modification of the suggestion of Levine and co-workers (13, 14) and as recommended by Tittsler and Sandholzer (19).

Cultures that could not be identified on the first attempt were repurified, and biochemical studies were repeated.

The pH determinations were made with a Coleman glass electrode, pH electrometer, model 3D.

Identification of the cultures was made according to Bergey's Manual of Determinative Bacteriology, 5th Edition, 1939 (4).

PRESENTATION OF EXPERIMENTAL DATA

Preliminary Studies. Several preliminary observations were made, the first of which was to determine whether or not a presumptive medium with a 1:30,000 concentration of brilliant green had any appreciable inhibitory effect on certain strains of coliform organisms when a sterile ice cream mix, inoculated with these organisms, was planted into brilliant green-lactose-bile

broths containing dye concentrations of 1 : 30,000 and 1 : 75,188. The second preliminary study was made to determine whether a buffered brilliant green-bile broth gave a higher coliform count than an unbuffered broth when inoculated with a sample of a sherbet containing certain strains of coliform organisms.

Comparative studies were made with the same broths and violet red-bile

TABLE 1

Comparative numbers of coliform group in factory-packed samples of frozen desserts

Plant	Vanilla ice cream	Chocolate ice cream	Strawberry ice cream	Sherbet or ice	Cheerio
(a) Brilliant green-lactose-bile broth (most probable number per ml.)					
A	3.29	2.40	2.75	0.032	3.29
B	0.009	0	0	0	3.29
C	0.110	4.93	116.0	0.110	1.93
D	13.0	6.22	6.22	0	2.23
E	4.93	4.93	1,160.0	0.275	3.24
F	0	0.933	10.20	2.40	.....
G	3.29	3.29	3,490.0	0	33.40
H	15.0	0.493	4.93	0	17.0
I	474.0	197.0	150.0	0.101	116.0
J	0.214	19.7	0.087	2.31	2.31
K	1.01	0.792	1.71	0.168	6.22
L	0.073	0.275	0.032	0	0.78
M	6.22	0.217	9,180.0	0.020	79.20
N	0.792	0.053	13.0	0	17.1
(b) Violet red-bile agar (plate count per ml.)					
A	0	2	1	0	2
B	0	0	0	0	2
C	0	0	*	0	0
D	9	2	3	0	*
E	50	14	450	0	2
F	0	0	8	2	.....
G	0	0	26,900	0	100
H	*	*	*	0	*
I	130	50	85	0	3,600
J	1	10	0	0	*
K	1	0	2	0	0
L	0	0	0	0	0
M	20	0	6,850	0	40
N	0	0	1	0	10

* Counts could not be made because of density of inoculum, formation of gas bubbles, or overgrowth by other organisms.

agar. Five separate determinations were made in each of two trials, where sterile vanilla ice cream mixes were inoculated with suspensions of separate strains of *Escherichia coli, E. freundii, Aerobacter aerogenes, A. cloacae,* and a mixture of *E. coli* and *A. aerogenes.*

No significant differences were found between the counts obtained on brilliant green-bile broths, containing the different dye concentrations, and on violet red-bile agar. In the case of the broths the percentage deviations above and below the mode, or most probable number, given by Halvorson

and Ziegler (10) were used to determine the lower and upper limits of variation. In the case of the violet red-bile agar, a deviation of 100 per cent above and below the average counts was assumed.

Comparative studies were made on buffered and unbuffered brilliant green-bile broths and on violet red-bile agar using a coliform-free orange sherbet inoculated with fairly heavy suspensions of separate strains of *E. coli*, *A. aerogenes*, and a mixture of the two species.

No significant differences were found in the three types of presumptive media. However, when 1.0 milliliter and 0.1 milliliter amounts of inoculum were used, there was an apparent inhibition of the coliform organisms, both in the buffered and unbuffered broths, but growth was unrestricted in higher

TABLE 2

Comparison of most probable numbers of coliform group in sherbets and ices
Buffered and unbuffered brilliant green-lactose-bile broth

Plant	Type of sample	Most probable number	
		Buffered brilliant green-bile broth	Unbuffered brilliant green-bile broth
		per ml.	*per ml.*
A	Orange sherbet	.....	0.032
B	Orange sherbet	.....	0
C	Lime sherbet	0.020	0
D	Orange ice	0	0
E	Orange sherbet	0.329	0.231
F	Pineapple sherbet	2.400	2.400
G	Orange sherbet	0	0
H	Orange sherbet	0	0
I	Orange sherbet	0.128	0.078
J	Orange sherbet	2.310	2.310
K	Orange sherbet	0.125	0.103
L	Orange ice	0	0
M	Orange sherbet	0.020	0.020
N	Pineapple ice	0	0

dilutions. The inhibition may have been due to the low pH of the sherbet or ice.

Numbers of the Coliform Group. Table 1 shows (a) the most probable numbers of coliform bacteria in vanilla, chocolate, and strawberry ice cream, in sherbets (or ices), and in "Cheerio" samples received from 14 ice cream manufacturers. In general, reasonably comparable results were obtained on the two presumptive media used.

The only apparent significant differences in the results with the two media, as shown in table 1, are in the following samples: vanilla ice cream from Plant E, strawberry ice cream from Plants C, G, and N, and "Cheerios" from Plant I.

Table 1 shows also that by using an inoculum of 10 milliliters of the sample as the largest portion planted into the brilliant green-bile broth it was possible to detect the presence of smaller numbers of the coliform group

than could be shown by direct plating on violet red-bile agar. Twenty-five samples out of a total of 69, which showed no characteristic coliform colonies on violet red-bile agar gave positive tests in the brilliant green-bile medium, and of this number, 21 were confirmed.

The samples of sherbet from Plants A and B were planted into unbuffered brilliant green-bile broth (10 tubes inoculated in each dilution) and violet red-bile agar only. The samples of sherbets and ices from Plants C to N, inclusive, were planted into both buffered, and unbuffered, brilliant green-bile broths and in violet red-bile agar. The most probable numbers for the sherbets and ices, shown in table 1, were determined for the combined number of positive tubes in both the buffered and unbuffered liquid presumptive media. Table 2 shows a comparison of the most probable number of the coliform group, obtained in samples of sherbets and ices. No significant differences are shown in the counts obtained.

TABLE 3

pH values of samples of sherbets and ices and of buffered and unbuffered brilliant green-lactose-bile broths + 10 ml. of sample

Plant	Type of sample	pH of Sample	pH values	
			Buffered brilliant green-bile broth + 10 ml. sample	Unbuffered brilliant green-bile broth + 10 ml. sample
A	Orange sherbet	.....	.....	6.40
B	Orange sherbet	2.72	.....	5.27
C	Lime sherbet	2.88	7.10	6.64
D	Orange ice	3.00	6.88	5.60
E	Orange sherbet	3.72	7.13	6.30
F	Pineapple sherbet	3.98	6.91	5.98
G	Orange sherbet	2.68	6.60	5.12
H	Orange sherbet	2.82	6.62	5.22
I	Orange sherbet	3.37	7.22	5.98
J	Orange sherbet	3.53	7.10	6.10
K	Orange sherbet	3.58	6.87	5.67
L	Orange ice	3.22	6.97	5.70
M	Orange sherbet	3.24	6.88	6.05
N	Pineapple ice	3.07	7.10	6.15

Table 3 shows that the increase in pH brought about by buffering ranged from 0.46 to 1.48, with the average increase in pH for 12 determinations being 1.07.

Table 4 gives the most probable numbers of coliform bacteria in 30 scoop samples of ice cream obtained from 30 different retail dealers. The only apparent significant differences in the results with the two presumptive media are in Samples 14 and 21.

It is demonstrated in table 4 also that by using brilliant green-bile broth as the presumptive medium it was possible to detect the presence of smaller numbers of the coliform group than could be shown by direct plating on violet red-bile agar. Six samples, out of a total of 30, which showed no

TABLE 4

Comparative numbers of coliform group in scoop samples of ice cream

Sample	Brilliant green-lactose-bile broth	Violet red-bile agar
	Most probable number	Plate count
	per ml.	*per ml.*
1	3.99	6
2	0.20	1
3	0.19	2
4	792.00	1,290
5	93.30	60
6	1.64	2
7	860.00	260
8	101.00	44
9	93.30	100
10	1.93	1
11	101,000.00	83,000
12	2.68	0
13	70,000.00	70,500
14	1.69	170
15	166.00	350
16	0.78	1
17	0	0
18	1.01	0
19	399.00	250
20	0.20	0
21	11,600.00	93,000
22	13,300.00	17,100
23	4.93	0
24	125.00	30
25	130.00	105
26	74.20	30
27	1.10	0
28	3.99	0
29	792.00	180
30	125.00	60

characteristic coliform colonies on violet red-bile agar gave positive tests in the brilliant green-bile medium, and of this number all were confirmed.

The relative numbers of the coliform group found in factory-packed samples and in scoop samples of ice cream are indicated in table 5. These results suggest the possibility of contamination during dispensing.

TABLE 5

Relative numbers of coliform group in frozen desserts*

Type of sample	Per cent of samples showing			
	Zero coliform count	Less than 10 per ml.	Less than 100 per ml.	More than 100 per ml.
Factory-packed (69 samples)	13.0	75.4	88.4	11.6
Scoop (30 samples)	3.0	46.7	56.7	43.3

* Most probable numbers.

Identity of Isolated Cultures. The cultures isolated from the 69 samples of factory-packed ice cream and from 30 samples of scoop or dipper ice cream were identified by the usual methods. The results are presented in table 6. *Escherichia coli* was clearly a minor factor in these samples.

TABLE 6

Species of coliform group isolated from frozen desserts

Organism	Factory-packed samples (227 cultures)	Scoop samples (89 cultures)
	per cent	*per cent*
Escherichia coli	5.3	1.1
E. coli var. *acidilactici*	1.3	1.1
E. coli var. *neapolitana*	3.1	5.6
E. coli var. *communior*	0.0	1.1
Escherichia freundii	27.3	28.1
Aerobacter aerogenes	23.8	18.0
Aerobacter cloacae	29.5	38.2
Non-coliform	9.7	6.8

Fifteen cultures, which were identified as non-coliform types, were isolated from positive tubes of brilliant green-bile broth which showed more than 10 per cent of gas after 48 hours' incubation at 37° C. These cultures were all single isolations (with one exception) and with the exception of five were Gram-negative rods. Two of the cultures appeared to be atypical *Aerobacter aerogenes* types on eosin-methylene blue agar while the others appeared to be non-coliform types. Microscopic examination showed one of the atypical *A. aerogenes* types to be a Gram-positive coccus, while three of the non-coliform types were Gram-positive cocci and one was a Gram-positive rod. It appears that the phenomenon of symbiosis or synergism may have been responsible for the presence of the gas in the presumptive tubes and also for the appearance of atypical *A. aerogenes* colonies on the eosin-methylene blue agar plates. Three cultures, identified as non-coliform, which resembled coliform types were isolated from violet red-bile agar plates. Symbiosis or synergism may have been involved again.

Studies were made of cultures isolated from tubes of brilliant green-bile broth that showed less than 10 per cent of gas after 48 hours incubation at 37° C. With one exception, only one culture was isolated from each of the ten tubes. These ten cultures represented ten different samples and with the exception of one culture were all Gram-negative rods. Six of the cultures were identified as coliform organisms.

The temporary appearance of eleven cultures with a ropy consistency on nutrient agar slants was noted. Five were identified, four as *Escherichia freundii* and the other a non-coliform type. This characteristic (ropiness) was not constant throughout the study of these cultures since it appeared on only one or two of the agar slants in the case of each culture.

The dependability of colony characteristics on eosin-methylene blue agar

plates as a basis for preliminary identification of coliform types is shown in table 7. In some cases, it was found that 48-hour incubation gave a better differentiation of colony types than 24-hour incubation.

TABLE 7

Identity of coliform and non-coliform types found on eosin-methylene blue agar plates

Appearance of colony on E.M.B. plate	Per cent of colonies actually identified as				
	E. coli	*E. freundii*	*A. aerogenes*	*A. cloacae*	Non-coliform
Typical *E. coli* (73 cultures)	35.6	64.4	.....	.....	.....
Atypical *E. coli* (13 cultures)	30.8	61.5	7.7	.....	.....
Typical *A. aerogenes* (70 cultures)	.....	4.3	31.4	64.3	.....
Atypical *A. aerogenes* (120 cultures)	.....	23.3	38.3	35.0	3.4
Non-coliform (40 cultures)	.....	2.5	5.0	32.5	60.0

All coliform cultures isolated and identified were definitely Gram-negative. Motility studies showed the *Escherichia coli* and *Aerobacter cloacae* cultures to be predominantly motile while the *E. freundii* and *A. aerogenes* cultures consisted of both motile and non-motile types. The shape and size of the different cultures varied considerably. Of the 288 cultures of coli-

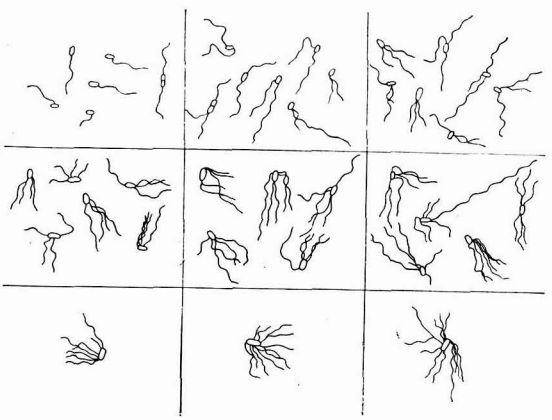


FIG. 1. Types of flagellation observed in cultures of coliform group studied.

form organisms 70.8 per cent showed peritrichic flagellation, 28.5 per cent atrichic, and 0.7 per cent monotrichic. The number and the length of the flagella and their positions on the organism varied considerably. Some cultures showed only one flagellum per organism while others showed 1 and 2, 1, 2, and 3, and so on. The largest number of flagella found on one bacterium was 12, this being a true peritrichic type. Flagella were found both

in the polar and lateral positions. (See figure 1, which was prepared from actual observation of stained cultures in this study.)

Fermentation studies showed that a number of coliform variants isolated in this study, had lost the ability to produce gas from some carbohydrates. A few variants were found which failed to produce both acid and gas from lactose. However, all other biochemical reactions and the morphological characteristics were normal and indicated that these variants were members of the coliform group. These data show that there was variability among certain strains of coliform organisms in their ability to ferment different carbohydrates.

Formation of indol, citrate utilization, gelatin liquefaction, and action on litmus milk for the cultures studied conformed closely to the reactions listed in Bergey's Manual of Determinative Bacteriology (4).

Usually an inverse correlation exists between the methyl red and the Voges-Proskauer tests. This study showed a greater degree of negative correlation between these two tests for Vaughn, Mitchell, and Levine's further modification of the Barritt modification than for Werkman's. The former method gave 33 positive Voges-Proskauer reactions that were negative according to Werkman's modification. The methyl red reactions were negative for these 33 tests. According to Bergey's Manual some strains of *Escherichia freundii* give both positive methyl red and positive Voges-Proskauer tests. Fourteen cultures of *E. freundii* which gave both positive methyl red and positive Voges-Proskauer tests were found in this study.

The ability of coliform organisms to reduce nitrates to nitrites is a property which is considered constant. However, nine coliform cultures which failed in this function were found. These cultures were typical in all other respects.

Although Bergey's Manual states that the majority of strains of *Escherichia freundii* produce hydrogen sulfide in peptone-iron agar, only 17 *E. freundii* cultures produced hydrogen sulfide in peptone-iron agar while 70 cultures failed to do so.

DISCUSSION

This study showed that many of the samples of frozen desserts had high coliform counts and that some contained the fecal coliform type, viz., *Escherichia coli.* The greater prevalence of the non-fecal Aerobacter species was definitely established, however, for this group of samples.

Since a dye concentration of 1:30,000 of brilliant green in brilliant green-lactose-bile broth had no appreciable inhibitory effect on certain strains of coliform organisms, it may be assumed that the presumptive medium with this higher dye concentration may be used for the detection of the coliform group in ice cream. Such a medium would have a greater selective action in inhibiting those Gram-positive organisms which are responsible for false presumptive tests.

Since no appreciable differences were shown in the coliform counts made in buffered and unbuffered presumptive media where the inocula were sherbets or ices, buffering does not appear to be necessary even for the more highly acid products.

It is possible to detect the presence of smaller numbers of coliform bacteria in the brilliant green-bile broths where a 10-milliliter or a 1-milliliter inoculum is used as the largest quantity planted than in the violet red-bile agar medium where a 1-milliliter inoculum is used. Another reason why the broth appears to be more satisfactory for determining low coliform counts is that it is more free from those defects which mask or interfere with reading the agar plates. Another fault of the solid medium is that certain non-coliform organisms may produce colonies that appear to be, or closely resemble, coliform colonies.

The "skips" which occurred in the case of three samples are characteristic of random sampling, and their presence in the dilution technique should not be considered unreasonable because such phenomena may occur where there are changes in the culture medium.

It seems reasonable to expect that factory-packed samples of ice cream should contain less than 10 coliform organisms per milliliter of sample. This figure appears to be fair since 75.4 per cent of the samples complied with it. It is realized, of course, that further work on the same subject is desirable and until that is done a coliform standard which will be applicable over a wide area cannot be set. Perhaps a coliform standard for scoop samples of ice cream should be established by sanitarians who are dealing with restaurants and other eating places.

SUMMARY AND CONCLUSIONS

1. Sixty-nine samples of factory-packed ice cream and 30 scoop or dipper samples of ice cream were studied to determine the numbers of the coliform group and the different types or species present therein.

2. A preliminary study failed to show that a dye concentration of 1:30,000 of brilliant green in brilliant green-lactose-bile broth had any appreciable inhibitory effect on certain strains of coliform organisms.

3. In general, no significant differences were found in the numbers of the coliform group present when comparisons were made between counts obtained in brilliant green-bile broth and on violet red-bile agar.

4. Comparisons were made between coliform counts obtained in buffered, and unbuffered, brilliant green-bile broths which had been inoculated with samples of sherbets or ices. The results were essentially the same in each case.

5. The range of coliform counts, in terms of most probable numbers, in the factory-packed samples was between 0 and 9, 180 per milliliter.

6. The range of the coliform counts (most probable numbers) in the scoop samples of ice cream was between 0 and 101,000 per milliliter.

7. Brilliant green-bile broth appeared to be a better presumptive medium than violet red-bile agar for the detection of the coliform group where the counts were quite low.

8. The cultures isolated from the factory-packed samples of ice cream were distributed as follows: *Escherichia coli*, 5.3 per cent; *E. coli* var. *acidilactici*, 1.3 per cent; *E. coli* var. *neapolitana*, 3.1 per cent; *E. coli* var. *communior*, 0.0 per cent; *E. freundii*, 27.3 per cent; *Aerobacter aerogenes*, 23.8 per cent and *A. cloacae*, 29.5 per cent. Non-coliform species isolated from these samples constituted 9.7 per cent of the total number.

9. The species and varieties isolated from the scoop samples were distributed as follows: *Escherichia coli*, 1.1 per cent; *E. coli* var. *acidilactici*, 1.1 per cent; *E. coli* var. *neapolitana*, 5.6 per cent; *E. coli* var. *communior*, 1.1 per cent; *E. freundii*, 28.1 per cent; *Aerobacter aerogenes*, 18.0 per cent, and *A. cloacae*, 38.2 per cent. Non-coliform species isolated from these samples constituted 6.8 per cent of the total number.

10. The results obtained in this study indicate that factory-packed samples of ice cream should contain less than 10 coliform organisms per milliliter of sample.

REFERENCES

(1) American Public Health Association. Standard Methods for the Examination of Water and Sewage. Am. Pub. Health Assoc., New York, 8th Ed. 1936.

(2) American Public Health Association. Standard Methods for the Examination of Dairy Products. Am. Pub. Health Assoc., New York, 7th Ed. 1939.

(3) Barritt, Maxwell M. The Intensification of the Voges-Proskauer Reaction by the Addition of A-Naphthol. Jour. Path. and Bact., 42: 441–454. 1936.

(4) Bergey, David P., Breed, Robert S., Murray, E. G. D., and Hitchens, A. Parker. Bergey's Manual of Determinative Bacteriology. The Williams and Wilkins Co., Baltimore, 5th Ed. 1939.

(5) Breed, Robert S., and Norton, John F. Nomenclature for the Colon Group. Am. Jour. Pub. Health, 27: 560–563. 1937.

(6) Conn, H. J., and Wolfe, Gladys E. Flagella Staining as a Routine Test for Bacteria. Jour. Bact., 36: 517–520. 1938.

(7) Fay, A. C. A Comparison of the Volumetric and Gravimetric Methods for Bacteriological Examination of Ice Cream. Jour. Dairy Sci., 13: 40–47. 1930.

(8) Fay, A. C., Hammer, B. W., Fabian, F. W., and Breed, R. S. Methods of Analyzing Dairy Products. Jour. Dairy Sci., 16: 277–288. 1933.

(9) Halvorson, H. O., and Ziegler, N. R. Application of Statistics to Problems in Bacteriology. I. A Means of Determining Bacterial Population by the Dilution Method. Jour. Bact., 25: 101–121. 1933.

(10) Halvorson, H. O., and Ziegler, N. R. Application of Statistics to Problems in Bacteriology. III. A Consideration of the Accuracy of Dilution Data Obtained by Using Several Dilutions. Jour. Bact., 26: 559–567. 1933.

(11) Halvorson, H. O., and Ziegler, N. R. Quantitative Bacteriology. Burgess Publishing Co., Minneapolis. 1938.

(12) Levine, Max. Bacteria Fermenting Lactose and Their Significance in Water Analysis. Iowa State Col. Agr. and Mech. Arts., Bul. 62. 1921.

(13) Levine, Max, Epstein, S. S., and Vaughn, R. H. Differential Reactions in the Colon Group of Bacteria. Am. Jour. Pub. Health, 24: 505–510. 1934.

(14) LEVINE, MAX, VAUGHN, REESE, EPSTEIN, S. S., AND ANDERSON, D. Q. Some Differential Reactions in the Colon-Aerogenes Group of Bacteria. Soc. Expt. Biol. and Med., Proc., 29: 1022–1024. 1932.

(15) MCAULIFFE, HERBERT D., AND FARRELL, M. A. Dye Concentration in Culture Media Employed for the Analysis of Escherichia-Aerobacter Members in Milk. Am. Jour. Pub. Health, 28: 1217–1221. 1938.

(16) RUCHHOFT, C. C., KALLAS, J. G., CHINN, BEN, AND COULTER, E. W. Coli-Aerogenes Differentiation in Water Analysis. Jour. Bact., 21: 407–440. 1931.

(17) RUCHHOFT, C. C., KALLAS, J. G., CHINN, BEN, AND COULTER, E. W. Coli-Aerogenes Differentiation in Water Analysis. II. The Biochemical Differential Tests and Their Interpretation. Jour. Bact., 22: 125–181. 1931.

(18) SOCIETY OF AMERICAN BACTERIOLOGISTS. Manual of Methods for Pure Culture Study of Bacteria. Biotech. Publications, Geneva, N. Y. 1939.

(19) TITTSLER, RALPH P., AND SANDHOLZER, LESLIE A. Advantages of Peptone Iron Agar for the Routine Detection of Hydrogen Sulphide Production. Am. Jour. Pub. Health, 27: 1240–1242. 1937.

(20) VAUGHN, REESE, MITCHELL, N. B., AND LEVINE, MAX. The Voges-Proskauer and Methyl Red Reactions in the Coli-Aerogenes Group. Jour. Am. W. W. Assoc., 31: 993–1001. 1939.

(21) WERKMAN, C. H. An Improved Technic for the Voges-Proskauer Test. Jour. Bact., 20: 121–125. 1930.

SEVENTY YEARS OF SELECTION FOR CONFORMATION IN DAIRY CATTLE*

A. A. LEWIS

Department of Dairy Husbandry, University of Missouri

For many years on the Island of Jersey in the English Channel there has been a system of inspection and classification for conformation of all registered Jersey cattle. Importations of Island cattle have frequently been brought to this country. The Island type Jersey has supplanted to a large extent, in the show-ring and leading breeders' herds, the larger, more rugged but rougher type of Jersey which was once popular here and was founded on the blood of Canadian Jersey families.

With the publication of the first volume of the herd book in 1866 by the Royal Jersey Agricultural and Horticultural Society of the Island there was inaugurated the official type classification of all Jerseys registered by the society (1). The written requirements for classification have been changed little since that time. Considerable emphasis apparently has been laid in the selection of breeding stock on the type classification of the cattle. A study of the results obtained through the long period of selection for improved conformation should be of interest to students of dairy cattle breeding.

Questions involved in the study are: What was the proportion of animals of superior conformation which produced the registered Island Jersey cattle during different periods? Did this proportion show any tendency to increase as a result of the program to improve conformation? What proportion of the matings were of animals of superior conformation? Did they show assortive mating? What proportion of offspring with excellent conformation resulted from these matings? Does this proportion show an increase as genes for poor conformation were removed from the population by the selection practised? Does there appear to have been any difference in the influence of the sire and the dam on the conformation of the offspring?

The requirements for registration are that when a qualified cow drops a calf, the birth must be attested within 24 hours by a member of the Agricultural Society. This calf must then be registered within eight days of birth. At this stage the calf is not given an entry number in the herd book and may be finally rejected. The first calf of a registered heifer, not yet qualified, is entitled to registration provided the sire and the dam's parents are quali-

Received for publication February 20, 1942.

* This study was initiated and the data largely compiled while the author was a graduate student at Ohio State University. He is indebted to Dr. E. E. Heizer for aid in the organization and initiation of the study and to Dr. J. L. Lush for advice in the analysis of the results and for critical reading of the manuscript.

fied, and provided the dam is herself qualified within nine months of the birth of the calf.

Qualifications require a public examination of the animal by a panel of usually two or three judges. The qualities which must be possessed by the animals are left to the discretion of the judges and have undoubtedly changed somewhat with changing show ideals. The cattle are graded as "Commended" (C), or "Highly Commended" (HC), or are rejected. Animals of satisfactory conformation are then assigned a herd book number. A bull calf is inspected as a yearling and must be presented with its dam if she is on the Island. The merits of the dam are possibly considered in evaluating the bull. In that case the classification of the bulls should resemble that of the dam in more cases than it does the sire. In cases where it is necessary to show the bull without its dam it cannot be classed higher than "Commended" unless the dam has been a prize winner at an Island show.

Any animal that has been rejected may be offered for re-examination but is usually slaughtered. Heifers whose dams have not been registered may be accepted as foundation stock and the progeny, other than the first calf, may be registered. Ninety per cent of the dairy cattle on the Island in 1936 were registered Jerseys (1).

Animals which do not meet the requirements for at least "Commended" cattle may not be registered and are thus not recorded in the books of the Royal Jersey Agricultural and Horticultural Society. This provision considerably weakens the material from the standpoint of a study of breeding methods and results. The classification given at registration is retained throughout the life of the animal. Cases were observed in this study where "Commended" bulls had become champions of Island shows and had been extensively used.

In spite of there being no record of rejected calves an indication of the results of the classification program can be attained by comparing the proportions of "Commended" and "Highly Commended" progeny obtained. If the type requirements for these classifications changed much from period to period the proportions of "HC" and "C" calves would differ even if classification had been made of the same population. Any conclusions drawn must be predicated, therefore, on the assumption that classification standards did not change much or at least were not lowered.

METHOD OF TABULATION OF THE DATA

The data were obtained from the herd books of the Royal Jersey Agricultural and Horticultural Society. The classification of each animal was recorded and then the same information obtained for its dam and sire. Every animal listed in the registry books was tabulated, with a very few exceptions, from the first volume listed in table 1 and as far through the

TABLE 1

The proportion of progeny from HC sires and from HC dams compared to the proportion of such parents

Periods	HC sires	Progeny		HC dams	Progeny	
		Bulls	Heifers		Bulls	Heifers
	%	%	%	%	%	%
I 1866 to 1882 ♀ ♂	64.3	63.5	65.1	29.2	30.5	28.2
II 1890 to 1891 ♀ 1890 to 1893 ♂	82.1	89.0	75.3	76.0	84.6	67.4
III 1906 to 1907 ♀ 1906 to 1909 ♂	81.2	90.3	72.0	59.3	73.2	45.4
IV 1926 to 1927 ♀ 1922 to 1927 ♂	74.7	78.2	72.2	79.3	88.4	70.1
V 1935 ♀ 1930 to 1935 ♂	90.5	92.3	88.8	79.7	90.6	68.9
Summary	78.6[a, b]	82.6[a, e]	74.5[b, e]	64.7[c, d]	73.4[c, f]	55.9[d, f]

Sections I to V based on 1036 sires or dams and 518 bulls and 518 heifers.
Summary based on 5180 sires or dams and 2590 bulls and 2590 heifers.
Statistical significance (3) of the difference between selected proportions by

$$\sigma D\% = \sqrt{pq\left(\frac{1}{N_1} \quad \frac{1}{N_2}\right)} :$$

[a] HC sires and their male progeny, Summary Difference 4.0% ± 1.9.
[b] HC sires and their female progeny, Summary Difference 4.1% ± 2.0.
[c] HC dams and their male progeny, Summary Difference 8.7% ± 2.2.
[d] HC dams and their female offspring, Summary Difference 8.8% ± 2.3.
[e] Bull calves and heifers from HC sires, Difference 8.1% ± 1.7.
[f] Bull calves and heifers from HC dams, Difference 17.5% ± 1.3.

last volume listed as it was necessary to go in order to obtain 518 male and the same number of female progeny in each group. Since five such groups of data were obtained for five periods since 1866 the total number of offspring tabulated in this study was 5180. The classification of dam and sire was obtained wherever listed. Each mating which resulted in a registered offspring was recorded as a separate entity. The actual number of parents would not be double that of the progeny since popular and long-lived bulls sired many calves and thus tended to dominate the results.

RESULTS

I. *The type classification of parents of Island Jersey cattle. Proportion of "Commended" and "Highly Commended" parents.* Since the numbers of cattle registered were few in the first years of registration, a period of 16 years had to be covered to secure the necessary number of progeny for period I (table 1). During this period slightly less than two-thirds of the sires were classified as "Highly Commended" but only 29.3 per cent of the dams. The proportion of "HC" parents in the 1890–3 period had increased to 82.1 per cent for the sires and 76 per cent for the dams, showing a strong tendency to breed to animals of better conformation unless

the classification standards had been dropped. In the 1906–9 period the percentage of "Highly Commended" dams dropped to 59.3 per cent, while the proportion of such sires was maintained near the previous level. Possibly the requirements for "HC" classification of dams had become more stringent or breeders had decreased their emphasis on the use of better type dams. The latter condition would result if there were increased sale of stock for exportation. A further increase in use of excellent type bulls occurred in the 1930–5 period. The surprising proportion of 90.5 per cent of the sires of calves registered during that period were of "Highly Commended" conformation.

Proportion of different matings producing registered progeny. There are four possible matings between "Commended" and "Highly Commended" cattle. They are "C" sires × "HC" dams, "HC" sires × "C" dams, "C" sires × "C" dams, and "HC" sires × "HC" dams (table 2). In the earliest period studied, 27.1 per cent of the 1036 matings were of "Commended" sires to "Commended" cows. Matings of "HC" cows and "C" bulls produced only 8.6 per cent of the registered calves. The mating of "HC" bulls to "C" dams produced 43.6 per cent of the registered calves while one-fifth were from bulls and cows both of which were "Highly Commended" (table 2).

In the 1890–3 period the proportion of "C" × "C" matings had declined to 4.9 per cent. Matings of "Commended" bulls to "Highly Commended" cows had, however, increased considerably. Registered calves from "HC" sires × "C" dams had also declined to less than half the proportion found in the first period due especially to a decrease in the number of registered bull calves from this mating. "HC" × "HC" matings produced over three-quarters of the registered bull calves and half of the heifers.

During the 1906–9 period either the stringency of selection for conformation declined or the classification standards were raised for the number of registered calves produced by "C" × "C" matings had increased considerably (table 2). Only eight per cent of the matings were of "C" sires × "HC" dams. The mating of "HC" sires × "C" dams produced almost 30 per cent of the registered calves. "HC" × "HC" matings had consequently declined to about half.

The 1922–7 period showed a considerable increase in matings of "C" sires × "HC" dams and a decline in the proportion of "HC" sire × "C" dam matings. "C" × "C" matings had declined to the 1890–3 figure. "HC" × "HC" matings producing registered bull calves did not change much but heifers from the same matings increased 13 per cent.

In the latest period, 1930 to 1935, almost three-quarters of the matings were of "HC" × "HC" parents. Very few were "C" × "C" matings, 17.5 per cent "HC" × "C" and 6.7 per cent "C" × "HC."

From table 2 may be calculated the amount of assortive mating which

TABLE 2

Proportion and number of the four matings of Island Jersey cattle producing registered progeny

Matings Sires × Dams	Percentage of progeny			Number of progeny		
	Both sexes	Bulls	Heifers	Both sexes	Bulls	Heifers
Period I: 1866–1882						
C × C	27.1	28.8	25.5	281	149	132
HC × C	43.6	40.7	46.5	452	211	241
C × HC	8.6	7.7	9.5	89	40	49
HC × HC	20.7	22.8	18.5	214	118	96
All matings	100.0	100.0	100.0	1036	518	518
Period II: 1890 to 1891–3						
C × C	4.9	1.5	8.3	51	8	43
HC × C	19.1	13.9	24.3	198	72	126
C × HC	12.9	9.5	16.4	134	49	85
HC × HC	63.0	75.1	51.0	653	389	264
All matings	100.0	100.0	100.0	1036	518	518
Period III: 1906 to 1907–9						
C × C	10.8	2.9	18.7	112	15	97
HC × C	29.9	23.9	35.9	310	124	186
C × HC	8.0	6.8	9.3	83	35	48
HC × HC	51.3	66.4	36.1	531	344	187
All matings	100.0	100.0	100.0	1036	518	518
Period IV: 1922–6 to 1927						
C × C	4.8	1.7	7.9	50	9	41
HC × C	15.9	9.9	22.0	165	51	114
C × HC	20.5	20.1	20.8	212	104	108
HC × HC	58.8	68.3	49.2	609	354	255
All matings	100.0	100.0	100.0	1036	518	518
Period V: 1930–5 to 1935						
C × C	2.8	1.5	4.1	29	8	21
HC × C	17.5	7.9	27.0	181	41	140
C × HC	6.7	6.2	7.1	69	32	37
HC × HC	73.1	84.4	61.8	757	437	320
All matings	100.0	100.0	100.0	1036	518	518
Summary						
C × C	10.1	7.3	12.9	523	189	334
HC × C	25.2	19.3	31.2	1306	499	807
C × HC	11.3	10.0	12.6	587	260	327
HC × HC	53.4	63.4	43.3	2764	1642	1122
All matings	100.0	100.0	100.0	5180	2590	2590

occurred during these periods. If much attention was paid to the type classification of these cattle the "Highly Commended" cattle should usually have been mated to similar animals. Breeders with "Commended" cattle,

especially bulls, would be expected to be less particular about whether their animals were mated with "C" or "HC" animals. Owners of "Commended" cows might also be anxious, however, to improve the type of the offspring by mating to "HC" bulls. Any such matings, although tending to improve the conformation of the breed, reduce the amount of assortive mating. The coefficient of association used for calculating assortive mating (4) shows whether animals with similar type classification tended to be mated with similar or with dissimilar mates. This coefficient of association is rather erratic and not very dependable except for distinguishing between rather high proportions of assortive mating and none.

The amount of assortive mating varied considerably during different periods in this population (table 3). In only the 1906–9 period was there a significant amount of assortive mating in the matings which produced registered heifers. In the other periods the amount of assortive mating was not statistically significant according to the chi square.

TABLE 3

The proportion of assortive mating among the parents of registered Island Jersey cattle

Period	All matings		Matings			
			Producing bulls		Producing heifers	
1866–82	.20[a]	7.5[b]	.35[a]	12.2[b]	.04[a]	.12[b]
1890–93	.11	1.5	−.06	.10	.03	.08
1906–09	.40	28.8	.09	.28	.34	12.2
1922–27	−.07	.59	−.25	1.85	−.08	.58
1930–35	.28	5.8	.45	5.63	.13	.80
Summary	.31	8.6	.41	67.1	.17	15.07

[a] Yule's (4) coefficient of association for two-fold table

$$q = \frac{ad - bc}{ad + bc}.$$

[b] Chi square for two-fold table (3)

$$\chi^2 = \frac{(ad - bc)^2 (a + b + c + d)}{(a + b)(c + d)(a + c)(b + d)}.$$

A chi square value of 3.841 or more is considered significant.

In the matings which produced the registered bull calves the amount of assortive mating was highly significant in two widely separated periods, 1866–82 and 1930–5. In the matings which produced bull calves from 1922–7 there was some tendency to mate the parents to animals of the other type classification. The figure for assortive mating, although high, does not appear to be statistically significant.

The nature of the dairy business on the Island was such that the management of herds from which most of the bulls were registered might well have followed practices different from those where only heifers were registered. Bulls were kept by a few breeders with the larger herds. Cows were brought from the neighboring small herds to be bred. Figures on assortive mating

based on an equal number of bulls and heifers are of doubtful significance as in the column of "All Matings," table 3.

II. *The progeny from Commended and Highly Commended parents. The proportion of Highly Commended offspring.* In the 1866–88 period tabulated, only 24.1 per cent of the bull calves and 18.5 per cent of the heifers registered were classified as "Highly Commended" (table 4). This proportion jumps, however, in the 1890–3 period to about two-thirds for the male and 71.2 per cent for the female progeny. The 1906–9 period showed a decline in the proportion of "Highly Commended" progeny to close to 50 per cent for both sexes. This corresponded to a considerable decline in the proportion of "Highly Commended" dams in the group but occurred in spite of 81.2 per cent of the sires being "Highly Commended." Recovery was good in the 1922–7 period when practically 70 per cent of both bull calves and heifers registered during that period were classed as "Highly Commended." The remaining 30 per cent were, of course, classified as "Commended."

There was no consistent increase in the proportion of "Highly Commended" progeny produced, when compared to the proportion of similarly classified parents (table 4). These figures were obtained by dividing the number of "HC" progeny in each period by the number of "HC" sires plus the "HC" dams. Since two parents are required to produce one offspring the proportion of "HC" progeny to "HC" parents could not rise above 50 per cent even if all parents produced only "HC" progeny. The proportion for the first period is 22.8 per cent, rises to 43.2 per cent for the second period, is 36.7 per cent for the third, 45.3 for the fourth, and 36.4 per cent for the fifth period. This is consistent with the genetic view of the mass selection (2). Mass selection of epistatic factors results in rapid improvement during only the first few generations it is practiced. The improvement can then only be maintained through stringent culling. If the vigilance of selection is reduced the population tends to return to the original condition. Only through inbreeding can the homozygosity of the population be appreciably increased under practical conditions.

The increase between the first and second periods is highly significant. It indicates either a lowering of standards or the elimination of considerable inferior germ plasm. In later periods the proportion of "HC" progeny fluctuated considerably.

Examining the "HC" calves which were produced by "HC" sires it is seen that only in the 1866–82 period is the proportion of heifers greater than that of the bull calves (table 4). There was evidently a stronger tendency to register bull calves than heifers from "HC" sires during the second and third periods by 13.7 and 18.3 per cent. This tendency practically disappeared in the last two periods for bull calves from "HC" sires were only 5 and 3.5 per cent more numerous than heifers. Of course, in this study the numbers of bull calves and heifers in each group were kept equal at 518.

TABLE 4

Proportion of Highly Commended progeny from the four matings of registered Island Jersey cattle

Sires × Dams	Percentage of HC progeny*			Proportion HC parents† to HC progeny
	Both sexes	Bulls	Heifers	
Period I: 1866 to 1882				
All matings	21.3	24.1	18.5	22.8
C × C	15.3	13.4	17.4	
HC × C	18.6	23.2	14.5	
C × HC	27.0	25.0	28.6	
HC × HC	32.7	40.0	25.0	
Period II: 1890 to 1891–3				
All matings	68.2	65.3	71.2	43.2
C × C	66.7	50.0	69.8	
HC × C	59.1	59.7	58.7	
C × HC	71.6	61.2	77.7	
HC × HC	70.4	67.1	75.4	
Period III: 1906 to 1907–9				
All matings	51.0	52.5	49.4	36.7
C × C	32.1	20.0	34.0	
HC × C	39.4	39.5	39.3	
C × HC	51.8	42.9	58.3	
HC × HC	61.6	59.6	65.2	
Period IV: 1922–6 to 1927				
All matings	69.7	69.5	69.9	45.3
C × C	62.0	66.7	61.0	
HC × C	59.4	52.0	63.2	
C × HC	71.2	65.4	76.9	
HC × HC	72.6	73.5	71.4	
Period V: 1930–5 to 1935				
All matings	62.1	63.7	60.4	36.4
C × C	48.3	50.0	47.6	
HC × C	49.2	51.2	48.6	
C × HC	63.8	81.3	48.7	
HC × HC	65.5	63.8	67.8	
Summary—Five Periods				
All matings	54.5	55.0	54.0	38.1
C × C	30.2[a]	19.6	36.2	
HC × C	39.0[a,c]	37.7	39.9	
C × HC	61.0[b,c]	57.3	63.9	
HC × HC	64.9[b]	64.0	66.3	
Summary—Last Four Periods				
All matings	42.7	62.7	62.7	40.3
C × C	47.5	42.5	48.5	
HC × C	49.9	48.3	50.7	
C × HC	67.1	63.2	70.1	
HC × HC	67.6	65.9	70.2	

* The numbers of registered progeny are the same as the numbers given in table 2.

† $\frac{\text{HC progeny}}{\text{HC sires} + \text{HC dams}}$.

Statistical significance of the difference between selected proportions:

[a] Both sexes from C × C and HC × C dams matings, Summary Diff. = 9% ± 2.5.

[b] Both sexes from C sires × HC and HC × HC matings, Summary Diff. = 3.9% ± 2.2.

[c] Both sexes from HC × C dams and C sires × HC matings, Summary Diff. = 22.0% ± 2.5.

Calves registered from "HC" dams show a more marked numerical superiority of bull calves over heifers. During the second, third, fourth and fifth periods bull calves exceeded heifers by 17.2, 27.8, 18.3 and 21.7 per cent. These figures are highly significant and seem to indicate either that there was a stronger tendency to register bull calves from "HC" dams than from "HC" sires or that bull calves being shown for classification with their "HC" dams had a better chance of being accepted than heifers which were shown alone. The latter does not appear to be the true explanation, however, because of data presented later.

The proportion of "HC" calves from different matings. A tabulation of the results secured in the proportion of offspring "Highly Commended" from the four matings of Island Jersey cattle shows significant differences in certain instances and a surprising lack of difference in others.

Thirty per cent of the progeny of *"Commended" × "Commended"* cattle were classed as highly commended. Of this proportion 19.6 per cent were bull calves and 26.2 per cent heifers. The variation in highly commended calves registered from this mating is from 15.3 per cent in the first period to two-thirds in the second. Eliminating the first period when a very low proportion of the offspring were being classed as "HC" an average of 47.5 per cent were given this classification in the last four periods (table 4). This disparity between the average proportion of "HC" progeny for all five periods and for the last four is due to the large proportion of the total "HC" bull calves from this mating which occurred in the earliest period. Eliminating the first period, the proportion of "HC" calves is 48.6 per cent for the heifers and 42.6 per cent for the bull calves.

The mating of "Highly Commended" bulls to "Commended" cows resulted in a total of 39 per cent "HC" progeny. This varied from 18.6 per cent in the first to 59.4 per cent in the third period. Eliminating the first period the proportion of "HC" calves from this mating was practically 50 per cent.

Using "Highly Commended" in place of "Commended" bulls did not change substantially the proportion of "HC" offspring resulting. In fact, when the last four periods are considered, practically the same proportion of "HC" calves resulted from "HC" × "C" matings as from "C" × "C" matings, 47.3 and 49.9 per cent, respectively. The average of all five periods gives, however, the "HC" × "C" mating an advantage of 9 per cent, which is 3.6 times the standard error.

One might hastily conclude that since bull calves are shown with the dams that these "Commended" dams had influenced the judges' decisions to a considerable extent, thus producing this similarity. Instead, however, of the proportion of "HC" bull calves being low from the "HC" bull × "C" cow mating, the proportion is higher in four out of the five groups of data than is the percentage of "HC" heifers. The averages for the five periods

are very close, 37.7 and 39.9 per cent, as are the averages for the last four groups, 48.3 and 30.4 per cent, respectively, for bulls and heifers. It does not seem reasonable that the classification of the dams would affect that of the heifers for the latter are not shown with them. Is it possible that the influence of the sire on the conformation, taken as a whole, of his offspring is less than that of the dam? Or has the selection practiced resulted in this situation?

The proportion of "HC" calves registered from the mating of *"Commended" sires* and *"Highly Commended" dams* was 61 per cent. The variation was from 27 per cent in the first to 71.6 in the second period. Eliminating the first period, 67.1 per cent of the progeny was classed as "HC."

The remarkable increase in proportion of "HC" progeny from this mating (61 per cent) compared with that obtained with the "C"×"C" (30.2 per cent) and "HC" sires×"C" dams (39 per cent) matings is worthy of note.

This difference is highly significant, being based on 587 progeny from "C" male×"HC" female matings, 1306 progeny from "HC" male×"C" female matings, and 523 from "C"×"C" matings (table 4). The difference between the proportions of "HC" progeny from "HC" sires×"C" dams and "C" sires×"HC" dams is 6.8 times the standard error. If this high proportion of "HC" offspring from "C" sires×"HC" dams were due to the bull calves being shown with their dams, then a higher proportion of male progeny than of female should be "Highly Commended" in this group of data. This, however, is not the case. The average for five periods is 63.9 per cent of the heifers "Highly Commended" and 57.3 per cent of the bull calves. The proportion of "HC" bull calves is lower in four of the groups of data for in only the 1930 to 1935 period, when the remarkable proportion of 81.3 per cent "HC" bulls was secured, does the proportion of "HC" males exceed that of the "HC" females. The average of the last four groups of data shows 63.2 per cent of the males "Highly Commended" as compared to 70.1 per cent of the heifers.

The mating of *"Highly Commended" bulls to "Highly Commended" cows* resulted in about 65 per cent "HC" calves (table 4). The variation in different periods is from 32.7 in the first to 72.6 in the third. Eliminating the first period, 67.6 per cent of the calves were "Highly Commended." The average for the five groups is not significantly different at 64.9 per cent from that secured when "Commended" bulls were mated to "Highly Commended" cows (61 per cent), being only 1.86 times the standard error. These figures are based on 2764 and 587 offspring, respectively. Almost the same proportion of bull calves was classed as "HC" (64 per cent) as of heifers (66.3 per cent).

Progeny from "HC" dams compared with those from "C" dams. The

results secured in classification of progeny seemed to be little influenced by the classification of the sires. Progeny from the two matings, "HC" × "HC" and "C" sires × "HC" dams, were then combined and the propor-

TABLE 5

Proportion of HC progeny when the dams are Commended (C × C and HC sires × C dams combined) compared with the proportion when the dams are highly Commended (C sires × HC dams combined with HC × HC matings)

HC progeny from Commended dams				HC progeny from Highly Commended dams		
Both sexes	Bulls	Heifers		Both sexes	Bulls	Heifers
Period I: 1866–1882						
16.3	19.2	15.5	Percentage	31.0	35.4	26.2
733	360	373	Total No. progeny	303	158	145
Period II: 1890 to 1891–3						
60.6[a, b]	58.7	61.6	Percentage	70.6[a]	66.4	75.9
249	80	169	Total No. progeny	787	438	349
Period III: 1906 to 1907–9						
37.4[b]	37.4	37.5	Percentage	60.3	58.0	63.8
422	139	283	Total No. progeny	614	379	235
Period IV: 1922–6 to 1927						
60	53.3	62.6	Percentage	72.2	71.6	73.0
215	60	155	Total No. progeny	821	458	363
Period V: 1930–5 to 1935						
49.1	51.0	48.5	Percentage	65.4	65.0	65.8
210	49	161	Total No. progeny	826	469	357
Summary						
36.5[c]	32.7[d]	38.8[d]	Percentage	64.3[c]	63.1[e]	65.8[e]
1829	688	1141	Total No. progeny	3351	1902	1449

Statistical significance of the difference between selected proportions by

$$\sigma D\% = \sqrt{pq\left(\frac{1}{N_1}+\frac{1}{N_2}\right)}:$$

[a] Both sexes from C and HC dams: Period II. Difference = 10% ± 3.4.
[b] Both sexes from C dams: Periods II and III. Difference = 23.1% ± 3.9.
[c] Both sexes from C and HC dams: Summary Difference = 27.8% ± 1.5.
[d] Bulls and heifers from C dams: Summary Difference = 6.1% ± 2.3.
[e] Bulls and heifers from HC dams: Summary Difference = 2.7% ± 1.7.

tion of "HC" and "C" calves compared with the results secured when the other two matings, "HC" sires × "C" dams and "C" × "C," were combined (table 5).

The average results from the two types of matings based on 1829 calves from "Commended" dams and 3351 from "Highly Commended" dams show about one-third of the calves "HC" in the former and almost two-thirds in the latter case. The difference is extremely significant statistically, being 19.2 times the standard error. When the 1866–82 period, in which the proportion of "HC" offspring was low, is eliminated one-half of the offspring from "Commended" dams were "HC" while two-thirds of those from "HC" dams were classed as "HC." The differences in proportion of "HC" offspring obtained in the two groups of data between bull calves and heifers, although 6.1 per cent where the dams are "Commended" are in neither case statistically significant. It can be concluded, therefore, that although the bull calves were shown with dam they received substantially the same unbiased judgment as did the heifers.

The proportion of "HC" progeny secured was less during the 1866–82 period with both types of groupings, *i.e.*, 16.3 per cent when the dams were only "Commended" and 31 per cent with "Highly Commended" dams. Results for the 1890–3 period, to 1891–3, were only 10 per cent apart with 60.6 per cent "HC" progeny from "Commended" dams and 70.6 from "Highly Commended" dams. During the 1906–9 period the proportion of "HC" progeny from both matings dropped somewhat but the difference in "HC" results when the dams are "HC" is still 22.9 per cent greater than when the dams are only "Commended." In the 1922–7 period the difference is 12.2 per cent, and 16.3 per cent in the 1930–5 period.

It is possible that the explanation for the high per cent "HC" calves from the "C" × "HC" mating lies in the fact that bull calves shown without dam cannot be classed better than "Commended." Several cases were encountered in this study of "Commended" bulls which had become champions of Island shows and were extensively used. These bulls possessing "HC" conformation when mated to "HC" cows raised the proportion of "HC" progeny above that to be expected from the mating. To account for the low proportion of "HC" calves from the "HC" sire × "C" dam mating on this basis one would have to conclude that the "HC" sires which were throwing a low proportion of "HC" calves tended to be mated to "C" cows.

SUMMARY

A study is reported of 5180 "Commended" and "Highly Commended" Island Jersey cattle and their parents. The data were tabulated in five period groups from 1866, including practically all calves registered during each period.

It was found that the proportion of the sires of Island Jersey cattle which were classified as "Highly Commended" increased from 64 per cent in 1866–82 to 82 per cent in 1890–3, declined somewhat in the 1922–7 period but rose to the surprising proportion of 90 per cent in 1930–5. Only 29 per cent of the dams were "HC" in 1866–83 but over $\frac{2}{3}$ were so classified in three of the following periods. There appeared to be a greater tendency to select "HC" bulls than heifers from "HC" sires and dams.

The mating of "Commended" sires to "Commended" dams declined from 27 per cent of the total matings in 1866–82 to 2.8 per cent in 1930–5. "HC" males × "C" dams declined from 43.6 per cent to 17.5 per cent while "HC" × "HC" matings increased from 21 per cent to 73 per cent in the same periods. There appeared to be considerable assortive mating among the parents of registered bull calves in the 1866–82 and 1930–5 periods. Only in the 1906–9 period was assortive mating appreciable among the parents of heifer calves. The proportion of "HC" progeny to "HC" parents shows a considerable increase, from 23 per cent to 43 per cent between the first and second periods and thereafter considerable fluctuation but no consistent increase. The assumption is that no increase in homozygosity for the genes which influence "HC" conformation occurred after the 1890–3 period.

When the dams were only "Commended" 36.5 per cent of the calves received the rating of "HC" whereas when the dams were "HC," 64.3 per cent of the progeny received this rating. When "HC" sires were mated to "Commended" dams there were only 9 per cent more "HC" progeny. The same change when the dams were "HC" caused an increase of only 3.9 per cent in the proportion of "HC" progeny. Whether this was due to a greater genetic influence of the dam on her offspring or was a result of the selection practiced was undetermined. It could be due to the "Commended" classification of some better type bulls because of being shown without dam and to the genetically poorer "HC" sires being generally mated to "C" dams.

REFERENCES

(1) Gow, R. H. The Jersey. The Amer. Jersey Cattle Club, N. Y. C., pp. 51–62. 1936.
(2) Lush, J. L. Animal Breeding Plans. Collegiate Press Inc., Ames, Iowa, pp. 259. 1937.
(3) Snedecor, G. W. Statistical Methods. Collegiate Press Inc., Ames, Iowa, pp. 12–21.
(4) Yule, G. U. An Introduction to the Theory of Statistics, 8th ed. rev. Ch. Giffen and Co., London, pp. 25–41. 1927.

COMPARATIVE PALATABILITY OF SOME CEREAL PASTURES*

A. O. SHAW AND F. W. ATKESON
Department of Dairy Husbandry, Kansas State College, Manhattan

Cereal crops are used extensively as pasture crops in Kansas. Wheat grown for grain is quite often pastured in late fall and early spring without decreasing grain yield if judiciously done (3). Such practices occur in areas where large acreages of wheat are grown and relatively few livestock are available, thereby resulting in large numbers of acres per animal unit. In the southwestern section of the state where winter wheat is the primary crop and winters are often favorable to excellent wheat growth, it has been profitable to utilize wheat pasture by shipping in cattle and sheep for pasture, usually on a contract basis. Wheat is seldom planted as a supplemental pasture crop only, although several acres are sometimes fenced off exclusively for pasture purposes. Winter barley comes on earlier and makes more winter growth than does wheat. For that reason it is recommended in some states as a special pasture crop. In much of Kansas the hazard of winter killing makes barley less dependable than wheat or rye for pasture. Rye is more universally planted for pasture purposes only than any of the cereals in Kansas. Its rank growth compared with the other small grains, and its ability to withstand severe winters makes rye a dependable, heavy yielding supplementary pasture crop. Common rye is used by most dairymen as a means of extending the pasture season through late fall and early spring grazing when other pastures are not available. It is also used when the pasture program consists primarily of a sequence of special pasture crops, either with or without native or tame pasture. Improved varieties of rye have been developed in recent years. Among the most promising varieties is Balbo, which has developed in Tennessee (2). It appears to be winter hardy in Kansas and produces more pasture than common rye. Another advantage is that it grows more upright during the grazing period than does common rye or wheat.

Differences of opinion among stockmen regarding the relative palatability of these cereals as pasture crops prompted this investigation. It is realized that palatability may not be of paramount importance in pasture crops, particularly when used alone, because cows will often do well on relatively unpalatable pasture crops if nothing else is available. Palatability would seem worthy of some consideration along with other factors in the selection of pasture crops, however, especially for high producing dairy cows

Received for publication February 21, 1942.

* Contribution No. 141, Department of Dairy Husbandry.

when maximum food intake is important. Just how much influence palatability has on the amount of pasture consumed by dairy cows is unknown.

In this study a five-acre field was planted in four strips to Reno barley, Turkey wheat, common rye, and Balbo rye. Seeding was done on October 9, 1939, at the rate of two bushels per acre with a small grain drill. Six cows were used, two each of the Holstein, Ayrshire and Jersey breeds. The cows were being fed grain and silage, besides hay at night. It was thought that well fed cows would more truly reflect differences in palatability of the pastures than would cows which were so hungry that they would eat any kind of pasture. When turned out, however, all these cows ate pasture with relish. Cows varying in production were purposely selected to determine whether plane of production would be a factor in palatability or grazing time. The production plane varied from two dry cows to a cow giving more than 70 pounds of fat per month.

As a matter of convenience in gathering data, the cows were turned into the pasture at about 1:30 P.M. The cows received no pasture during the six-day period except in the afternoon of each day. Observations were taken at one minute intervals by recording the length of time spent in grazing on each strip by each cow until all cows had ceased grazing. The observations were taken on six consecutive days (March 19–24, 1940) and each day the cows were driven to different strips at the beginning of the grazing period. All the plots were ideal for pasture purposes, the plants averaging from four to six inches high with good stands.

TABLE 1

Palatability of cereal pastures as measured in grazing time by dairy cows
(Mar. 19–24, 1940)

Cow No.	Lbs. fat daily	Grazing time									
		Balbo rye		Common rye		Winter wheat		Winter barley		Total	
		Ave. No. min.	Per cent	Ave. No. min.	Per cent	Ave. No. min.	Per cent	Ave. No. min.	Per cent	Ave. No. min.	Per cent
133	1.4	51	57	32	35	7	8	0	0	90	100
144	1.1	44	49	24	27	20	22	2	2	90	100
272	Dry	47	60	10	13	20	25	2	2	79	100
267	2.4	47	60	22	28	6	8	3	4	78	100
322A	Dry	42	47	19	21	22	25	6	7	89	100
319A	0.2	39	44	15	17	15	17	20	22	89	100
Ave.		45	52	21	24	15	18	5	6	86	100

Summary of the results (Table 1) showed that the average time spent in grazing the four different cereals was: Balbo rye—45 minutes, or 52 per cent of the total time; common rye—21 minutes, or 24 per cent; wheat—15 minutes, or 18 per cent; and barley—5 minutes, or 6 per cent. Without

exception, the cows showed a pronounced preference for Balbo rye, but the cows varied some in their relative preference for the different crops. A notable difference was the time spent in grazing barley by cow No. 319A, while all the other cows practically refused to stay on the barley plot even when driven on to it. Some variations existed with individual cows from day to day during the six-day period, but there were few daily exceptions in the order of preference for the different pasture plots.

The cows grazed for an average of approximately an hour and a half. The time spent in grazing was quite uniform, regardless of plane of butterfat production, the shortest average grazing times being recorded for the heaviest producing cow and a dry cow. These results are in agreement with the report of Fuller (1) who found that cows on winter rations spent approximately the same time eating, regardless of production. He stated also that about one and one-half hours were required for the cows to eat their grain, silage and hay. The short time required for cows to get their fill of pasture is of interest in both pasturing methods and cattle management.

These results show that cows have such a distinct dislike for barley that palatability would be an important factor in considering its value in comparison with other cereals as a pasture crop. Gross observations of herd cows over longer periods of time substantiate these conclusions. The pronounced preferences for Balbo rye by all the cows is of particular importance considering its heavier yield and more desirable growth habits. Although the preference shown for common rye over wheat was not so striking, the rank in palatability again agrees with rank in yield of pasture. It might be well to emphasize, however, that all plots represented good pasture conditions, and although Balbo rye was tallest, that factor was not the measure of palatability because the barley ranked second in height and appeared to be the most uniformly good pasture of the group.

SUMMARY AND CONCLUSIONS

Comparative palatability of the following cereal pastures was measured: Balbo rye, common rye, Turkey wheat and Reno barley. A five-acre field was divided into four strips and planted to these small grain crops in the fall. The time spent by six dairy cows of varying production in grazing each crop was recorded. The trial was conducted in the spring under ideal pasturage conditions.

The cows spent an average of 45 minutes, or 52 per cent of the grazing time, on Balbo rye; 21 minutes, or 24 per cent on common rye; 15 minutes, or 18 per cent, on wheat; and 5 minutes, or 6 per cent, on barley. The preference for Balbo rye and the dislike for barley was uniform for all the cows but the relative time spent on each of the cereals varied with individual cows.

The cows grazed an average of approximately an hour and a half to get their fill. The time spent in grazing was quite uniform, regardless of plane of production.

REFERENCES

(1) FULLER, J. M. Some Physical and Physiological Activities of Dairy Cows. N. H. Agr. Expt. Sta. Tech. Bul. 35. 1928.

(2) NEEL, L. R. Rye for Pasture and Seed in Tennessee. Tenn. Agr. Expt. Sta. Cir. 52. 1937.

(3) SWANSON, A. F. Pasturing Winter Wheat in Kansas. Kans. Agr. Expt. Sta. Bul. 271. 1935.

THE NUTRITIVE VALUE OF ALFALFA HAY. I. CYSTINE AS A SUPPLEMENT TO AN ALL ALFALFA HAY RATION FOR MILK PRODUCTION*

C. F. HUFFMAN AND C. W. DUNCAN

Dairy Husbandry Section and the Chemical Section of the Michigan Agricultural Experiment Station, East Lansing

The experimental work reported in this paper is one phase of an extensive project initiated for the purpose of investigating the nutritive value and methods of feeding alfalfa hay to dairy cattle for efficient milk production. Since the trend in the feeding of dairy cattle is toward the greater use of home-grown rations it becomes imperative to have additional knowledge concerning various nutritional factors affecting milk production. The results reported in this paper are of further interest because of the absence in the literature of data on the effect of feeding cystine to lactating dairy cows.

In a previous report (11) it was indicated that alfalfa hay grown in the vicinity of East Lansing, Michigan, and fed as a sole ration to milking cows was deficient in a factor or factors essential for efficient milk production. The addition of isocaloric amounts of either corn or beet pulp in place of some of the alfalfa resulted in a marked increase in milk production. More recent work (13) has shown that the addition of either corn starch or glucose to an all alfalfa ration was much less effective than the addition of corn or beet pulp. The literature pertaining to the nutritive value of alfalfa hay has been summarized by Graves and co-workers (7) and Huffman (12).

The earlier work on the amino acid content of alfalfa protein has been reviewed by Mitchell and Hamilton (19). Chibnall (1) has summarized the amino acid content of alfalfa protein which was reported in the literature by Lugg (15, 16) and Tristram (22) as follows (expressed as percentage of protein):

Arginine	8.0	Lysine	6.2
Aspartic acid	8.8	Methionine	2.3
Cystine	1.9	Tyrosine	6.1
Glutamic acid	11.4	Tryptophane	2.4
Histidine	1.5		

The possibility of a cystine deficiency in alfalfa protein has been indicated by the work of Haag (8) with growing rats. Rats receiving alfalfa leaf meal as their only source of protein responded favorably when cystine was added to the ration. Similar results were obtained by Kellermann (14) who found that rats fed alfalfa as the only source of protein suffered from

Received for publication February 24, 1942.

* Published with the approval of the Director of the Agricultural Experiment Station as Journal Article no. 576 (n. s.).

a deficiency which was immediately relieved by the addition of 0.1 per cent l-cystine. Smuts and Marais (21) found that the addition of 0.2 per cent cystine to an all alfalfa diet fed to rats increased markedly the biological value of the alfalfa protein from 67 to 87. Marais and Smuts (17) reported more recently that methionine was a better supplement than cystine to alfalfa protein but that the best results were obtained when both methionine and cystine were fed.

Wright and Haag (24) reported that the addition of 0.4 per cent l-cystine to the diet of female rats receiving 9 per cent alfalfa protein markedly enhanced the lactation-promoting properties of the ration. In a more recent report, Haag and Wright (9) concluded that cystine and methionine served primarily in making sulphur-deficient rations nutritionally adequate rather than acting as unique lactation stimulants.

In view of the above investigations it appears that the cause of low milk production of our cows on an all alfalfa hay ration might be due to a deficiency of cystine. The object of the present paper is to report the value of cystine as a specific nutrient when fed to lactating cows as a supplement to an all alfalfa hay ration.

METHODS

Five cows, two Holsteins, Nos. A7 and A14, two Brown Swiss, Nos. 237 and 239, and one Jersey, No. 77, which had been maintained on an all alfalfa hay ration as their only source of protein and energy since calving, were used in this study. The cows were fed all of the first cutting, No. 2 alfalfa hay that they would eat. The all-roughage ration was supplemented with salt and in some cases with bone meal. Each cow was paired with normally fed cows in the herd to check any marked variation in milk or fat production which might be attributed to environment. Since these data do not show any significant variations, they are not presented. The cows were fed and cared for twice daily and weighed each day. They received their feed while stanchioned in the barn but they were turned out in a dry lot between milking periods. The milk produced by each cow was weighed after each milking and an aliquot sample of the milk (preserved with 5 drops of formalin) was composited over a 3-day period for a butterfat determination. Fat-corrected milk (F.C.M.) was determined by the Gaines formula (5).

The cystine was forcibly fed to each cow in gelatin capsules to insure complete ingestion. The cystine fed to cows Nos. A7 and 239 was prepared from human hair by the method of Gortner and Hoffman (6) while that fed to the other three cows was purchased from a reliable drug manufacturing company.

Corn was fed to four cows and barley to one cow in place of isocaloric quantities of alfalfa or corn starch following the feeding of cystine in order to determine whether or not the cows had the inherent ability to produce more milk when a cereal grain supplemented the alfalfa ration. All of the

cows used in this experiment were past the peak of their production on the all alfalfa hay ration and the rate of production was declining.

The average values obtained from the analysis of the two hays used in this study are shown in table 1. The coefficients of digestibility, digestible

TABLE 1

Proximate composition of the two alfalfa hays used in this investigation

	Alfalfa (A) 1st cutting fed to cow No. 239	Alfalfa (B) -light grass 1st cutting fed to cows Nos. A7, A14, 77 and 237
	%	%
Moisture	17.22	11.57
Protein	14.94	10.81
Ether extract	1.16	1.21
Crude fiber	33.50	35.96
N.F.E.	32.43	35.02

protein and total digestible nutrients obtained for cows Nos. A17, A23, A14 and 237 are shown in table 2. These data are based on 10-day collection

TABLE 2

Coefficients of digestibility, digestible protein and total digestible nutrients of the two alfalfa hays

Alfalfa No.	Cow No.	Coefficients of digestibility				Digestible protein	Total digestible nutrients
		Protein	Ether extract	Crude fiber	N.F.E.		
		%	%	%	%	%	%
(A)	A 18	71.1	17.0	46.0	62.7	10.6	46.8
	A 23	67.4	8.0	48.9	67.9	7.2	47.0
	Average	69.2	12.5	47.5	65.3	8.9	46.9
(B)	A 14	64.1	45.6	51.4	58.6	6.5	44.4
	237	59.8	28.1	50.2	54.5	6.9	47.2
	Average	62.0	36.8	50.8	56.5	6.7	45.8

periods. Aliquot samples of feces and urine were taken each day, preserved with hydrochloric acid, and saved for chemical analysis. The nitrogen

TABLE 3

Nitrogen metabolism data of cows receiving alfalfa hay (B)

Cow No.	Weight	Milk	Intake		Nitrogen outgo				Balance
			Hay	Nitrogen	Feces	Urine	Milk	Total	
	kg.	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*
A 14	605.4	12,442	19,688	346.0	126.8	166.6	54.4	347.8	− 1.8
237	524.5	9,426	17,417	297.7	119.7	145.5	50.1	315.3	−17.6

TABLE 4

*Effect of supplementing an all alfalfa hay or alfalfa-starch ration with cystine and with corn or barley**

Cow No.	Experimental period	In milk	Body weight	Milk	Test	Fat	F.C.M.	Alfalfa consumed	Digestible protein		Total digestible nutrients		Remarks
									Rec.	Req.	Rec.	Req.	
	days	*days*†	*lb.*	*lb.*	*%*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	
237	15	102	1159	20.9	4.2	0.87	21.4	39.7	2.66	1.79	18.2	16.0	Alfalfa alone
	15	117	1151	22.3	3.8	0.86	21.8	38.7	2.59	1.80	17.7	16.0	" plus 20 gm. cystine per day
	6	132	1151	20.3	3.9	0.79	20.0	38.7	2.59	1.72	17.7	15.4	" alone
	15	138	1143	25.0	3.6	0.91	23.6	24.4	2.28	1.89	18.4	16.5	" plus 9 lb. corn per day
A14	15	167	1340	27.0	3.3	0.88	24.1	44.8	3.00	2.05	20.5	18.1	Alfalfa alone
	15	182	1351	28.3	3.1	0.87	24.4	44.5	2.98	2.07	20.4	18.2	" plus 20 gm. cystine per day
	6	197	1356	25.9	3.2	0.84	23.0	44.6	2.99	2.00	20.4	17.8	" alone
	15	203	1337	31.8	3.0	0.97	27.2	30.0	2.65	2.21	21.0	19.0	" plus 9 lb. corn per day
239	12	74	1170	23.5	3.9	0.91	23.1	41.4	4.24	1.88	19.2	16.6	Alfalfa alone
	12	86	1170	23.8	3.9	0.92	23.4	41.9	4.29	1.90	19.4	16.7	" plus 20 gm. cystine per day
	9	98	1143	23.7	3.9	0.93	23.4	41.2	4.22	1.88	19.1	16.5	" alone
	18	107	1116	28.2	3.7	1.04	26.8	27.0	3.41	2.07	19.7	17.4	" plus 9 lb. corn per day
77	12	121	764	18.0	5.1	0.93	21.1	26.3	1.76	1.53	12.5	13.1	Alfalfa alone
	12	133	768	17.7	4.9	0.87	20.1	26.4	1.77	1.49	18.1	12.8	" plus 6 lb. glucose per day
	12	145	767	16.9	4.8	0.82	19.0	27.6	1.85	1.44	18.4	12.5	" plus 6 lb. starch per day
	15	157	784	16.5	5.1	0.84	19.1	27.2	1.82	1.45	18.2	12.6	" plus starch plus 20 gm. cystine per day
	6	172	792	17.1	5.4	0.92	20.7	28.0	1.88	1.53	18.5	13.2	" plus 6 lb. starch per day
	12	178	796	18.3	5.2	0.95	21.6	28.0	2.31	1.58	18.2	13.5	" plus 6 lb. corn per day
A7	15	95	1165	25.7	2.8	0.73	21.2	39.1	2.62	1.83	18.1	15.9	Alfalfa alone
	12	110	1185	16.0	3.1	0.50	13.9	34.9	2.34	1.45	16.1	13.7	" plus 40 gm. cystine per day
	24	122	1157	20.1	2.9	0.59	16.9	38.4	2.57	1.59	17.8	14.5	" alone
	15	146	1152	24.1	2.7	0.66	19.6	25.0	2.38	1.72	17.5	15.3	" plus 7.5 lb. barley per day

* The original experimental data were compiled by 3-day periods whereas the above values represent the mean values obtained for each experimental period.
† At beginning of experimental period.

metabolism data for cows Nos. A14 and 237 are presented in table 3. The values obtained for digestible protein and total digestible nutrients were secured from the metabolism trials and these data were used to calculate the intake of digestible protein and total digestible nutrients reported in table 4.

RESULTS AND DISCUSSION

The experimental data obtained from this experiment are summarized in table 4. These data include body weight, days in milk, milk and fat production, hay consumption and the total digestible nutrient requirement of each cow and the actual amount each cow received per day during each period. The digestible protein and total digestible nutrients for corn and barley were obtained from Morrison (20) whereas the total digestible nutrients for corn starch and glucose were estimated. As shown in table 4, all of the cows were consuming sufficient total digestible nutrients to meet their requirements for maintenance and milk production, with the exception of cow No. 77 during the initial alfalfa feeding period. Most of the cows were fed more than two pounds of total digestible nutrients in excess of the Morrison (20) feeding standard recommended for good cows under usual conditions.

The data presented in table 4 indicate that the ingestion of 20 grams of cystine per day by cows which had received an all alfalfa hay ration since calving aided in maintaining milk and fat production but did not increase milk production significantly. Cows Nos. 237, A14, and 239 had an average increase in fat-corrected milk of 0.4, 0.3 and 0.3 pounds per day, respectively. The test had a tendency to decrease but the amount of fat produced was not changed significantly. The ingestion of 20 grams of cystine had no effect on the consumption of alfalfa hay. After the cystine had been removed from the ration the fat-corrected milk decreased 1.8, 1.4 and 0.0 pounds per day, respectively. There was a tendency for the test to increase and fat production to decrease. The replacement of 15 pounds of alfalfa with 9 pounds of corn markedly increased the production of butterfat, milk and fat-corrected milk, and decreased the test.

Cow No. 77 was used to study the effect of additional available energy in the ration on milk production. The results show that the addition of glucose, corn starch or corn starch and cystine to an all alfalfa hay ration had no lactation-stimulating effect. A more favorable influence was noted after cystine had been omitted from the alfalfa-starch ration but the addition of six pounds of corn in place of six pounds of corn starch was even more favorable for the production of milk and fat than during the corn starch and cystine feeding period or the initial alfalfa feeding period.

The addition of 20 grams of cystine per day to cows Nos. 237, A14, 239, and 77 did not affect appetite or body weight although Wright and Haag (24) reported that the addition of 0.1 to 0.4 per cent cystine added to the

diet of lactating rats receiving 9 per cent alfalfa protein usually increased the food intake, increased the milk yields, and reduced body weight losses. Daggs and Lidfeldt (3) and Haag and Wright (9) reported that the addition of cystine and methionine to sulfur-deficient diets of lactating rats stimulated lactation. The failure of cystine to increase milk production significantly in cows on an all alfalfa ration may be explained on the basis of a higher percentage of protein in the ration (10.8 to 14.0 per cent) and the somewhat higher coefficient of digestibility of the protein of alfalfa by cows than by rats. Dougherty (4) has suggested that the failure of cystine to increase milk production in dairy cows may be due to its complete or nearly complete destruction in the rumen. This concept is not in complete harmony with the results obtained by feeding cystine (20 grams) as indicated in table 4, because the decline in milk and fat production was checked and a slight improvement in milk yield was obtained. Whether the improvement in milk production can be attributed to the cystine supplement or to a stimulation in metabolism in not known. Our results indicate, however, that cystine is not the first deficiency of an all alfalfa hay ration or of a ration of alfalfa and glucose or corn starch. The possibility of the synthesis of methionine by the rumen flora cannot be ruled out entirely although Woodman and Evans (23) have shown that cystine is not synthesized in the rumen.

The results obtained from cow No. A7, which received 40 grams of cystine per day as a supplement to an all alfalfa ration, are summarized also in table 4. The cow's appetite was not affected during the first three days after receiving the cystine supplement but milk production dropped at once from 18.9 pounds of fat-corrected milk per day during the previous 3-day period to 15.1 pounds per day during the first three days of the cystine feeding period. During each subsequent 3-day cystine feeding period the cow's appetite for alfalfa decreased. This was also accompanied by a decrease in milk yield, an increase in fat percentage and an increase in body weight. After the cystine was discontinued, the cow's appetite and milk production increased and body weight and fat percentage decreased. With the exception of the increase in body weight and the decrease in appetite, no toxic symptoms were manifested. Wright (25) has reported that toxic symptoms were observed in young rats when they received 1 per cent cystine in their diet, but that mature rats were less susceptible than the young rats. Since A7 received about 0.2 per cent cystine in the ration and about 0.5 per cent on total digestible nutrients basis it appears that the bovine has a low tolerance for cystine. The replacement of 15 pounds of alfalfa with 7.5 pounds of barley increased milk and fat production markedly over the cystine feeding period and the subsequent all alfalfa feeding period, further reduced the percentage of fat in the milk and increased the fat production significantly, but did not quite equal the results obtained during the initial alfalfa feeding period.

It should be pointed out that in all cases the milk and fat productions were significantly higher during the corn feeding periods than during the alfalfa feeding periods preceding the ingestion of 20 grams of cystine, which serves to emphasize the fact that the cows had the ability to increase their production against the rapid decline in lactation on the all alfalfa ration provided the necessary lactation-stimulating nutrients were present in the ration.

The increase in milk production obtained when either corn or barley was fed as a supplement to the alfalfa ration confirms the early work of Hart and Humphrey (10) who observed that cows receiving a ration of alfalfa and corn starch declined in milk production but that milk production could be stimulated by changing the cows to a ration of corn, corn gluten feed and corn stover. Marais and Smuts (18) found that the corn grain protein has a fairly high biological value but that the combination of alfalfa and corn proteins supplement each other to a marked degree. Corn is reported to be low in cystine (2) but it contains the necessary factor or factors for efficient milk production when fed as a supplement to an all alfalfa hay ration.

SUMMARY AND CONCLUSIONS

1. Five lactating cows which had received alfalfa hay as the sole ration since calving and which had declined in milk production to the point where they were consuming larger amounts of total digestible nutrients than were required by a liberal standard were used in this investigation.

2. The addition of 20 grams of l-cystine per day to the ration of four cows appeared to check the rapid decline in milk and fat production obtained on the all alfalfa hay ration but did not increase milk production significantly.

3. The addition of 40 grams of l-cystine per day to the ration of one cow produced a sharp drop in milk and fat production. The consumption of hay was decreased but body weight increased.

4. The replacement of part of the alfalfa hay with isocaloric amounts of corn produced significant increases in milk and fat production over the initial alfalfa feeding period and the subsequent cystine feeding period.

5. The results of this experiment indicate that cystine is not the first deficiency of an all alfalfa hay ration or of an alfalfa and corn starch ration.

ACKNOWLEDGMENT

The authors are indebted to Miss Lillian I. Butler for the chemical determinations made on the hay, urine and feces samples.

REFERENCES

(1) CHIBNALL, A. C. Protein Metabolism in the Plant. Chap. 7. Yale Univ. Press, New Haven, Conn. 1939.

(2) CSONKA, F. A. Amino Acids in the Corn Kernel. Jour. Agr. Res., 59: 765–768. 1939.

(3) DAGGS, R. G., AND LIDFELDT, V. S. M. The Effect of the Sulphydryl Compounds on Milk Production. Jour. Nutr., 15: 211–220. 1938.

(4) DOUGHERTY, R. W. Further Investigations of Rumen Gases and Bloat in Ruminants. Amer. Vet. Med. Assoc. Jour., 99: 110–114. 1941.

(5) GAINES, W. L. The Energy Basis of Measuring Milk Yield in Dairy Cows. Ill. Agr. Expt. Sta. Bul. 308. 1928.

(6) GORTNER, R. A., AND HOFFMAN, W. F. Organic Syntheses. Vol. 5, pp. 39–41. John Wiley and Sons, Inc., New York. 1925.

(7) GRAVES, R. R., DAWSON, J. R., KOPLAND, D. V., WATT, A. L., AND VAN HORN, A. G. Feeding Dairy Cows on Alfalfa Hay Alone. U. S. Dept. Agr. Tech. Bul. 610. 1938.

(8) HAAG, J. R. The Physiological Effect of Rations Restricted Principally or Solely to the Alfalfa Plant. II. Cystine as a Limiting Factor in the Nutritive Value of Alfalfa Proteins. Jour. Nutr., 4: 363–370. 1931.

(9) HAAG, J. R., AND WRIGHT, L. D. Cystine and Methionine for Growth and Lactation. Jour. Nutr., 19: 563–568. 1940.

(10) HART, E. B., AND HUMPHREY, G. C. The Comparative Efficiency for Milk-Production of the Nitrogen of Alfalfa Hay and Corn Grain. Wis. Agr. Expt. Sta. Res. Bul. 33. 1914.

(11) HUFFMAN, C. F. A Method of Studying the Deficiencies of Alfalfa Hay and the Feeding Value of Various Feeds as Supplements to Alfalfa Hay. JOUR. DAIRY SCI., 21: 5, 101. 1938.

(12) HUFFMAN, C. F. Roughage Quality and Quantity in the Dairy Ration, A Review. JOUR. DAIRY SCI., 22: 889–980. 1939.

(13) HUFFMAN, C. F., AND DUNCAN, C. W. Unpublished data. Mich. Agr. Expt. Sta. 1942.

(14) KELLERMANN, J. H. Further Observations on the Cystine Deficiency of Lucerne Proteins and the Effect of Heat and Incubation upon Their Growth-Promoting Value. Onderstepoort Jour. Vet. Sci. and Anim. Indus., 4: 437–452. 1935.

(15) LUGG, J. W. H. The Amide, Tyrosine and Tryptophan Contents and Sulphur Distributions (Cystine plus Cysteine and Methionine Contents) of Some Leaf Plant Protein Preparations. Biochem. Jour., 32: 2123–2128. 1938.

(16) LUGG, J. W. H. The Representativeness of Extracted Samples and the Efficiency of Extraction of Protein from the Fresh Leaves of Plants; and Some Partial Analyses of the Whole Proteins of Leaves. Biochem. Jour., 33: 110–122. 1939.

(17) MARAIS, J. S. C., AND SMUTS, D. B. The Effect of Supplementing Lucerne with Cystine and Methionine on the Growth of Rats. Onderstepoort Jour. Vet. Sci. and Anim. Indus., 21: 369–375. 1939.

(18) MARAIS, J. S. C., AND SMUTS, D. B. The Amino Acid Deficiencies of Certain Plant Proteins and the Supplementary Effect between Plant Proteins as Measured by Means of Their Biological Values. Onderstepoort Jour. Vet. Sci. and Anim. Indus., 15: 225–238. 1940.

(19) MITCHELL, H. H., AND HAMILTON, T. S. The Biochemistry of the Amino Acid. The Chemical Catalog Co., Inc., New York. 1929.

(20) MORRISON, F. B. Feeds and Feeding. 20th ed. Unabridged. The Morrison Publishing Co., Ithaca, N. Y. 1936.

(21) SMUTS, D. B., AND MARAIS, J. S. C. Plant Proteins. III. The Supplementary Effect Among Certain Plant Proteins. Onderstepoort Jour. Vet. Sci. and Anim. Indus., 11: 151–159. 1938.

(22) TRISTRAM, G. R. The Basic Amino Acids of Leaf Proteins. With a Discussion of Various Methods of Analysis. Biochem. Jour., 33: 1271–1283. 1939.

(23) WOODMAN, H. E., AND EVANS, R. E. Cystine and Wool Production. Nature, 130: 1001. 1932.

(24) WRIGHT, L. D., AND HAAG, J. R. The Lactation-Promoting Effect of l-Cystine When Fed With Alfalfa Proteins. Jour. Nutr., 17: 263–268. 1939.

(25) WRIGHT, L. D. The Role of Cystine and Methionine in Lactation. Ph.D. Thesis. Oreg. State Col. 1940.

A STATISTICAL STUDY OF THE INFLUENCE OF MOISTURE AND ACIDITY ON THE PALATABILITY AND FERMENTATION LOSSES OF ENSILED HAY CROPS[1]

T. E. WOODWARD AND J. B. SHEPHERD
Bureau of Dairy Industry, U. S. Department of Agriculture

Since the recent awakened interest in the preservation of hay crops in the silo, we have made about 175 lots of experimental silage at the Beltsville Research Center, with a view to determining the most efficient, practicable, and economical methods of making silage from hay crops.

Most of the silages were made in small wooden silos 4 feet in diameter by 8 feet high and holding about 1 ton each, but some were made in larger silos of paper-lined slatted fence or of concrete. The small silos have proved very useful for this type of work. The quantity in each silo was sufficient for reliable tests of palatability and still not so much as to preclude the practicability of the accurate weighing in and weighing out of all the material. The quantities were also small enough so that all the conditions surrounding the tests could be kept identical except the treatment to be tried. The use of small silos made it possible to try a greater number of methods, and also to make a greater number of replications, than would have been possible with large silos.

Some investigators have claimed that typical silage cannot be made in silos holding only 1 ton. It does appear that the radiation of heat from a small silo prevents the temperature from rising as high and from persisting as long as it would in a larger silo. Furthermore, weighting the top, even at the rate of 40 pounds to the square foot in order to simulate conditions in a deeper silo, still does not cause as much pressure on the silage as would occur in the lower part of a silo of ordinary size. In spite of these differences we have found that the silages preserved in small silos have all the characteristics of normal silage and cannot be distinguished by appearance or odor from those made by similar methods in larger silos. Therefore, we maintain that the most feasible way to try out different methods in well-controlled experiments is by the use of small silos, also that the comparative results of different treatments in small silos will be similar to those that would be obtained in large silos.

PROCEDURE IN MAKING AND FEEDING THE SILAGE

The chopped crop was always blown into a pile near the small silos. As few as 2 or as many as 12 silos were filled at one time with identical material

Received for publication February 28, 1942.

[1] All chemical determinations were made by C. G. Melin, Junior Chemist, Bureau of Dairy Industry.

but with different treatments. The material was weighed in baskets holding 50 pounds each, and one or two basketfuls were placed in each silo in succession. When molasses or acid was used it was added with a sprinkling can after every 100 pounds of chopped material. When crops wilted in the field were compared with unwilted crops the silos were filled at different times, but care was exercised to have wilting the only important variable. When chopped dry hay was used to reduce the percentage of moisture it was mixed with each 100 pounds of the chopped green crop before it was put in the silo. A sample for compositing was taken from the pile every time 100 pounds had been put in each of the silos. The composite sample was analyzed for moisture, nitrogen, and carotene. Since some nitrogen and considerable carotene are lost in drying, the practice was to make the determinations of these constituents on the moist material.

When the silos were nearly full a layer of tarred paper was placed on top of the chopped material and 200 to 400 pounds more chopped material was placed on top of the paper. This made it possible to estimate the losses by fermentation, exclusive of the top spoilage. The filled silo was covered with a wooden follower, and weighted with rock at the rate of 40 pounds per square foot of area.

After 1 to 6 months the silos were opened, one at a time, and the silage fed at once as the sole ration, or with only a few pounds of grain, to 3 or 4 cows for about 6 days in order to see how much they would eat. Individual lots of the silages under comparison were always fed to the same cows, and if any grain was fed, which was seldom, the quantity remained unchanged. Samples of silage for compositing were taken at 5 different depths. Analyses were made for the same constituents and in the same way as when the crop was put in the silo.

STATISTICAL ANALYSIS

The first step in making the statistical analysis was to assemble the data into 3 tables. Table 1 shows a comparison of silages with different contents of moisture; table 2 a comparison of silage having a high pH value with silage having a lower pH value in which the lower pH value was brought about by addition of molasses; table 3, a comparison of silage having a high pH with silage having a low pH in which the low pH was brought about by the addition of hydrochloric and sulfuric acids. Since the silages on both sides of each table are the same, except for the treatment at the time the silos were filled, comparisons to determine the influence of the treatment can properly be made only from left to right and not up and down.

The silages were all free of mold and decay. The odor showed that except for certain of the untreated high-moisture legumes, the silages had undergone a desirable type of fermentation. Some of the bad smelling silages lacked palatability, but some of the good smelling acid-treated silages were even more unpalatable.

TABLE 1

Influence of moisture content on the palatability of silage as judged by the quantity of dry matter dairy cows consumed and on the losses of dry matter, protein and carotene in the silo

(Comparisons to be made from left to right and not up and down)

Kind of crop put in the silo	Higher moisture					Lower moisture				
	Moisture	Dry matter consumed per cow per day	Losses in the silo exclusive of top spoilage			Moisture	Dry matter consumed per cow per day	Losses in the silo exclusive of top spoilage		
			Dry matter	Protein	Carotene			Dry matter	Protein	Carotene
	per cent	*pounds*	*per cent*	*per cent*	*per cent*	*per cent*	*pounds*	*per cent*	*per cent*	*per cent*
Orchard grass	81.8	19.8	14.0	.....	.....	57.5	23.4	26.0	.....	.....
Crabgrass, pigeon grass, alfalfa	64.0	17.6	25.0	.....	.....	28.0	21.6	27.0	.....	.....
Crabgrass, pigeon grass, alfalfa	67.0	19.5	27.0	.....	.....	28.0	21.6	27.0	.....	.....
Orchard grass rowen	71.3	16.7	0.2	+ 2.5	.....	51.1	18.6	0.6	+ 5.4	.....
Kentucky bluegrass	66.4	21.8	6.1	+ 3.4	14.1	20.6	23.0	3.4	+ 0.2	23.4
Alfalfa	60.0	16.6	3.6	15.0	.....	40.2	17.6	1.0	+ 1.9	.....
Alfalfa	75.6*	17.7	8.4	+ 0.8	+ 9.2	26.0	29.4	2.4	11.5	52.2
Alfalfa + HCl and H_2SO_4	75.9	10.3	8.3	10.3	+ 14.8	36.5	18.5	6.8	+ 0.2	41.3
Alfalfa + 3% molasses	75.2*	19.4	10.0	8.4	21.1	27.7	31.0	2.3	6.0	51.1
Soybeans	70.9	22.2	5.1	+ 3.6	36.9	42.4	24.0	1.1	+ 3.7	56.3
Alfalfa	71.6	28.9	7.5	1.2	67.0	65.1	30.3	6.3	3.2	61.4
Alfalfa	71.6	28.9	7.5	1.2	67.0	37.0	31.6	+ 0.6	+ 6.4	20.3
Alfalfa	74.1*	23.5	9.6	3.6	42.9	58.9	26.3	2.6	4.5	58.9
Lespedeza sericea	66.6	21.7	8.2	+ 1.3	19.3	42.1	22.0	8.3	9.6	51.5
Lespedeza sericea + 2.5% molasses	65.8	22.6	10.0	1.3	23.3	44.4	22.3	12.5	4.3	30.7
Lespedeza sericea + 5.0% molasses	65.9	23.6	7.9	+ 2.9	4.8	44.0	22.2	10.4	2.8	25.9
Alfalfa	73.5*	13.7	4.2	3.6	26.0	66.2†	21.5	9.8	+ 1.5	34.1
Oats (slatted fence silo)	73.4	18.3	19.4	14.0	33.9	61.6	23.6	10.6	15.9	37.4
Oats + 2% molasses (slatted fence silo)	74.2	17.5	12.9	22.1	5.9	64.3	21.9	10.7	7.0	33.6
Alfalfa (14′ × 42′ silo)	69.2	24.1	14.0	.....	13.0	48.5	27.1	5.3	.....	25.6
Alfalfa (14′ × 42′ silo)	69.2	24.1	14.0	.....	13.0	37.2	25.3	7.7	.....	33.5
Alfalfa + 4% molasses (14′ × 42′ silo)	67.4	24.9	11.2	.....	6.3	41.1	26.3	2.5	.....	26.2
Alfalfa + 4% molasses (14′ × 42′ silo)	67.4	24.9	11.2	.....	6.3	34.4	26.5	13.2	.....	25.1
Alfalfa	72.9‡	28.7	6.7	9.7	33.9	57.5	34.0	5.6	1.4	48.7
Alfalfa	72.9‡	28.7	6.7	9.7	33.9	65.8§	31.0	5.3	3.9	29.5
Average	70.6	21.4	10.3	4.8	22.2	45.0	24.8	8.3	2.8	38.3

* Ojectionable odor. All other silages in this table had a good odor and were free of mold and decay.

† Moisture reduced by adding 19% of dry alfalfa hay.

‡ Odor slightly off.

§ Moisture reduced by adding 15% dry alfalfa hay.

TABLE 2

Influence of pH values on palatability and on losses of dry matter, protein and carotene in the silo when a reduced pH is brought about by the addition of molasses

(Comparisons to be made from left to right and not up and down)

Higher pH							Lower pH						
Kind of crop put in the silo	pH	Moisture	Dry matter consumed per cow per day	Losses in the silo exclusive of top spoilage			Kind of crop put in the silo	pH	Moisture	Dry matter consumed per cow per day	Losses in the silo exclusive of top spoilage		
				Dry matter	Protein	Carotene					Dry matter	Protein	Carotene
		per cent	*pounds*	*per cent*	*per cent*	*per cent*			*per cent*	*pounds*	*per cent*	*per cent*	*per cent*
Kentucky bluegrass	5.52	66.4	21.8	6.1	+ 3.4	14.1	Ky. bluegrass + 3% molasses	5.36	63.1	23.6	5.6	3.4	11.2
Alfalfa	5.30	74.4	14.0	12.1	20.3	6.1	Alfalfa + 3% molasses	4.93	73.9	13.5	12.7	19.9	40.4
Alfalfa*	5.48	75.6	17.7	8.4	+ 0.8	+ 9.2	Alfalfa + 3% molasses*	5.13	75.2	19.4	10.0	8.4	21.1
Alfalfa	5.20	26.0	29.4	2.4	11.5	52.2	Alfalfa + 3% molasses	5.12	27.7	31.0	2.3	6.0	51.1
Soybeans	5.04	70.9	22.2	5.1	+ 3.6	36.9	Soybeans + 3% molasses	4.66	67.3	22.7	9.9	11.0	38.7
Alfalfa	4.48	71.6	28.9	7.5	1.2	67.0	Alfalfa + 4% molasses	4.07	70.6	31.2	9.2	6.4	34.4
Soybeans	4.85	71.4	28.3	5.9	6.0	16.8	Soybeans + 4% molasses	4.09	69.4	29.5	5.2	12.1	3.9
Alfalfa and crab grass	4.36	75.0	22.1	4.9	18.8	62.2	Alfalfa and crab grass + 4% molasses	3.85	73.6	27.0	3.2	12.7	48.3
Lespedeza sericea	4.38	66.6	21.7	8.2	+ 1.3	19.3	*Lespedeza sericea* + 2.5% molasses	4.10	65.8	22.6	10.0	1.3	23.3
Lespedeza sericea	4.38	66.6	21.7	8.2	+ 1.3	19.3	*Lespedeza sericea* + 5.0% molasses	4.06	65.9	23.6	7.9	+ 2.9	4.8
Lespedeza sericea	4.85	42.1	22.0	8.2	9.6	51.5	*Lespedeza sericea* + 2.5% molasses	4.32	44.4	22.3	12.5	4.3	30.7
Lespedeza sericea	4.85	42.1	22.0	8.2	9.6	51.5	*Lespedeza sericea* + 5.0% molasses	4.30	44.0	22.2	10.4	2.8	25.9
Soybeans*	5.32	78.7	16.6	17.3	15.7	15.1	Soybeans + 4% molasses	4.20	75.8	23.5	13.6	5.5	10.9
Oats (slatted fence silo)	4.07	73.4	18.3	19.4	14.0	33.9	Oats + 2.2% molasses (slatted fence silo)	3.64	74.2	17.5	12.9	22.1	5.9
Oats (slatted fence silo)	4.31	61.6	23.6	10.6	15.9	37.4	Oats + 3.0% molasses (slatted fence silo)	4.16	64.3	21.9	10.7	7.0	33.6
Alfalfa (14′ × 42′ silo)	4.70	69.2	24.1	14.0	.....	13.0	Alfalfa + 3.4% molasses (14′ × 42′ silo)	3.94	67.4	24.9	11.2	.....	6.3
Alfalfa (14′ × 42′ silo)	4.70	48.5	27.1	5.3	.....	25.6	Alfalfa + 4.2% molasses (14′ × 42′ silo)	4.69	41.1	26.3	2.5	.....	26.2
Alfalfa (14′ × 42′ silo)	4.71	37.2	25.3	7.7	.....	33.5	Alfalfa + 4.3% molasses (14′ × 42′ silo)	4.65	34.4	26.5	13.2	.....	25.1
Alfalfa	3.98	72.9	28.7	6.7	9.7	33.9	Alfalfa + 4% molasses	3.65	71.3	30.6	1.4	4.0	4.2
Average	4.76	62.6	22.9	8.7	7.6	30.5	Average	4.36	61.5	24.2	8.6	7.8	23.5

* Objectionable odor.

TABLE 3

Influence of pH values on palatability and on losses of dry matter, protein, and carotene in the silo when the pH is brought to 4.2 or lower by the addition of hydrochloric and sulphuric acids

(Comparisons to be made from left to right and not up and down)

Higher pH							Lower pH						
Kind of crop put in the silo	pH	Moisture	Dry matter consumed per cow per day	Losses in the silo exclusive of top spoilage			Kind of crop put in the silo	pH	Moisture	Dry matter consumed per cow per day	Losses in the silo exclusive of top spoilage		
				Dry matter	Protein	Carotene					Dry matter	Protein	Carotene
		per cent	*pounds*	*per cent*	*per cent*	*per cent*			*per cent*	*pounds*	*per cent*	*per cent*	*per cent*
Orchard grass rowen	4.45	71.3	16.7	0.2	+ 2.5	19.4	Orchard grass rowen + 6% 2N acid	4.02	72.6	18.3	3.5	+12.2	12.6
Kentucky bluegrass	5.52	66.4	21.8	6.1	+ 3.4	14.1	Ky. bluegrass + 10% 2N acid	3.49	65.4	14.2	1.9	+ 5.0	6.2
Alfalfa	5.30	74.4	14.0	12.1	20.3	6.1	Alfalfa + 10% 2N acid	3.55	74.2	8.6	6.6	+ 2.0	0.9
Alfalfa*	5.48	75.6	17.7	8.4	+ 0.8	+ 9.2	Alfalfa + 9% 2N acid	3.66	75.9	10.3	11.4	10.3	+14.8
Alfalfa	5.20	26.0	29.4	2.4	11.5	52.2	Alfalfa + 14% 2N acid	3.54	36.5	18.5	8.6	+ 0.2	41.3
Alfalfa	4.83	59.3	28.1	6.7	2.5	55.4	Alfalfa + 10% 2N HCl	3.93	61.7	20.3	5.4	6.7	34.8
Alfalfa*	5.43	74.1	23.5	9.6	3.6	42.9	Alfalfa + 6% 2N acid	4.06	73.8	18.6	1.8	+ 1.4	12.0
Alfalfa*	5.43	74.1	23.5	9.6	3.6	42.9	Alfalfa + 8% 2N acid	3.72	73.8	13.3	+ 1.3	+ 6.4	11.5
Soybeans	5.12	71.0	28.3	9.8	12.5	21.6	Soybeans + 4% 2N acid	4.20	70.8	25.1	5.6	13.2	5.0
Soybeans	5.12	71.0	28.3	9.8	12.5	21.6	Soybeans + 6% 2N acid	3.19	71.0	16.2	7.3	17.8	6.6
Soybeans	5.12	71.0	28.3	9.8	12.5	21.6	Soybeans + 8% 2N acid	2.95	71.1	15.4	4.0	11.3	+14.1
Average	5.18	66.8	23.6	7.7	6.6	26.2	Average	3.66	67.9	16.3	5.0	2.9	9.3

* Objectionable odor.

The F test for significance[2] was applied to 3 comparative treatments: (1) high moisture vs. low moisture, (2) high pH vs. lower pH brought about by the addition of molasses, and (3) high pH vs. low pH brought about by the addition of hydrochloric and sulfuric acids. (See table 4.)

TABLE 4

F tests for significance

	Dry matter consumed	Losses in the silo		
		Dry matter	Protein	Carotene
High moisture vs. low moisture				
F values found	25.74	4.06	1.05	10.36
F values required at odds of 99 : 1	7.82	7.82	8.40	8.18
F values required at odds of 19 : 1	4.26	4.26	4.45	4.38
Significance in favor of	Low moisture	Neither	Neither	High moisture
Higher pH vs. lower pH through addition of molasses				
F values found	7.89	58.33*	200*	2.98
F values required at odds of 99 : 1	8.28	.....	.....	8.28
F values required at odds of 19 : 1	4.41	.....	.....	4.41
Significance in favor of	Lower pH	Neither	Neither	Neither
High pH vs. low pH through addition of hydrochloric and sulphuric acids				
F values found	32.70	2.98	1.67	25.11
F values required at odds of 99 : 1	10.04	10.04	10.04	10.04
F values required at odds of 19 : 1	4.96	4.96	4.96	4.96
Significance in favor of	High pH	Neither	Neither	Low pH

*Mean square of error exceeded mean square of treatment.

The data presented in table 1 show that a reduction of the moisture content of high-moisture crops improves the quality of the silage, as judged by the odor and dry matter consumed, without at the same time increasing the losses of dry matter or protein. But they show also that reducing the moisture content by wilting or by adding dry hay increases the loss of carotene in the silo, and there is, of course, a greater loss of carotene in the field when the crop is allowed to wilt. Furthermore, we found that low-moisture silages do not keep as well when exposed to the air as high-moisture silages, and they must be fed out more rapidly after the silo is opened to prevent spoilage.

On the other hand, high-moisture silages exert a greater lateral pressure on the silo walls than low-moisture silages; and they are likely to leak juice, which is not only a nuisance but is also destructive to any sort of concrete or metal with which it comes in contact. Moreover, high-moisture crops require more labor.

[2] Snedecor, Geo. W. Statistical Methods, pp. 171–218. Collegiate Press, Inc., Ames, Iowa. 1937.

We feel that one should wilt the crop only enough to prevent leakage. If wilted only to this extent the odor will be good, the carotene will be well preserved, and there will be no need for any so-called preservative.

Silages made from low-moisture material have about the same pH values as silages made from high-moisture material, indicating that reducing the moisture content of the crop has no material effect on the acidity of the silage. The fact that low-moisture legumes make good silages shows that the development of considerable acidity is not necessary. Our work, and that of others, shows that legume silages that have a high-moisture content and a low acidity are likely to be ill-smelling, but if the acidity is high the odor of the silage will be good. In other words, a legume crop with a high-moisture content should be ensiled with such treatment as will produce considerable acidity in order to make a good-smelling silage. A wilted crop, however, can have a low acidity and still make good silage.

Our experience indicates that 68 per cent of moisture in legumes is about the dividing line so far as both leakage and odor are concerned. Legumes with more moisture should either be wilted or mixed with a dry material, or the acidity should be increased by the addition of acid or some material from which acid is formed.

The addition of molasses improves the odor of high-moisture legume silages and the palatability of all silages. It has no significant effect upon the losses that occur in the silo. No one appears to know just what products are formed from the molasses in the silo, nor what the nutritive values of these products are. It is impossible to say, therefore, whether or not a farmer gets back in feeding value 100 cents for every dollar he spends for molasses. In spite of this, the use of molasses is a good practice with high-moisture legumes, because of the improvement it brings about in the odor and palatability of the silage.

The addition of hydrochloric and sulfuric acids is not to be advised no matter how perfectly they appear to preserve the nutrients of a crop. No silo made of metal, tile, or concrete can long withstand the action of these acids. The silage is definitely unpalatable. The efficient preservation of carotene may be more apparent than real, as the Nutrition Division of the Bureau of Dairy Industry has found that much of the material passing for carotene in acidified silage is not true carotene. Investigations with silage to which acids have been added show the necessity for conducting actual feeding tests before making definite recommendations regarding the practical application of a method on dairy farms.

THE USE OF ULTRAVIOLET RAYS IN THE CHEESE FACTORY AND STORAGE ROOM[1]

F. R. SMITH
Division of Dairy Industry, College of Agriculture, University of California, Davis, California

The relative inexpensiveness of low-pressure ultraviolet lamps has awakened interest in their possible commercial value. Their maximum ultraviolet emission is in the 2500–2600Å region, which according to Gates (5) is the region of maximum lethal activity. Broadbent (1) gave installation data on the lamps as well as initial and upkeep cost. Several investigators have studied the lamps' lethal action on air-borne bacteria. On this subject the work of Sharp (9) and Whisler (11) deserves particular attention.

Because of the enthusiastic claims of some investigators, such as Garrett and Arnold (4), attention was given to the possible use of these low-pressure lamps in the dairy industry. Since mold contamination of cheese is a problem, tests were made on the value of the lamps in controlling the mold. Price (8), using the carbon lamp, had been unable to prevent the molding of cheese; but this new source might possibly prove more effective than the carbon lamp.

EXPERIMENTAL

Air-Borne Mold Spores

Six 15-watt hot cathode lamps were placed in a cheese-curing room measuring 15′7″ × 12′2″ × 11′3″. Air circulation was effected by two fans with 6-inch blades. Data on the condition of the room were collected by placing open Petri plates containing hardened Sabouraud's agar at four places in the room. These plates were exposed for 15 minutes and incubated at 30° C. for 72 hours. Observations covering a year failed to show any effective action—any control of the undesirable surface mold formation.

In studies to determine the efficacy of the lamp in killing air-borne mold spores, a 15-watt lamp was installed in a 3-inch tube. With the tube in a vertical position, mold spores were dislodged from a Petri plate and allowed to fall by the lamp. These spores, having been collected on sterile filter paper coated with sterile glycerine, were dispersed into distilled water adjusted to a surface tension of 35 dynes with sodium ricinoleate.[2] A total

Received for publication March 3, 1942.

[1] The author is indebted to the Committee on the Relation of Electricity to Agriculture, whose grant made this work possible; and to the General Electric Company for the lights used in these studies.

[2] Previous study had shown that this concentration of ricinoleate had no demonstrable effect on the spores, but did aid in dispersing them into the liquid.

count was made with a blood-counting chamber, and a viable count was taken by the plate method, using Sabouraud's agar. Judging from a series of tests with the light burning and the light off, the average percentage kill traceable to the lamp was 10 per cent.

Conceivably, the mold spores in this experiment would be clumped and would thus not allow the best conditions for ultraviolet activity. In the second experiment, therefore, air from contaminated room was pulled through a 3-inch tube containing a 15-watt hot cathode tube. The rate of flow as calculated by a venturi nozzle was 10 feet per minute. The air was circulated for 1 hour around an open Petri plate containing Sabouraud's agar. Tests were made with the lamp turned on and off. The average count with the lamp off was 12 molds per plate; with the lamp operating, 14 molds. With this apparatus it was impossible to secure a slower air flow.

These observations were confined to mold spores (*Penicillium roqueforti*) that have been shown to require 40–80 times as much radiation as *Escherichia coli* for complete killing (7). The data reported in the literature have been largely confined to *Escherichia coli* and do not indicate the value of the lamps on mold studies.

THE IRRADIATION OF CHEESE

The paraffined types of cheese were studied. Immediately before being coated, they were exposed to ultraviolet light for 10 minutes. The distance from the cheese surface to the lamp was 10 inches. Three lamps were arranged so that all surfaces of the cheese would be exposed to the rays. A second series of cheeses were similarly exposed for 10 minutes, paraffined, and again irradiated for 10 minutes. Judging from a study of 40 cheeses, exposure to ultraviolet light for the periods used in this study was not effective in preventing mold growth on the surface of the cheese or of the paraffin.

Curran's work (3) indicated that bacterial spores were more sensitive to heat after exposure to ultraviolet light. The experiments described above failed to indicate that the irradiated spores were more susceptible to the hot paraffin than those not irradiated. Possibly by the time of dipping (2–3 days) mycelia may have already penetrated the surface of the cheese. If this were true they would be more resistant to the ultraviolet. According to Tanner (10) the mycelia that had penetrated the surface of agar were very hard to kill.

Conceivably, some of the ultraviolet might penetrate the coating of the cheese and exert a lethal action on the organisms under the paraffin. Although no absolute figure could be secured for the thickness of the paraffin coating, values from 0.4–1.0 mm. were secured. Penetration studies were then made on certain of the materials used in coating or covering the cheese. The following values were obtained:

Coating material tested	Thickness in mm.	Microwatts/cm²
None	0	2100
Paraffin	0.64	370
Beeswax	0.56	110
*Pliofilm	0.07	800
*Pliofilm	0.07	400

* The pliofilm giving a value of 800 μ w/cm² had no inking, whereas that with the 400 μ w/cm² was selected to contain the maximum inking.

The values in this table were secured by means of a General Electric light meter with a germicidal attachment. This apparatus was described by Luckiesch (6), and the conversion factor from foot candles to micro watts has been given by Buttolph (2).

These data indicated that irradiation before or after paraffining with 15-watt low-pressure mercury-vapor lamps would not be effective in preventing the mold growth on cheese. Coating materials commonly used exerted a marked screening action on the 2537Å ultraviolet light.

According to experiments on canned Cheddar cheese, the lamp failed to prevent mold growth in the canned product even though cans and wrappers were autoclaved.

CONCLUSIONS

Ultraviolet light emitted from the 15-watt low-pressure mercury-vapor lamps has not proved effective in decreasing air-borne mold spores in the cheese curing room. Direct irradiation has failed to prevent mold growth on the surface of the cheese.

REFERENCES

(1) BROADBENT, H. S. A New Process Goes to Work. II. How to Apply Rentschlerizing. Food Indus., **10**: 327, 365. 1938.

(2) BUTTOLPH, L. J. The Measurement of 2537Å Radiation. G. E. Engineer's Bul., **78**: 27–29. 1941.

(3) CURRAN, H. R., AND EVANS, F. R. Sensitizing Bacterial Spores to Heat by Exposing Them to Ultraviolet Light. Jour. Bact., **36**: 455–465. 1938.

(4) GARRETT, O. F., AND ARNOLD, R. B. A Possible New Tool for the Industry. (Sterilization by Radiation.) Milk Plant Monthly, **27**: 39, 42. 1938.

(5) GATES, F. L. A Study of the Bactericidal Action of Ultraviolet Light. I. The Reaction to Monochromatic Radiations. Jour. Gen. Physiol., **13**: 231–248. 1929.

(6) LUCKIESH, MATTHEW. A Meter for Germicidal Lamps. G. E. Engineer's Bul., **48**: 5–6. 1939.

(7) PORTER, L. C. Developments in Germicidal Lamps. Agr. Engin., **20**: 437–438. 1939.

(8) PRICE, W. V. Irradiation Failed to Prevent Molding of Cheese. Food Indus., **6**: 163, 171. 1934.

(9) SHARP, D. G. A Quantitative Method of Determining the Lethal Effect of Ultraviolet Light on Bacteria Suspended in Air. Jour. Bact., 35: 589–599. 1937.
(10) TANNER, F. W., AND APPLING, J. W. Bactericidal Effect of Ultraviolet Rays on Non Spore-forming Bacteria and Molds. Soc. Exp. Biol. and Med. Proc., 47: 47–51. 1941.
(11) WHISLER, B. A. The Efficacy of Ultraviolet Light Sources in Killing Bacteria Suspended in Air. Iowa State Col. Jour. Sci., 14: 215–231. 1940.

FACTORS AFFECTING THE PASSAGE OF LIQUIDS INTO THE RUMEN OF THE DAIRY CALF. II. ELEVATION OF THE HEAD AS MILK IS CONSUMED*

GEORGE H. WISE,[1] G. W. ANDERSON,[2] AND P. G. MILLER[1]
Dairy Department, South Carolina Agricultural Experiment Station, Clemson

INTRODUCTION

The accumulation of milk in the rumen and the reticulum of young calves is an abnormal state that is generally considered undesirable physiologically and nutritionally. In order to prevent this anomaly many systems of feeding and management have been devised and advocated. Since the esophageal groove is the only opening into this rumenoreticular cavity, the control of the course taken by the milk into and through the complex stomach of the calf is associated directly with the physiology of this groove. Thus many theories, involving factors from mechanical manipulation to psychic stimulation, have been advanced to explain the functional response of the esophageal groove.

Among the factors that have been assigned rôles in determining the reaction of this groove is the position of the calf's head (up or down) while the milk is being consumed. According to the postulation of Schmoker (3) when a calf suckles, the uplifted head and extended neck draw and close the esophageal groove, thus preventing the entrance of the milk into the two fore compartments of the stomach. Contrariwise, if the calf drinks from an open pail on the ground or floor, its lowered head and relaxed neck fail to close the esophageal groove permitting milk to enter the rumenoreticular cavity. This theory from the viewpoint of either practical calf feeding or fundamental physiology seemed to merit investigation to ascertain its validity.

EXPERIMENTAL

The problem was studied from the standpoint of anatomy as well as that of physiology. The experimental subjects were dairy calves within the normal milk feeding age, six months or less.

ANATOMICAL OBSERVATIONS

Methods. Young male calves were sacrificed and dissected to study the physical relationships of the esophagus and of the reticular, or esophageal, groove to other organs. Immediately after "knocking" the calf, the esoph-

Received for publication March 5, 1942.

* Technical Publication No. 94, published with the approval of the Director of the South Carolina Agricultural Experiment Station.

[1] Associate Dairyman.

[2] Associate Animal Pathologist.

ageal groove was exposed by rumenotomy. As the groove was being observed, the head of the calf was moved back and forth several times to positions similar to those maintained while either drinking from a pail (head lowered and neck curved downward) or nursing a cow (head elevated, mouth extended and neck outstretched). Subsequently dissection was continued exposing the esophagus and parts of the thoracic and abdominal organs as shown in figure 1.

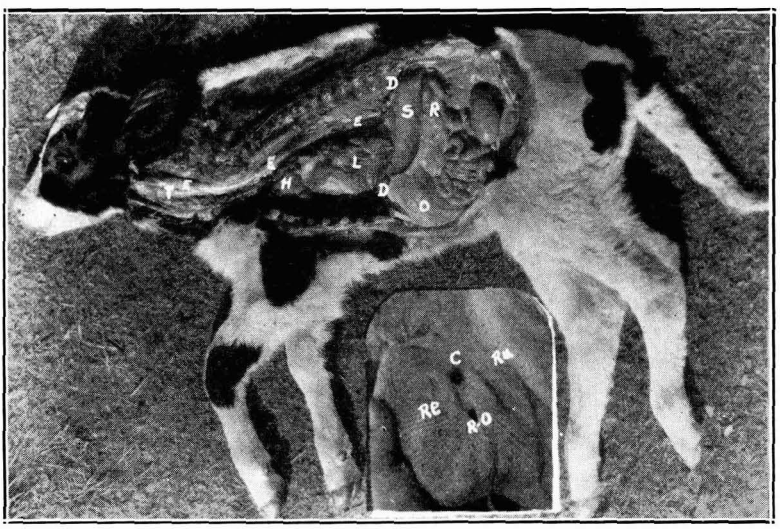


FIG. 1. Dissection view of calf showing the comparative length of the esophagus and its position in relation to other organs. T, trachea; E, esophagus; H, heart; L, lung; D, diaphragm; S, spleen; R, rumen; O, abomasum. Insert indicates the relative location of the esophageal groove in the stomach. C, cardia; R–O, reticular-omasal orifice; Ru, interior rumen wall; Re, interior reticulum wall.

Results. The esophageal groove (insert of figure 1) extends from the cardia (C), the distal terminal opening of the esophagus, to the reticulo-omasal orifice (R–O), the opening into the omasal canal. The groove, as normally found in young calves, was closed and twisted in a semi-spiral fashion, but as illustrated in figure 1, it is stretched open to show its relationship to surrounding organs. Though the groove is connected directly with the esophagus (E), these two organs are considered to be morphologically independent. "From a purely anatomical viewpoint, it is difficult to relate the positions of the head and neck of the calf to the functioning of the esophageal groove."

This point of view was substantiated by the failure of the manipulations, previously described, to alter the position of the groove lips, the proximity of which determines whether or not the groove is closed. Thus from ana-

tomical observations it would seem that the reaction of the esophageal groove is regulated by factors other than the mechanical movements and the positions of the head and neck of the calf.

PHYSIOLOGICAL OBSERVATIONS

Methods. The experimental animals were rumen-fistula calves, including ten Holsteins, four Jerseys and two Guernseys. From a managerial standpoint the only deviation from practiced methods was the continuous confinement of these calves within a barn. The rations, qualitatively and quantitatively, were considered typical for dairy calves.

As a means of determining the interrelationship of the elevation of the head (up or down) and the system of feeding (nipple or open pail) to the course followed by the milk in its passage through the esophageal groove, the feeding positions and systems illustrated in figure 2 were used.

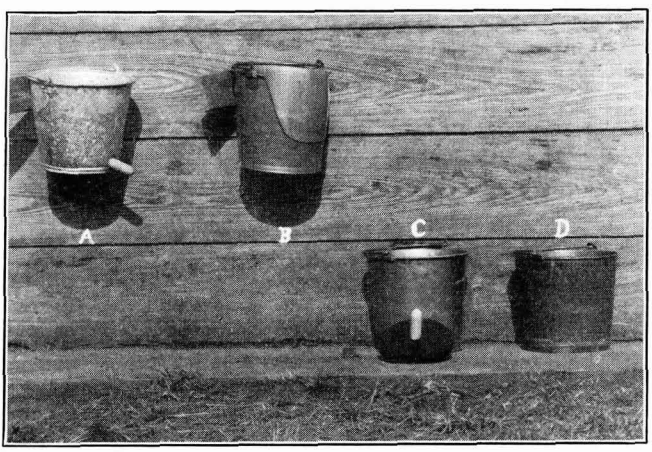


FIG. 2. Relative position of calf feeders used in studying the effect of head and neck elevation on the course followed by consumed milk in its passage through the esophageal groove. (A) elevated nipple, (B) elevated open, (C) lowered nipple and (D) lowered open.

In the lowered position the calf feeders were placed upon the level surface on which the calf stood while consuming the milk; whereas in the elevated position the height of the pail was adjusted so that when the calf was feeding, its poll was at approximately the same level as the point of its withers. Positions either higher or lower than these were considered abnormal and impracticable.

Two types of feeder pails were used, the nipple and the open. In the nipple system the regular Coyner feeder* was employed in the elevated

* Sold by Armour and Company, U. S. Stock Yards, Chicago, Ill.

position (A), but in the lowered position (C), the Coyner nipple was inserted into a hole in the center of a circular board cut to fit inside an open pail. The board, floating on the surface of the milk, maintained the nipple in an upright position. Thus the calf was able to suck the milk while holding its head and neck in a position similar to that assumed when drinking from a lowered open pail (D).

The normal nursing position (A) could not be simulated entirely in drinking from an open elevated pail (B). In this case the height could be adjusted properly, but obviously the calf could not drink conveniently with its mouth extended upward at a slight angle as is done in nursing. Therefore, in order to facilitate consumption from the open elevated feeder (B) a part of the side was cut from the pail.

The reactions of the esophageal groove and the path followed by the milk were determined either by direct visual inspection (9) or by palpation of the groove. These observations were made regularly immediately before feeding and during the time that the calf was consuming the milk.

Since the anatomical studies indicated that the mechanical movements of the head and neck had no effect on the reaction of the esophageal groove, the same manipulations and observations were repeated on the live fistulated calves, first in a normal state and later under general anesthesia.

In order to obtain information on the origin and the transmission of the stimuli that activate the esophageal groove, the left vagus in each of several anesthetized calves was exposed near the pharynx and was repeatedly irritated with a "tetanizing" electric current. This stimulation was applied with the head and neck in positions of lowered-pail feeding and elevated-pail feeding, respectively.

Results. The recorded observations indicating the relation of the elevation of the head and of the system of feeding, respectively, to the frequency with which consumed milk entered the rumenoreticular cavity are summarized in tables 1, 2, 3 and 4. The significance of the various differences was determined by the application of the chi-square test. The chi-square values as shown in tables 1 and 2 reveal a very significant difference

TABLE 1

Summary of observations on esophageal groove passage of milk when it was consumed from two different types of feeding pails at floor level

System of feeding	Course of consumed milk		Total	Frequency of entrance into rumen
	Passed rumen	Entered rumen		
	observations	*observations*	*observations*	*per cent*
Open pail	525	361	886	40.7
Nipple pail	307	17	324	5.2

Difference = 35.5%, $\chi^2 = 13.91$, P = 0.001

TABLE 2

Summary of observations on esophageal groove passage of milk when it was consumed from two different types of feeding pails in an elevated position

System of feeding	Course of consumed milk		Total	Frequency of entrance into rumen
	Passed rumen	Entered rumen		
	observations	*observations*	*observations*	*per cent*
Open pail	369	305	674	45.3
Nipple pail	835	43	878	4.9

Difference = 40.4%, $\chi^2 = 356.96$, P = <0.001

between nipple and open pail feeding when the milk was consumed from either an elevated or a lowered position. Invariably, drinking milk from an open pail resulted in greater spillage (frequency and quantity) into the rumenoreticular cavity than when consumed via nipple. On the contrary, the data presented in tables 3 and 4 indicate that the relative elevation of

TABLE 3

Summary of observations on esophageal groove passage of milk when it was consumed through a nipple at different positions of elevation

Position of feeding pail	Course of consumed milk		Total	Frequency of entrance into rumen
	Passed rumen	Entered rumen		
	observations	*observations*	*observations*	*per cent*
Floor level	307	17	324	5.2
Elevated	835	43	878	4.9

Difference = 0.3%, $\chi^2 = 0.06$, P = 0.80

TABLE 4

Summary of observations on esophageal groove passage of milk when it was consumed from an open pail at different positions of elevation

Position of feeding pail	Course of consumed milk		Total	Frequency of entrance into rumen
	Passed rumen	Entered rumen		
	observations	*observations*	*observations*	*per cent*
Floor level	525	361	886	40.7
Elevated	369	305	674	45.3

Difference = 4.6%, $\chi^2 = 3.18$, P = 0.10

the head and neck, irrespective of system of feeding, did not affect significantly the frequency of passage of milk into the rumen.

Further supporting evidence resulted from observations of the reactions of the esophageal groove. The movements of the head and neck, within the

limits previously indicated, did not affect the opening and closing of the groove. This was the case not only with anaesthetized animals but also with unaesthetized ones. Raising and lowering the head while the calf was either sucking or drinking likewise failed to alter the state of the groove.

The stimulus applied to the vagus nerve resulted in the closure of the open relaxed esophageal groove and in marked motility of the rumen. Relaxing and subsequent opening of the groove followed a few seconds after the cessation of the stimulation. The position of the head and neck again had no effect on the reaction of the groove.

DISCUSSION

The relation of the elevation of the calf's head, within practical limits, to the frequency of milk spillage into the two fore compartments of the stomach and the resulting effect on the health of the calf have been somewhat exaggerated. This fact is evidenced by the results in the foregoing anatomical and physiological investigations considered in the light of previous observations (9).

Even a cursory study of the morphology and the anatomy of the esophagus and esophageal groove would preclude erroneous conclusions relative to the effect of head elevation on the course followed by the milk. The esophagus is comparatively thin-walled, flexible and very dilatable. According to Sisson and Grossman (4) the muscle tissue is striped, consisting of two strata of spiral fiber, except near the stomach, where the tissues are longitudinal and circular. The esophagus has no terminal dilation and no part in the abdominal cavity. The reticular, or esophageal, groove being a part of the stomach obviously is anatomically distinct from the esophagus. The nature of the esophagus considered in conjunction with its relationship to the spiral-form groove renders it difficult to attribute the opening and closing of this organ to changes in the elevation of the head.

The physiological observations substantiated the postulations based on the anatomical studies. Only extremes in the elevations of the open feeder pail, resulting in abnormal deglutition, affected the course of the milk. In the few observations made the volume of the swallows seemed to be one of the primary factors involved. In all instances the groove closed irrespective of the posture assumed. When the milk was drunk from an abnormal and impractical height, the swallows were small and no milk escaped into the rumen, but when milk was drunk from a subnormal level, below footbase, the volume of the individual swallows seemed to be sufficiently large to force the liquid between the lips of the groove into the rumenoreticular cavity. Elevation changes within the limits considered practical did not alter the volume of the swallow to any marked extent.

Consumption of milk through a rubber nipple resulted, with rare exception, in direct passage of the milk into the distal stomach compartment,

the abomasum. This is in accord with previous findings (8, 9). Evidently the nursing stimulus, the size of the swallows and other closely related regulatory factors take precedence over the position assumed by the calf while ingesting the milk.

However, Watson (5) concluded that in the case of lambs the act of sucking did not affect the course of the milk in the stomach. His deduction is based on the observation that when sheep had become accustomed to quenching their thirst by sucking water from a rubber nipple, the replacement of water by either milk- or water-barium sulphate suspension resulted, on a majority of occasions, in the passage of the suspensions into the fore compartments of the stomach and not into the abomasum.

The observed reactions of the esophageal groove in fistulated calves are apparently at variance with Watson's results. In the case of calves beyond a month of age, tap water consumed via rubber nipple frequently entered the rumenoreticular cavity (9) but always in considerably less quantity than when drunk directly from an open pail. Furthermore, feeding milk through the same nipple-feeder immediately following water consumption did not result in passage of the milk into the rumen and reticulum; even though ingestion of much water, according to Wester (7), tends to lessen the reflex irritability.

In considering the physiological responses of the groove, cognizance must be taken of the fact that there are many variations in different calves and in the same individual at various times. As indicated in data previously presented (9) and further confirmed in this investigation, there is a wide range in the frequency and volume of spillage into the rumenoreticular cavity when calves ingested the milk from open pails. Evidently these variations may be attributed to an interaction of diverse factors, all of which probably have not been recognized. Thus it becomes difficult to appraise the effect of any one factor *per se;* consequently seemingly discordant results frequently appear.

Evidence has been adduced (2, 6, 7) indicating that the functioning of the groove is a reflex response elicited by either a mechanical or a chemical stimulant coming in contact with certain regions of the mouth and pharynx. From these receptors the stimulus, according to Wester (7), is transmitted through the vagi to the esophageal groove. The electrical irritation of the left vagus in foregoing experimental subjects, in accord with Doughterty's (1) observations on a mature cow, motilized the rumen. This response was accompanied by contraction of the lips of the esophageal groove. Normally, however, the closure of the groove in young calves is not associated with marked rumen motility. The nature of the irritant probably was one factor affecting the extent of the reaction. The results indicate that the vagi are paths over which certain stimuli may reach the esophageal groove. Whether or not there are other means of transmission remains a moot question.

The positions of the head and neck do not affect the stimulus transmission and the resulting reaction.

SUMMARY

1. Anatomical studies suggested that the elevation and the mechanical manipulation of the head and neck of calves, within limits that may be employed in practical feeding, are not primary factors affecting the functioning of the esophageal groove.

2. This suggestion was substantiated from observations of rumen-fistula calves fed milk either through a rubber nipple at different levels, floor and elevated, or from open pails at these levels.

3. Though the elevation of the head and neck was not an important factor affecting the extent of milk passage into the rumenoreticular cavity, the type of feeder, nipple or open, was very significant.

4. Irrespective of feeder level, milk rarely entered the rumen when consumed via nipple but frequently entered when drunk from an open pail.

5. The vagi are paths over which certain stimuli may be transmitted to the esophageal groove, but the transmission and resulting esophageal groove reaction are unaffected by positions of the head and neck.

REFERENCES

(1) DOUGHERTY, R. W. Further Investigations of Rumen Gasses and Bloat in Ruminants. Jour. Amer. Vet. Med. Assoc., **99**: 773, 110–114. 1941.

(2) ROSS, I. C. The Passage of Fluids through the Ruminant Stomach. III. The Effects of Volume of Fluid and the Site of Stimulation on the Reflex Closure of the Esophageal Groove. Aust. Vet. Jour., **12**: 1, 4–8. 1936.

(3) SCHMOKER, E. A. Inside Facts on Calf Feeding. pp. 11–15. Albers Bros. Milling Co., Seattle, Wash. 1937.

(4) SISSON, S., AND GROSSMAN, J. D. The Anatomy of Domestic Animals, 3rd Ed. pp. 454, 462. W. B. Saunders Co., Philadelphia, Pa. 1938.

(5) WATSON, R. H. Studies on Deglutition in Sheep: A Résumé of Observations on the Course Taken by Liquids through the Stomach of Sheep at Various Ages from Birth to Four Years. Aust. Vet. Jour., **17**: 52–58. 1941.

(6) WATSON, R. H., AND JARRETT, I. G. Studies on Deglutition in Sheep: A Résumé of Observations on the Influence of Copper Salts on the Course Taken by Liquids into the Stomach of the Sheep. Aust. Vet. Jour., **17**: 137–142. 1941.

(7) WESTER, J. The Rumination Reflex in the Ox. Vet. Jour. **86**: 401–410. 1930.

(8) WISE, G. H. Factors Affecting the Reactions of the Esophageal Groove of Dairy Calves. JOUR. DAIRY SCI., 22: 6, 465. 1939.

(9) WISE, G. H., AND ANDERSON, G. W. Factors Affecting the Passage of Liquids into the Rumen of the Dairy Calf. I. Method of Administering Liquids: Drinking from Open Pail Versus Sucking through a Rubber Nipple. JOUR. DAIRY SCI., 22: 9, 697–705. 1939.

STUDIES ON THE CHEMICAL COMPOSITION OF THE BLOOD OF DAIRY CATTLE. III. THE NORMAL CONCENTRATION OF INORGANIC PHOSPHORUS IN THE WHOLE BLOOD OF DAIRY CATTLE AND FACTORS AFFECTING IT[1]

A. H. VANLANDINGHAM,[2] H. O. HENDERSON,[3] AND G. A. BOWLING[3]
West Virginia Agricultural Experiment Station, Morgantown

The level of inorganic phosphorus in the blood of dairy cattle is especially sensitive to low levels of phosphorus intake (11, 16, 21, 22) to deficiencies of Vitamin D in the ration, or to exposure of animals to sunshine or ultra violet light (2, 10, 18). If it may be assumed that a ration just capable of supporting a normal (maximal) concentration of inorganic phosphorus in the blood is adequate in phosphorus for all prevailing functions, providing of course, the ration is well balanced in all other respects, the blood inorganic phosphorus level may be readily applied in the determination of the minimum phosphorus requirements of cattle. In order to determine the minimum phosphorus requirements of cattle by this means it is necessary to know the normal level of blood composition of animals at various ages (15, 21) and the effect of such factors as pregnancy, lactation and various environmental conditions.

Normal values for the inorganic phosphorus content of blood serum or plasma have been reported by Palmer, Cunningham and Eckles (15), Anderson, Galey and Pratt (1), Haag and Jones (7) and Eveleth, Eveleth and Walsh (4). Similar values for whole blood are relatively few. The inorganic phosphorus content of the blood is subject to wide fluctuations from day to day and from period to period (8, 15, 17). Values obtained on composite samples of whole blood show considerably less variation from time to time than similar values obtained on single samples of plasma or whole blood (8). Stare and Elvehjem (19) studied the phosphorus partition of the blood of rachitic and non-rachitic calves and came to the conclusion that whole blood was preferred for this determination. Whole blood has been used by Godden and Allcroft (6) in a study of the changes in the composition of cow's blood at the time of calving and a comparison of the blood of the calf with that of the dam. Theiler, Green and Du Toit (20), Malan, Green and Du Toit (13), and more recently Otto (14) used whole blood in studies of phosphorus metabolism of cattle in South Africa. In previous reports data showing the effects of age, phosphorus intake, gestation and lactation on the concentration of inorganic phosphorus in the whole blood of dairy heifers have been pre-

Received for publication March 19, 1942.

[1] Published with the approval of the Director of the West Virginia Agricultural Experiment Station as Scientific Paper No. 281.

[2, 3] Departments of Agricultural Chemistry and Dairy Husbandry, respectively.

sented (21, 22). More recently similar data for mature milking cows have been presented by Johnson (12).

The purpose of this paper is to report normal values for the concentration of inorganic phosphorus in the whole blood of dairy cattle during the periods of growth, gestation and lactation at different seasons of the year and with and without exposure to sunlight.

EXPERIMENTAL

Several important considerations governed the routine of this investigation. An effort was made to obtain comparable representative samples of whole blood from animals which were handled in a normal manner as well as animals maintained under strictly experimental conditions.

Methods of sampling and analysis. For this study composite samples of whole blood consisting of 10 ml. aliquots from six daily samples taken on alternate days over a period of ten days as previously described (8) were analyzed for inorganic phosphorus. All samples were handled in a uniform manner and analyzed for inorganic phosphorus by the Fiske and Subbarow (5) method. Potassium oxalate was used as an anti-coagulant. Determinations were made at one or two month intervals during the period the animals were under observation. Each value, therefore, represents an average of six daily samples for each individual animal at that particular time.

Description of animals and rations. Data for the period of growth up to the time of first calving were obtained on 26 Holstein heifer calves. Many of these animals were under observation for the entire period; however, some were not started on the experiment until several months of age while others were removed from the experiment from time to time for various reasons not related to this study.

The calves received whole milk for the first four to six weeks at which time they were gradually changed to skim milk. Concentrates and hay were offered as soon as the calves would consume them. The skim milk was gradually discontinued when the heifers were approximately six months of age. Eight of the calves were fed a normal mixed ration composed of yellow corn meal, ground oats, wheat bran, corn gluten meal and salt with timothy hay as roughage. This ration supplied ample quantities of calcium and phosphorus to meet the requirements of growing dairy heifers. These heifers were confined continuously to a well lighted and well ventilated experimental barn. The other eighteen heifer calves were fed an experimental ration composed of alfalfa hay, alfalfa leaf meal, corn starch and chipped corn sugar supplemented with salt and steamed bone meal. The heifers in this group were permitted to run outside in dry lot except during inclement weather.

During lactation data were obtained on three groups of milking Holstein

cows. Group 1 consisted of 12 cows in the regular milking herd. This group received the regular herd concentrate ration which is supplemented with salt and 2 per cent steamed bone meal. Alfalfa hay and corn silage were fed as roughages. The cows in this group were on pasture in season. The cows were selected in the spring of 1936 on the basis of producing at least 40 pounds of milk per day. Several of the animals produced from 50 to 60 pounds and two from 65 to 70 pounds per day at the peak of production during the lactation period. Inorganic phosphorus was determined at bi-monthly intervals for a period of two lactations or approximately two years. Nine of the cows were under observation throughout the entire period, whereas three of them were removed from the herd during the period. Group 2 consisted of 16 cows in the experimental herd. Five of the animals in this group received a ration composed of alfalfa hay and yellow corn meal supplemented with salt and steamed bone meal. The other 11 animals received an experimental alfalfa ration composed of alfalfa hay and a concentrate mixture made up of equal parts by weight of chipped corn sugar and alfalfa leaf meal supplemented with 1.5 per cent salt and 2 per cent steamed bone meal. All animals in Group 2 were confined to the experimental barn continuously during the lactation period. Group 3, consisting of 5 animals in the experimental herd, received a ration of timothy hay and a concentrate mixture composed of yellow corn meal, soybean oil meal, salt, and 2 per cent steamed bone meal. The animals in this group were permitted to run outside in dry lot except during inclement weather.

During the growing period hay was fed at the rate of 1.5 pounds per 100 pounds body weight per day. The remainder of the digestible crude protein and total digestible nutrients required to meet the average of the Morrison (9) feeding standard for growing dairy heifers was supplied by the concentrate mixture. During the lactation period all animals were fed hay at the rate of about 2 pounds per 100 pounds body weight per day and the concentrate mixture according to the rate of production. Digestible crude protein and total digestible nutrients supplied were calculated by the Morrison feeding standard for milking cows.

RESULTS

Effect of rations. There was no indication of any difference in the inorganic phosphorus content of the blood as a result of the ration fed in these experiments. The rations were composed of good alfalfa or timothy hay and a concentrate mixture supplying liberal quantities of phosphorus.

Effect of age. The data obtained during the period of growth up to about 28 months of age are presented statistically in table 1 and summarized graphically in figure 1. The heifers were bred when they were about eighteen months of age. Several of them failed to conceive promptly thus permitting an opportunity to obtain values for non-pregnant heifers for

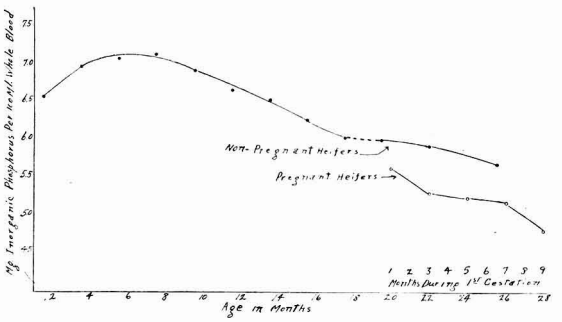


FIG. 1. Effect of age and gestation on the inorganic phosphorus content in the whole blood of growing dairy heifers.

comparison with those of about the same age as heifers which were pregnant. In table 1 is recorded the number of animals under observation for each time interval, the number of daily samples taken, the number of composite samples analyzed, the mean and standard error, the standard deviation, and the coefficient of variation. It may be observed that the inorganic phosphorus content of the blood increased until the heifers were about six to eight months of age and then gradually decreased as they grew older.

Effect of gestation. The data presented in table 2 and in figure 1 show the effect of both an increase in age and pregnancy of growing heifers during the period of first gestation. It may be seen in table 2 that there was a considerable decrease in the inorganic blood phosphorus from the beginning of gestation with an average of 5.65 mg. to the ninth month just preceding

TABLE 1

The normal concentration of inorganic phosphorus in the whole blood of growing dairy heifers

Age groups	Animals observed	Daily samples taken	Composite samples analyzed	Mean and standard error	Standard deviation	Coefficient of variation
months	*no.*	*no.*	*no.*	*mg. per 100 ml. whole blood*		%
1.0– 2.5	6	126	21	6.58 ± 0.10	0.46	6.99
2.5– 4.5	13	126	21	6.97 ± 0.11	0.52	7.46
4.5– 6.5	19	162	27	7.08 ± 0.11	0.53	7.49
6.5– 8.5	19	150	25	7.15 ± 0.09	0.44	6.15
8.5–10.5	19	156	26	6.94 ± 0.11	0.56	8.10
10.5–12.5	20	168	28	6.68 ± 0.08	0.43	6.44
12.5–14.5	20	168	28	6.56 ± 0.09	0.49	7.47
14.5–16.5	20	156	26	6.29 ± 0.11	0.55	8.74
16.5–18.5	18	144	24	6.06 ± 0.14	0.69	11.39
18.5–20.5*	18	144	24	6.03 ± 0.13	0.65	10.77
20.5–23.5*	11	138	23	5.95 ± 0.08	0.40	6.72
23.5–27.5*	6	114	19	5.68 ± 0.10	0.44	7.75
Average					0.51	7.96

* Non-pregnant heifers.

TABLE 2

Effect of stage of first gestation on the inorganic phosphorus of whole blood of dairy heifers

Stage of first gestation	Animals observed	Daily samples taken	Composite samples analyzed	Mean and standard error	Standard deviation	Coefficient of variation
months	*no.*	*no.*	*no.*	*mg. per 100 ml. whole blood*		%
0–2	16	108	18	5.65 ± 0.11	0.48	8.50
2–4	16	102	17	5.32 ± 0.11	0.45	8.46
4–6	16	102	17	5.30 ± 0.17	0.70	13.20
6–8	16	120	20	5.19 ± 0.14	0.61	11.75
9th*	11	66	11	4.81 ± 0.17	0.56	11.64
Average					0.56	10.71

* Average age at time of first calving 28 months.

calving with an average of 4.81 mg. per 100 ml. of whole blood. Figure 1 also shows that there was a gradual decline in blood composition of non-pregnant heifers from 18 to 27 months of age, but the decline was much more pronounced in the case of pregnant heifers of approximately the same age. This fact was particularly noticeable in the decided drop during the last month of the gestation period.

Effect of the number and stage of lactation. Data for all animals during the milking period according to the number and stage of lactation are

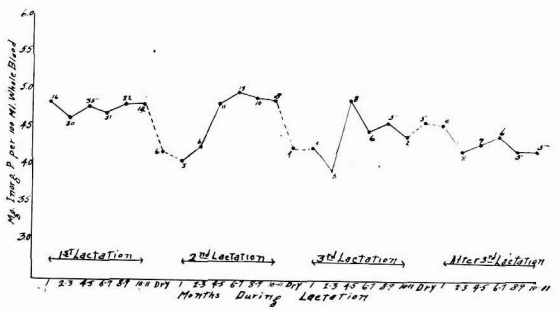


FIG. 2. Effect of the number and stage of lactation on the inorganic phosphorus content of whole blood. Numerals indicate the number of composite samples analyzed and averaged.

presented in table 3 and in figure 2. The data have also been summarized statistically according to lactations and recorded in table 4. It may be observed in figure 2 that the inorganic phosphorus of the blood showed practically no change throughout the first lactation period. The number of animals studied beyond the first lactation was somewhat smaller, but there appeared to be a definite tendency for the inorganic phosphorus to show a drop near the end of the second gestation period. The inorganic phosphorus continued at a low level during the first two or three months of the second lactation and then increased to about the same level as during the

TABLE 3

Effect of the number and stage of lactation on the concentration of inorganic phosphorus in whole blood of dairy cows

Stage of lactation	No. of animals observed	No. of daily samples taken	No. of composite samples analyzed	Mg. inorganic phosphorus per 100 ml. of whole blood		
				Minimum	Maximum	Mean
First Lactation						
During 1st month	16	96	16	3.80	5.91	4.86
2nd and 3rd "	23	180	30	3.75	5.94	4.65
4th and 5th "	24	210	35	3.32	6.51	4.81
6th and 7th "	23	186	31	3.57	6.06	4.73
8th and 9th "	22	132	22	3.65	5.70	4.84
10th and 11th "	14	84	14	4.17	5.76	4.86
Dry period	6	36	6	3.90	4.47	4.21
Second Lactation						
During 1st month	3	18	3	3.84	4.50	4.09
2nd and 3rd "	6	36	6	4.01	4.54	4.29
4th and 5th "	9	66	11	4.10	5.84	4.86
6th and 7th "	11	78	13	4.17	6.30	5.00
8th and 9th "	10	60	10	4.47	6.14	4.94
10th and 11th "	8	48	8	4.28	5.96	4.91
Dry period	4	24	4	3.39	5.01	4.26
Third Lactation						
During 1st month	5	30	5	3.30	5.03	4.27
2nd and 3rd "	7	42	7	3.30	4.58	3.98
4th and 5th "	5	48	8	3.77	5.39	4.92
6th and 7th "	5	36	6	3.90	5.70	4.51
8th and 9th "	5	30	5	3.86	5.45	4.63
Dry period	5	30	5	3.71	5.62	4.64
Four or More Lactations						
During 1st month	4	24	4	4.00	5.22	4.56
2nd and 3rd "	8	48	8	3.62	4.67	4.23
4th and 5th "	6	42	7	3.71	4.97	4.34
6th and 7th "	5	30	5	3.56	5.45	4.45
8th and 9th "	4	24	4	3.62	4.82	4.25
10th and 11th "	3	18	3	4.05	4.47	4.25

TABLE 4

Effect of number of lactations on the inorganic phosphorus content of whole blood of dairy cows

Lactations	Animals observed	Daily samples taken	Composite samples analyzed	Mean and standard error	Standard deviation	Coefficient of variation
no.	*no.*	*no.*	*no.*	*mg. per 100 ml. whole blood*		*%*
1	25	888	148	4.81 ± 0.04	0.44	9.15
2	13	306	51	4.80 ± 0.08	0.55	11.46
3	8	198	33	4.35 ± 0.10	0.57	13.10
4 or more	7	186	31	4.34 ± 0.09	0.52	11.98
Combined		1578	263	4.69 ± 0.04	0.61	13.01

TABLE 5

Effect of season on the inorganic phosphorus of whole blood of lactating animals
(Mg. per 100 ml. of blood)

Animal No.	Calving Dates	Group 1. Normal Milking Herd—Pasture in Season												
		June '36	August	October	December	February '37	April	June	July	September	November	January '38	February	April
176	Mar. 36, Feb. 37, Jan. 38	5.24	4.89	5.03	4.34	4.31 C	3.62	4.23	4.97	5.45	4.82	4.47	4.53	.....
305	Dec. 35, Mar. 37, Feb. 38	4.04	4.23	4.05	3.44	3.92 D	3.98	3.95	3.56	3.62	4.22	4.29 D	4.82	4.52
347	Feb. 36, Feb. 37, Jan. 38	5.84	5.16	4.77	4.82	4.50 C	4.34	5.18	5.39	5.70	5.45	5.62 D	5.22	4.67
355	Feb. 36, Feb. 37, Jan. 38	5.18	4.98	4.76	4.50	3.97 C	3.30	4.46	4.46	5.15	5.36	5.21 D	4.38	4.68
357	Feb. 36	5.64	5.01	4.52	4.50	4.10 D	.....	.....	.....	.....	.....	.....	.....	.....
358	Dec. 35, Mar. 37, Apr. 38	4.98	4.73	4.64	4.10	4.08 D	3.84	4.11	4.13	4.07	3.86	4.22	4.71 D	.....
360	Dec. 35, Dec. 36, Jan. 38	5.03	4.59	4.28	3.39 D	3.69	3.77	3.90	4.25	4.47	4.16	3.96 D	3.66	3.71
361	Jan. 35, Dec. 36, Feb. 38	5.69	5.33	5.07 D	4.56 D	4.35	4.70	4.58	4.70	5.36	5.37	5.01 D	5.03	4.58
362	Dec. 35, Oct. 36, Nov. 37	4.98	4.74	4.02 C	4.04	4.17	3.98	4.01	3.71 D	4.00	3.77	3.95	4.17	.....
365	Feb. 36	5.42	5.39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
373	Mar. 36, Mar. 37, Jan. 38	4.98	5.16	4.50	3.65	4.20 D	4.01	4.56	4.46	4.89	4.47	4.55 D	3.83	4.00
400	Aug. 36	.....	.....	4.34	3.96	4.43	4.29	4.49	4.19	.....	.....	.....	.....	.....
	Average	5.14	4.93	4.54	4.12	4.16	3.98	4.35	4.38	4.75	4.61	4.59	4.48	4.36
		Group 2. Experimental Herd—Kept in Barn												
		January '36	March	May	July	September	October	December	February '37	April	June	July	September	
389	Dec. 35, Dec. 36	4.34	4.65	4.35	4.29	4.71	3.90 D	3.84	4.07	4.10	4.17	5.30	5.96	
390	Dec. 35, Dec. 36	5.54	3.89	4.61	5.22	5.76	4.23 D	4.50	4.44	4.46	4.67	6.30	6.14	
391	Dec. 35, Jan. 37	5.87	4.19	4.91	4.76	4.71	4.67	3.93 D	3.93	4.54	4.23	5.82	.....	
393	Mar. 36, Feb. 37	.....	4.38	4.65	5.40	4.94	5.48	5.15	4.47	4.35	4.49	5.61	.....	
	Average	5.22	4.28	4.63	4.92	5.03	4.57	4.36	4.23	4.36	4.39	5.76	6.05	

C = Calved during 10-day sampling period.
D = Dry period.

first lactation. During the latter part of the third gestation period the inorganic phosphorus showed another decrease similar to that observed during the latter part of the previous gestation period. The inorganic phosphorus was again low during the first two or three months of the third lactation, but increased to about the former level during the latter part of the lactation period. After the third lactation no significant change in blood composition was observed.

Effect of season during growth and lactation. The data obtained for growing heifers from the age of one month to the time of first calving did not indicate that there were any differences in the composition of the blood depending upon the season of the year in which the calves were born. Neither did it seem to make any difference whether the calves were confined to the barn continuously or allowed to run outside in favorable weather.

In table 5 are presented data for the 12 animals in group 1 in the regular milking herd and for 4 animals of group 2 in the experimental herd. The cows in Group 1, with the exception of numbers 361 and 400, were beyond their first lactation when this study was begun, whereas the 4 cows in Group 2 were started at the beginning of the first lactation and continued through the second lactation. The other 12 cows in Group 2, and 5 cows in Group 3, were observed during the first lactation only. The cows in Group 1 were out on pasture from the first half of May until about the fifteenth of October each year. The 4 animals in Group 2 were confined to the barn continuously.

The first composite sample of blood for the animals in Group 1 was taken in 1936. It may be observed that there was a decrease in the average amount of inorganic phosphorus in the blood from 5.14 mg. in June 1936 to 3.98 mg. in April 1937, after which there was an increase reaching a peak of 4.75 mg. in September followed by another decline until April 1938 when the study was discontinued. In other words, there was a tendency for the blood inorganic phosphorus to be lower during the winter and spring than during the summer and early fall. This was not due entirely to the fact that the cows were outside and on pasture. This tendency may be observed also in the case of the 4 animals in Group 2, table 5 which were kept in the barn continuously. The blood inorganic phosphorus was relatively low in March 1936 with an average of 4.28 mg. per 100 ml. after which there was a gradual rise to 5.03 mg. in September. Following the peak of 5.03 mg. in September 1936 there was a gradual decline to 4.23 mg. in February 1937, then a gradual rise to 5.76 mg. in July. Two of the cows averaged 6.05 mg. in September when the experiment was discontinued.

DISCUSSION

Data obtained in this investigation indicate that for heifer calves receiving liberal quantities of phosphorus and such amounts of vitamin D as

occurred normally in the ration, age is the most important factor affecting the inorganic phosphorus of the blood. There is first an increase in the inorganic phosphorus up to about the sixth or seventh month and then a marked decrease as the animals increase in age up to the time of first calving. There is also a slight trend downward with an increase in the number of lactations until about the third or fourth lactation. These results are very similar to results obtained by Johnson (12).

The individual effect of such factors as the stage of lactation, milk production, gestation and season of the year on the inorganic phosphorus of the blood is difficult to evaluate. The cows were usually bred so as to calve during the winter months when on dry feed and for the most part confined to the barn. As has been pointed out, pregnancy caused a definite lowering of the inorganic phosphorus during the latter part of the gestation period in heifers bred for the first time. There is also a tendency for cows to show low blood inorganic phosphorus during the latter part of the second and third gestation when they are usually dry. Eckles and associates (3) found that there is a marked increase in the phosphorus requirements of a cow during the last 6 weeks to 2 months previous to parturition and that provisions must be made for this to prevent disaster to the mother following calving. Blood inorganic phosphorus was usually lower for the first two or three months of the second and third lactation periods than during the latter part of these lactations. This tendency for the blood phosphorus to be lower for a month or so before calving and at the beginning of the lactation period may represent a shift temporarily in the equilibrium between the phosphorus available and that required at that particular time, and not a deficiency of phosphorus in the ration. These animals were all receiving liberal quantities of phosphorus in the ration since the ration was supplemented with bone meal.

There was a tendency for milking cows to show a lower level of blood inorganic phosphorus during the winter and early spring than during the summer and fall, which may be explained in part on the basis of the effect of pregnancy and early lactation since most of the cows were bred to calve during the winter and early spring months. Fifty-one composite samples taken from 12 cows in the regular milking herd from November 1 to April 30 averaged 4.29 mg. whereas 56 samples taken from the same animals from May 1 to October 30 averaged 4.70 mg. per 100 ml. of whole blood. An average of 4.29 mg. per 100 ml. of whole blood from November until April compares very closely with results reported by Johnson (12). He obtained average values for the inorganic phosphorus in whole blood of milking and dry cows of 4.28 and 4.35 mg. per 100 ml., respectively. In this work all samples were taken during the spring when the animals had been away from pasture for 4 months or longer.

There is some indication that the concentration of inorganic phosphorus

in the blood of lactating cows under normal conditions is, in part, characteristic of the individual animal. Animals with average blood values either above or below the herd value for one lactation were likely to maintain the same relative position for the next lactation.

SUMMARY AND CONCLUSIONS

Inorganic phosphorus was determined in more than 600 composite samples of whole blood taken from 59 cows and heifers in normal states of health and nutrition.

When growing dairy heifers were fed rations composed of good alfalfa or timothy hay and a concentrate mixture supplying liberal quantities of phosphorus and such amounts of vitamin D as occurred normally in the ration, age was the most important factor affecting the concentration of inorganic phosphorus in the blood.

The inorganic phosphorus in the blood of growing dairy heifers showed an increase with age up to about the seventh or eighth month after which there was a gradual decline as the animals grew older. There was also a decrease in the blood inorganic phosphorus of lactating cows with an increase in the number of lactations up to about the third or fourth lactation.

During the period of first gestation a lower concentration of inorganic phosphorus is present in the blood of heifers than in that of unbred heifers of approximately the same age.

There was no significant change in blood inorganic phosphorus during the first lactation. There was a strong tendency for cows to show low values for inorganic phosphorus during the last 6 or 8 weeks of the second gestation period, and for the first two or three months of the second lactation. Blood phosphorus was also low during the last few weeks of the third gestation period and for a month or so at the beginning of the third lactation. After the third lactation no significant change in blood composition was observed.

Heifer calves receiving concentrates and about 1.5 pounds of alfalfa or timothy hay per 100 pounds body weight, daily, showed no indication that the season of the year born, or the fact that they were confined to the barn continuously or permitted to run outside in favorable weather, had any effect upon the inorganic phosphorus content of the blood.

There was a strong tendency for dairy cows after the first lactation to show a lower concentration of inorganic phosphorus in the blood during the winter and early spring than during the summer and early fall.

REFERENCES

(1) ANDERSON, A. K., GALEY, H. R., AND PRATT, A. D. Studies on the Chemical Composition of Bovine Blood. JOUR. DAIRY SCI., **13**: 336–347. 1930.

(2) BECHDEL, S. I., LANDSBURG, K. G., AND HILL, O. J. Rickets in Calves. Pa. Agr. Exp. Sta. Bul. 291. 1933.

(3) ECKLES, C. H., PALMER, L. S., GULLICKSON, T. W., FITCH, C. P., BOYD, W. L., BISHOP, LUCILLE, AND NELSON, J. W. Effect of Uncomplicated Phosphorus Deficiency on Estrous Cycle, Reproduction, and Composition of Tissue of Mature Dairy Cows. Cornell Vet., **25**: 22–43. 1935.

(4) EVELETH, D. F., EVELETH, M. W., AND WALSH, F. E. Inorganic Phosphorus of the Serum of Dairy Cattle. North Amer. Vet., **18**: 18–22. 1937.

(5) FISKE, C. H., AND SUBBAROW, Y. The Colorimetric Determination of Phosphorus. Jour. Biol. Chem., **66**: 375–400. 1925.

(6) GODDEN, W., AND ALLCROFT, W. M. Changes in the Composition of Cows' Blood at the Time of Calving and a Comparison of the Blood of the Calf With That of the Dam. Biochem. Jour., **26**: 1640–46. 1932.

(7) HAAG, J. R., AND JONES, I. R. The Calcium and Inorganic Phosphorus Contents of the Blood Plasma of Normal Dairy Cattle. Jour. Biol. Chem., **110**: 439–441. 1935.

(8) HENDERSON, H. O., AND VANLANDINGHAM, A. H. Method for Obtaining Representative Samples of Blood for Inorganic Phosphorus in Dairy Heifers. JOUR. DAIRY SCI., **15**: 313–319. 1932.

(9) HENRY, W. A., AND MORRISON, F. B. Feeds and Feeding. 18th Ed. Henry-Morrison Co., Madison. 1923.

(10) HUFFMAN, C. F. Study of Rickets in Calves. Mich. Agr. Expt. Sta. Quart. Bul. 14, 42–45. 1931.

(11) HUFFMAN, C. F., DUNCAN, C. W., ROBINSON, C. S., AND LAMB, L. W. Phosphorus Requirements of Dairy Cattle When Alfalfa Furnishes the Principal Source of Protein. Mich. Agr. Expt. Sta. Tech. Bul. 134. 1933.

(12) JOHNSON, S. R. The Level of Inorganic Phosphorus in the Blood of Dairy Cattle. Jour. Nutr., **17**: 15–21. 1939.

(13) MALAN, A. I., GREEN, H. H., AND DU TOIT, P. J. Studies in Mineral Metabolism. V. Composition of Bovine Blood on Phosphorus Deficient Pastures. Jour. Agr. Sci., **18**: 376–383. 1928.

(14) OTTO, J. S. The Assimilation of Calcium and Phosphorus by the Growing Bovine. Onderstepoort Jour. Vet. Sci. and Anim. Indus., **10**: 282–345. 1938.

(15) PALMER, L. S., CUNNINGHAM, W. S., AND ECKLES, C. H. Normal Variation in the Inorganic Phosphorus of the Blood of Dairy Cattle. JOUR. DAIRY SCI., **13**: 351–359. 1930.

(16) PALMER, L. S., AND ECKLES, C. H. Effect of Phosphorus Deficient Rations on Blood Composition in Cattle. Soc. Expt. Biol. and Med. Proc., **24**: 307–309. 1927.

(17) ROBINSON, C. S., AND HUFFMAN, C. F. Studies on the Chemical Composition of Beef Blood. I. The Concentration of Certain Constituents in Normal Plasma. Jour. Biol. Chem., **67**: 245–255. 1926.

(18) RUPEL, I. W., BOHSTEDT, G., AND HART, E. B. Vitamin D in the Nutrition of the Dairy Calf. Wis. Agr. Expt. Sta. Res. Bul. 115. 1933.

(19) STARE, F. J., AND ELVEHJEM, C. A. The Phosphorus Partition in the Blood of Rachitic and Non-rachitic Calves. Jour. Biol. Chem., **97**: 511–524. 1932.

(20) THEILER, A., GREEN, H. H., AND DU TOIT, P. J. Minimum Mineral Requirements in Cattle. Jour. Agr. Sci., **17**: 291–314. 1927.

(21) VANLANDINGHAM, A. H., HENDERSON, H. O., AND BOWLING, G. A. Studies on the Chemical Composition of the Blood of Dairy Cattle. I. The Effect of Age and Phosphorus Intake on the Calcium and Inorganic Phosphorus Content of Whole Blood of Dairy Heifers. JOUR. DAIRY SCI., **18**: 557–572. 1935.

(22) VANLANDINGHAM, A. H., HENDERSON, H. O., AND BOWLING, G. A. Studies on the Chemical Composition of the Blood of Dairy Cattle. II. The Effect of Phosphorus Intake on the Calcium and Inorganic Phosphorus Content of Whole Blood of Dairy Heifers During the Period of First Gestation and Lactation. JOUR. DAIRY SCI., **19**: 597–609. 1936.

BLIND HALVES IN A GOAT'S UDDER[1]

C. W. TURNER AND E. R. BEROUSEK
Department of Dairy Husbandry, University of Missouri, Columbia

The inability to remove milk from one or more quarters of a cow's udder is experienced occasionally. The term "blind or imperforate" teat or quarter is usually attached to this condition. A study of the literature indicates that there may be several causes of this condition. In some cases the condition arises from a hereditary or developmental defect in the mammary gland, whereas in other cases the defect arises as a result of a local injury, inflammatory or mastitic condition of the teat or gland. It is not always easy to distinguish between these causes.

1. *Imperforate teat.* This is a condition described by Alexander (1) and Billings (2) in which a membrane has formed at the end of the teat. While an anatomical study of this condition was not presented, it would necessarily involve the streak canal. Surgical treatment of this condition is rather simple.

2. *Blocked teat cistern.* A condition is frequently described in which a movable object blocks the inner entrance to the streak canal and thus prevents the removal of milk. If the object cannot be removed or caused to disintegrate by massage, this condition becomes rather exasperating. The following substances have been reported in the teat cistern: (a) coagulated mucus or casein (3); (b) milk calculus or stone (3, 1); (c) warty growths (1).

3. *Membrane separating teat and gland cistern.* The presence of a septum or membrane between the teat and gland cistern has been reported (1, 7). Normal milk secretion would be initiated following calving but the presence of the membrane would prevent the removal of milk from the gland. Foust (4) has presented a series of drawings indicating how this condition could arise in the fetal development of the udder. This condition has also been observed in sheep. Gardner (7) observed three such cases in a series of 26 udders examined.

4. *Closure of primary milk ducts.* Swett *et al.* (6) has presented figures of sections of a number of cow's udders where the obstruction to the removal of milk appeared to be due to an overgrowth of connective tissue or scar tissue around the cistern of the gland and the primary milk ducts leading from the cistern. It was suggested that this condition arose from the early infection of the quarter resulting in the discharge of pus. In calves shortly after birth, the gland consists of a cistern with limited growth of the duct

Received for publication March 25, 1942.

[1] Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series, No. 817.

system. An infection at this time with resulting scar tissue production might cause the permanent closure of the ducts but later hormonal stimulation of the ends of the duct system enables the upper secretory part of the gland to grow normally. The gland would thus develop normally during pregnancy but would be found to be blind after calving.

In the Missouri Station herd, a sterile cow which had had chronic mastitis in several quarters was observed some time later, upon the experimental stimulation of milk secretion, to have *three* blind quarters which upon section appeared similar to several of the sections presented by Swett *et al.* As these quarters had milked satisfactorily previously it would appear that in this case the closure of the primary milk ducts had occurred during the period when the cow was dry due to the condition of chronic mastitis (5). On the basis of these observations, it would appear possible for mastitis to cause the closure of the finer ducts in any part of the udder by overgrowth of the surrounding connective tissue.

The object of the present paper is to present a study of the case of a purebred dairy goat from both halves of whose udder milk could not be removed. It seems to differ significantly from previously reported cases in that the absence of milk secretion appears to be due to an embryological developmental closure of the primary milk ducts rather than to an overgrowth of connective tissue resulting from infection.

CASE HISTORY

Mrs. C. E. Pope of Springfield, Illinois, reported to the writers that a certain purebred Saanen goat (La Qualité Mi-Favorite, No. 55472) failed to give more than a few cubic centimeters of milk from either half following her first parturition. Thinking that there might be involved an interesting endocrine imbalance, it was suggested that the goat be rebred and if, after the second parturition, a similar condition prevailed, the animal be brought to Columbia for further study.

The animal kidded for the second time on February 4, 1941; however, she was not brought to Columbia until February 22. At that time, gross examination showed each half of the udder to be about the size of a man's fist. Palpation indicated a rather meaty, fibrous condition of the udder. As 18 days had elapsed since parturition without milk removal, one would expect considerable resorption of the milk present at that time.

In order to determine whether the possible endocrine imbalance was related to the growth of the udder, or to the stimulation of milk secretion, the right half of the udder was surgically removed[2] for gross and histological examination. The gland weighed 349 gms. An attempt was then made to inject Bouin's fluid through the teat into the gland. Not more than 10 cc.

[2] The authors are indebted to Dr. A. A. Lewis and E. P. Reineke for aid in removing the half.

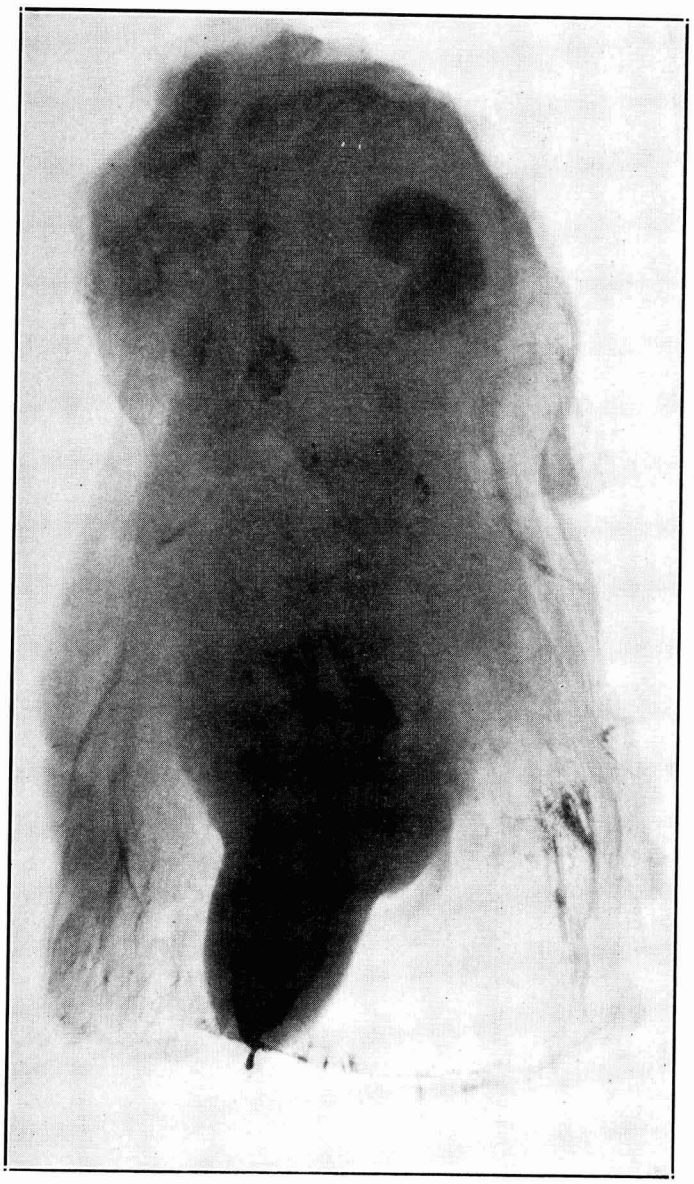


FIG. 1. An X-ray photograph of the udder half to which a suspension of barium sulphate had been injected. The cistern of the teat appears normal. The cistern of the gland is restricted to a duct. The primary ducts which normally branch from the cistern of the gland are restricted and end blindly. Secretion from the gland tissue above cannot be removed.

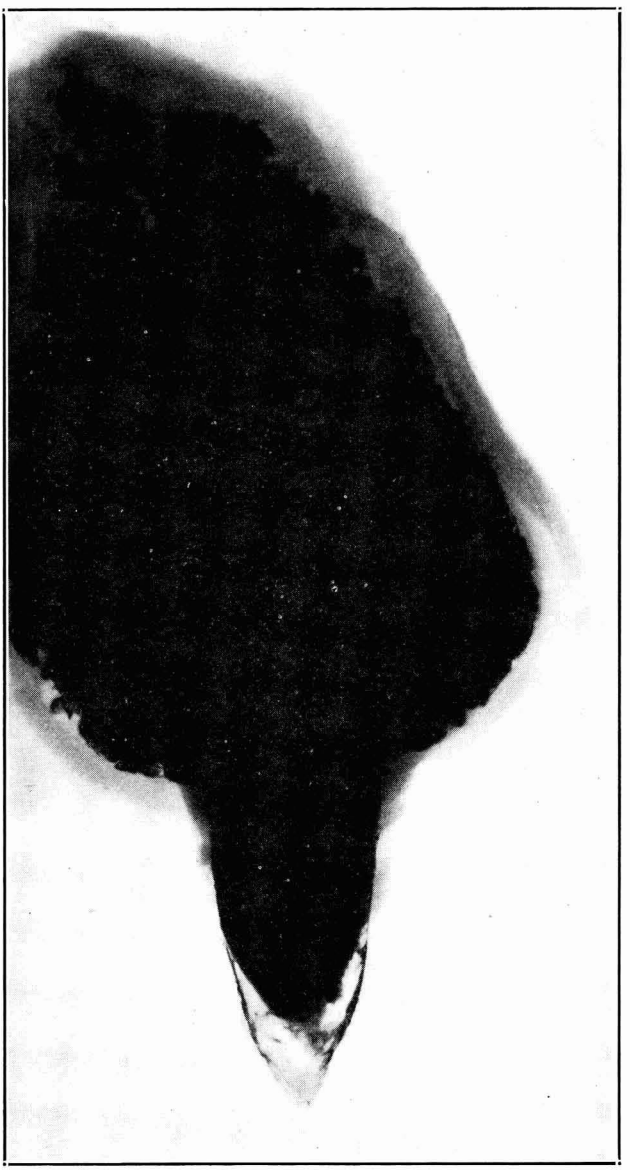


FIG. 2. An X-ray photograph of a normal udder half to which a suspension of barium sulphate had been injected. All parts of the gland communicate with the cistern and duct system.

could be injected into the teat and gland cistern. Beyond the gland cistern there seemed to be definite obstruction to the normal flow of fluid.

The teat therefore was cut lengthwise to note the condition at the point of the obstruction. It was found that the structure of the teat was approximately normal, but at the base of the teat there was a constriction but not a closure at the point where the teat cistern merges into the gland cistern. Above the teat, instead of an enlarged gland cistern, there was a duct from which several branches extended for a short distance into the gland, then ended blindly.

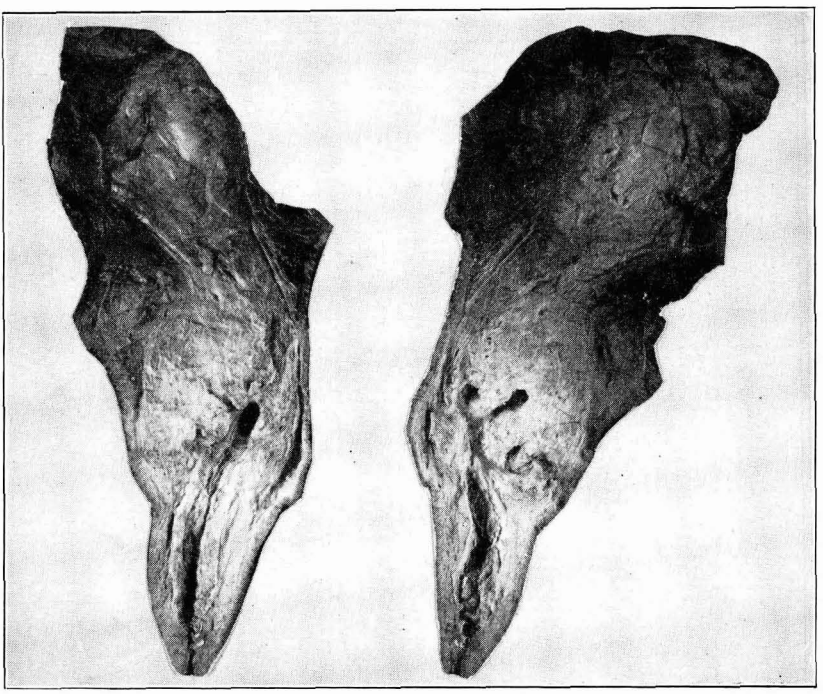


FIG. 3. Dissection of the same udder half as shown in fig. 1 following the injection of a formalin solution to harden the tissue. A perpendicular section shows the normal streak canal, cistern of the teat, duct-like gland cistern, and blind ends of the primary ducts. (For normal goat udder see reference 7.)

The observations up to this point led us to believe that the lack of milk production was due to constrictions of the primary milk ducts preventing the drainage of milk from the gland. That this was true was determined by the examination of fresh thin sections cut from the upper parts of the gland examined under the dissecting microscope and by histological sections.

While the resorption of milk was in a rather advanced stage and the size of the lumina of the alveoli were greatly reduced, there were abundant

signs of milk secretion from normal epithelial cells. No signs of mastitis, such as the excessive presence of leucocytes, were observed in any part of the gland. The strands of connective tissue appeared somewhat larger than normal but this should be expected with resorption of the bulk of the milk.

Sections cut at the point of constriction of one of the primary ducts showed a concave mass of connective tissue underlying the duct epithelium. Beyond this constriction no further evidence of the duct was observed but clumps of alveoli surrounded by rather heavy strands of connective tissue were present.

The animal was kept in our herd and rebred. In November 1941, the animal was sacrificed and the left half removed. The weight of the half was 227 gm. Fluid was again injected into the teat, but as before only about 10 cc. could be held. It was decided to fill the teat cistern with a suspension of barium sulphate and take an X-ray photograph (figs. 1 and 2). The photographs showed a normal cistern of the teat but a duct rather than a gland cistern. Only a few primary ducts were present which extended for a short distance into the gland and then ended blindly. The barium sulphate suspension was removed from the half and a 10 per cent formalin solution was injected into the cistern of the teat as far as it would go. After hardening, the teat and gland were sectioned (fig. 3). The two halves were thus observed to be essentially similar anatomically.

DISCUSSION

The present case is believed to differ from the previous described types of "blind" mammary glands in that the constriction and blockage of milk removal are located in the primary ducts rather than between the cistern of the teat and gland cistern. It is true that in dairy cattle a condition similar to this has been described in quarters, which either at an early age of the animal or following several lactations, were infected with mastitis. In such cases there appeared to be an overgrowth of the connective tissue surrounding the primary milk ducts closing the ducts.

The following facts are considered in opposition to the theory that the cause of this condition was due to an early infection of the udder. First, the two halves showed essentially the same condition. Second, the owner of the goat was of the opinion that other goats had not sucked her to set up an infection or irritation. Third, there was no histological evidence of a heavy leucocytic infiltration of the tissue. Fourth, there did not appear to be an overgrowth of the connective tissue around the ducts but rather a blind ending of the ducts.

On the other hand, the evidence in favor of the suggestion that the condition is either inherited or is due to a defective embryological condition follows: First, the owner of the goat studied is acquainted with another goat of similar breeding which also failed to give milk. Whether the anatomical con-

dition is the same is not known. Second, the two halves appeared to have the same defect.

SUMMARY AND CONCLUSIONS

A case of a goat is reported which failed to give milk after parturition. It was found that both halves were blind. The gland tissue was capable of secreting milk but the primary milk ducts ended blindly. It is believed that this condition is due to an inherited or developmental defect in the glands rather than to the development of connective tissue overgrowth resulting from mastitic infection.

REFERENCES

(1) ALEXANDER, A. S. Udder Diseases of the Cow. R. G. Bodger, Pub., Boston. 1928.
(2) BILLINGS, W. A. Livestock and Poultry Diseases. The Macmillan Co., New York. 1930.
(3) ———— Trouble with the Milk Ducts. Va. Agr. Dept. Bul. 110, p. 15.
(4) FOUST, H. L. The Surgical Anatomy of the Teat of the Cow. Amer. Vet. Med. Assoc. Jour., **98**: 1934.
(5) LEWIS, A. A., AND TURNER, C. W. (unpublished). 1942.
(6) SWETT, W. W., MATTHEWS, C. A., AND GRAVES, R. R. Injury or Infection in Udders of Heifers May Terminate in Blind Quarters. JOUR. DAIRY SCI., **22**: 993. 1939.
(7) TURNER, C. W. The Comparative Anatomy of the Mammary Glands. Univ. Cooperative Store, Pub., Columbia, Mo. 1939.

VOLUME XXV JUNE, 1942 NUMBER 6

JOURNAL OF DAIRY SCIENCE

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION
R. B. STOLTZ, Sec.-Treas.
Ohio State University, Columbus, Ohio

ABSTRACTS OF LITERATURE

T. S. SUTTON, Editor
Columbus, Ohio

MILK AND MILK PRODUCTS

Published in cooperation with
INTERNATIONAL ASSOCIATION OF ICE CREAM MANUFACTURERS
R. C. HIBBEN, 1105 Barr Bldg., Washington, D. C., Exec. Sec.

INTERNATIONAL ASSOCIATION OF MILK DEALERS
R. E. LITTLE, 309 W. Jackson Blvd., Chicago, Illinois, Exec. Sec.

CONTENTS

THE SCIENCE PRESS PRINTING COMPANY LANCASTER, PA.

PUBLICATIONS AND ABSTRACTORS

EDITORS

Dahle, C. D., Dahlberg, A. C., Elliker, P. R., Petersen, W. E., Tracy, P. H. and Weckel, K. G.

ABSTRACTORS

Archibald, J. G.	Dorsey, L. M.	Irvine, O. R.	Riddell, W. H.
	Downs, P. A.		
Babcock, C. J.		Josephson, D. V.	Sheuring, J. J.
Bennett, F. W.	Erb, J. H.		Stebnitz, V. C.
Berggren, Ruth E.	Ely, Fordyce	Lucas, P. S.	
Brueckner, H. J.	Espe, D. L.	Lush, J. L.	Thomsen, L. C.
Burgwald, L. H.			Trout, G. M.
Bushnell, L. D.	Frazier, W. C.	Marquardt, J. C.	
		Martin, W. H.	Webb, B. H.
Cole, W. C.	Garrett, O. F.	Mueller, W. S.	Weckel, K. G.
Cone, J. F.	Glick, D. P.		Weiser, H. H.
Coulter, S. T.	Goss, E. F.	Price, W. V.	White, G. C.
Doan, F. J.	Huffman, C. F.	Reece, Ralph P.	Yale, M. W.

JOURNALS

American Butter Review
American Milk Review
American Journal of Diseases of Children
American Journal of Physiology
American Journal of Public Health
Archives of Pediatrics
Australian Journal of the Council for Scientific and Industrial Research

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Canadian Public Health Journal
Certified Milk
Cornell Veterinarian

Dairy Industries
Dairy World
Deutsche Molkerei Zeitung

Endocrinology

Food Industries
Food Manufacture
Food Research

Ice and Refrigeration
Ice Cream Field
Ice Cream Review
Ice Cream Trade Journal
Industrial and Engineering Chemistry

Journal of Agricultural Research
Journal of Agricultural Science
Journal of American Medical Association
Journal of American Veterinary Medical Association
Journal of Animal Science
Journal of Bacteriology
Journal of Biological Chemistry
Journal of Dairy Research
Journal of Dairy Science
Journal of Endocrinology
Journal of Experimental Medicine
Journal of General Physiology
Journal of Genetics
Journal of Heredity
Journal of Industrial and Engineering Chemistry
Journal of Infectious Diseases
Journal of Milk Technology
Journal of Nutrition
Journal of Pathology and Bacteriology
Journal of Physical Chemistry
Journal of Physiology
Journal of Veterinary Research

Kaeseindustrie
Kolloid-Zeitschrift

Lancet
Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry
Milk Plant Monthly
Molkerei Zeitung
National Butter and Cheese Journal
New Zealand Journal of Science and Technology

Oil and Soap

Pacific Dairy Review
Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture
Southern Dairy Products Journal

Tierernährung
Tierzüchter

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zeitschrift für Untersuchtung der Lebensmittel
Zeitschrift für Züchtung. Reihe B. Tierzuchtung und Zuchtungbiologie
Zentralblatt für Bacteriologie
Züchtungskunde

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment. Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers

National Institute for Research in Dairying, Reading, England
New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

ADVANCE ABSTRACTS OF REPORTS ACCEPTED FOR PUBLICATION IN THE JOURNAL OF DAIRY SCIENCE

353. A Comparison of Rats Fed an Evaporated Milk with Those Fed a "Milk" in Which the Naturally Occurring Fat Has Been Replaced by Cocoanut Oil. SMITH FREEMAN AND A. C. IVY, Dept. Physiology and Pharmacology, Northwestern Univ. Med. School, Chicago.

The growth of rats fed an evaporated milk was greater over a 97-day period than for a similar group of rats maintained on a "filled milk" in which the butter fat had been replaced by coconut oil. The percentage of bone ash and of liver fat is quite similar for the two groups of rats, both after 49 and 97 days on the diets. There were more volatile fatty acids deposited in the storage fat of the coconut oil group.

354. A Colorimetric Method for Estimating the Quality of Butter. G. KNAYSI AND E. S. GUTHRIE, Cornell Univ., Ithaca, N. Y.

A simple method of estimating the quality of butter is described. It consists in dissolving 1 ml. of the melted milk fat in 3 ml. of chemically pure xylol saturated with the free base of neutral red, and comparing the color with standards containing known quantities of oleic acid. The base of neutral red is prepared by precipitation with sodium hydroxide from an aqueous solution of the dye salt.

The test, which is a measure of the degree of hydrolysis of the butter fat, is found to be of value in quickly detecting bad samples and the majority of fair or good samples of butter, and in adding precision to the judgment of the expert.

355. A New Colorimetric Method for the Determination of Free Fatty Acids in Milk. V. N. KRUKOVSKY AND G. KNAYSI, Cornell Univ., Ithaca, N. Y.

A simple and quick colorimetric method for the determination of free fatty acids in milk fat is described. The method is shown to be highly sensitive and accurate and consist in dissolving one ml. of the milk fat in 3 ml. of a saturated solution of the free base of neutral red in chemically pure xyol and comparing with a set of standards of known oleic acid contents. In neutral fat and in xylol, the dye base gives an orange yellow solution. Free fatty acids form red soaps with the dye base and the degree of shift to the red is proportional to the concentration of the soap and, therefore, of the free fatty acids. Equal normal concentrations of various fatty acids produce equal shift in the color.

356. Further Studies on the Use of Basic Dyes for Measuring the Hydrolysis of Fat. G. KNAYSI, Cornell Univ., Ithaca, N. Y.

Four basic dyes, namely methylene blue, Nile blue, spirit blue and neutral red, are studied from the point of view of suitability in the study of fat. Preparation of the free bases from solutions of the dye salts is described, and the solubilities and stability of those bases under different conditions are studied. It it concluded that Nile blue is unsuitable on account of the instability of its base, and its use may lead to serious errors. The base of neutral red is found to be the most suitable on account of its stability and the ease with which it is prepared. In microscopic work, where excessive contrast is desirable, it is recommended that methylene blue or spirit blue be used.

357. The Evaluations of Flavor Defects of Butter, Cheese, Milk, and Ice Cream as Designated by Dairy Products Judges. G. M. TROUT, P. A. DOWNS, M. J. MACK, E. L. FOUTS, AND C. J. BABCOCK, Committee on Judging Dairy Products, A.D.S.A.

Evaluations of flavor scores of butter, milk, cheese, and ice cream by forty-seven trained judges and by a panel of five selected judges for each product were made. The judgments of the selected judges were found, for the most part, to be within a narrower range than those of the group of judges as a whole.

A knowledge of the classes or groups of off-flavors of butter, cheese, milk, and ice cream as arranged from the numerical scores given by the selected judges would seem to be of material value, 1, to those interested in becoming proficient in dairy products judging; 2, in unifying and standardizing dairy products judging throughout the United States; and 3, in furnishing a common basis for recording and evaluating research in which flavor data are involved.

358. Ortho Phosphoric Acid as a Cheese Solvent. V. CONQUEST, A. W. TURNER AND B. ROGERS, Armour and Company, Chemical Res. Lab., Chicago, Ill.

A method for the use of 1.0% ortho phosphoric acid as a solvent for cheese in the cheese sediment test is described. This method has the advantages of simplicity, low cost, and rapidity of execution, a combination not found in other similar techniques.

359. Shark Liver Oil and the Vitamin A Potency of Milk. L. L. RUSOFF, H. E. SKIPPER, AND P. T. DIX ARNOLD, Florida Agr. Expt. Sta., Gainesville.

Ten Jersey cows from the Florida station herd were placed in 4 groups receiving 0, 2.5, 5 and 10 pounds of shark liver oil (9,000 International Units

of vitamin A per gram) per ton of the mixed concentrates in the ration. The cows were subjected to three distinct feeding periods: pre-period before the use of shark oil, a winter or dry lot period, and a spring period on pasture. During the winter period all cows received clover hay.

Milk samples, taken at the end of each period, were assayed for vitamin A potency by slight modification of the U.S.P. XI biological technique. The vitamin A potency of the milk ranged from 1570 to 2035 I.U. per quart.

The addition of 2.5 pounds of shark liver oil per ton of feed (0.125 per cent of the concentrates) increased the vitamin A potency of the basal ration from 744,000 I.U. to 795,000 I.U. per cow daily, which was sufficient to produce milk of maximum vitamin A potency. Addition of shark liver oil above this level did not further increase the vitamin A potency of the milk.

Even when the cows were allowed pasture in addition, in the spring, no increase in the vitamin A potency of the milk was observed. One of these cows received orally an additional 1,400,000 I.U. of vitamin A daily in the form of shark liver oil (6 ounces) without further effect.

There was a slight tendency to depress the percentage of butterfat in the milk without affecting milk production.

The high vitamin A intake from the ration did not influence the ascorbic acid content of the milk.

BACTERIOLOGY

360. Preserving and Germicidal Action of Various Sugars and Organic Acids on Yeasts and Bacteria. F. J. Erickson and F. W. Fabian, Mich. State Col., East Lansing, Mich. Food Res., *7*, No. 1: 68. Jan.–Feb., 1942.

The preserving and germidical action of the sugars, fructose, dextrose, sucrose and lactose and the organic acids, acetic, lactic and citric, were determined, using thermophilic and mesophilic bacteria, several yeasts and a torula.

The order of activity for sugars was found to fructose > dextrose > sucrose > lactose on bacteria, the thermophiles being more susceptible than the mesophiles. The yeasts were more resistant than the bacteria to all the sugars, sucrose requiring 15% greater concentration than the hexose sugars for preserving indications, while lactose had no preserving action on yeasts. Fructose and dextrose, only, exhibited germicidal action on all yeasts. Sucrose was germicidal only to *Saccharomyces cerevisiae.*

The same method used for evaluating the preserving and germicidal activity of the acids indicated that on a percentage basis the effectiveness was lactic > acetic > citric for bacteria, whereas, on a pH basis, it was acetic > citric > lactic and that the mesophilic streptococci were more resistant than the thermophiles. These findings indicate that acids do not

depend entirely on the hydrogen ion for their action but partly on the anion and the un-ionzed molecule. Yeasts were more tolerant of acids than the bacteria since a strength of between 0.5 and 5 normal were necessary to show activity which was had with concentrations of between 0.1 and 0.3 normal on the bacteria.

For bacteria the order of effectiveness of the acids in combination with the sugars was lactic > acetic > citric and again fructose and dextrose were much more active than sucrose. No germicidal action was exerted by lactose in combination with any of the preserving quantities of the acids.

In an acid and sugar combination the acid is the more important factor of the two in producing a germicidal effect on microorganisms. F.J.D.

361. A Group of Coliform Bacilli Serologically Related to the Genus Salmonella. C. A. PELUFFO, P. R. EDWARDS, AND D. W. BRUNER, Ky. Agr. Expt. Sta., Lexington, Ky. Jour. Infect. Dis., *70*, No. 2: 185–192. Mar.–Apr., 1942.

A group of 7 paracolon strains, all of which liquefied gelatin and fermented lactose slowly, were compared serologically with *Salmonella düsseldorf* and *S. cerro*. The paracolon organisms displayed only slight 0 relationships to the known *Salmonella* types, but the H antigens were closely related to those of *S. düsseldorf* and *S. cerro*. The 7 strains represented 5 serological types, the antigenic compositions of which were studied. The biochemical characteristics of these 7 strains differ from those of any of the genera now recognized. J.F.C.

362. The Brucella Complement Fixation Reaction. BOWMAN WISE AND H. W. CRAIG, Duke Univ. School Med., Durham, N. C. Jour. Infect. Dis., *70*, No. 2: 147–151. Mar.–Apr., 1942.

The Brucella complement fixation reaction was found to possess no advantage over the more easily performed agglutination tests, except that the complement-fixing antibodies frequently appear before agglutinins in acute Brucellosis. J.F.C.

363. The Nutritive Requirements of the Salmonellas. II. The Typhoid Bacillus: Carbon Source and Amino Acid Requirements. WILLIAM BURROWS, Univ. Chicago Dept. Bact. and Parasitol. Jour. Infect. Dis., *70*, No. 2: 126–130. Mar.–Apr., 1942.

In a basal medium of inorganic salts six carbon sources were used in testing the ability of 11 strains of typhoid bacilli to use various amino acids. The results on the utilization of amino acids varied not only with the different strains of organisms but also within strains as the carbon sources were varied. J.F.C.

BUTTER

364. Recent Russian Food Research. ANONYMOUS. Food Mfg., *17*, No. 3: 72–73. 1942.

Methods are described for the use of a colloid mill in the production of synthetic foods of the "butter" type. It was found that under certain conditions butter-like products can be prepared from emulsions composed of milk, fat and water; this butter is said to have a better taste and constitution than ordinary margarine. It is also stated that production is very economical. J.C.M.

365. The Flavor of Butter. ANONYMOUS. Food Mfg., *17*, No. 2: 40–41. 1942.

This article goes into the history of butter making with emphasis on discoveries which led up to present-day ways of controlling the flavor by means of a starter. J.C.M.

366. Butter in National Health. CHRIS L. CHRISTENSEN, Univ. Wis., Madison, Wisconsin. Med. Jour., *41*, No. 1: 48. Jan., 1942.

Butter is a concentrated food which furnishes large amounts of energy; it is an excellent source of certain vitamins and accessory food substances which promote growth, health and well-being. Butter ranks second only to fish-liver oils in ease of digestion and completeness of utilization. Vitamin A and carotenes are present in good butter in varying proportions. About two ounces per day of good butter will supply the vitamin A requirements of an average child, while two to three ounces plus a pint of milk will be adequate for an adult's vitamin A needs. All butter is a fair source of vitamin D. A new unnamed growth factor also present in butter is being investigated. W.V.P.

367. Use of Cereal Anti-oxidant to Prevent Tallowiness in Butter. W. J. CORBETT AND P. H. TRACY, Univ. Ill., Urbana, AND C. N. HANSEN, Beatrice Creamery, Champaign, Ill. Natl. Butter and Cheese Jour., *33*, No. 4: 16. April, 1942.

See JOUR. DAIRY SCI., **25**, No. 1: A9. Abstract 21. W.V.P.

CHEESE

368. Right Way to Make Processed Cheese. C. R. BARKER. Food Indus., *13*, No. 12: 53–55. 1941.

This article presents a technological method for preparing processed cheese. Making processed cheese is a science, not an art. Familiarity with the art only helps to get the desired results.

Mr. Barker outlines in this article what he considers the best procedure for making processed cheese. J.C.M.

369. **Smoked Cheese.** J. C. MARQUARDT, N. Y. Agr. Expt. Sta., Geneva, N. Y. Natl. Butter and Cheese Jour., *33,* No. 4: 20. April, 1942. (Also published in Vol. 8, No. 1, Farm Research, Geneva, N. Y.)

Smoking cheese adds flavor; wood smoke, "liquid" smoke or smoked salt may be used. When wood smoke is used its temperature should be kept below 100° F. and exposure should be from 18 to 36 hours. Three to 5 pound loaves should be cut lengthwise into two equal parts and smoked on wire grids. "Liquid" smoke may be added to the milk or to the cheese if it is to be processed; legal requirements are established for inter-state trade. Smoked salt introduces a "streaking" problem and lacks sufficient flavor. W.V.P.

370. **Suggestions on Complying with Federal Cheese Standards.** A. T. BRUHN, Wis. Dept. Agr., Madison. Natl. Butter and Cheese Jour., *33,* No. 4: 42. April, 1942.

The qualities of acceptable cheese are described. Such cheese is made from good milk which is protected and not unduly agitated in transit to the factory. Methylene blue and sediment tests are necessary to check production methods. Salt must be well dissolved and absorbed when curd is put to press. W.V.P.

371. **How to Use Waste Rind in Processed Cheese.** SIMON BRICKNER. Food Indus., *14,* No. 3: 47. 1941.

The thick, tough rind of natural Swiss cheese can be used in the making of processed cheese. The rind, which contains approximately 35% fat and 20% moisture, can be reduced to a fine powder by means of a special hammer mill.

It has been found by experience that up to one third of the batch may be replaced by this powdered rind without impairing the flavor, body, texture, or slicing qualities. J.C.M.

372. **Utilization of Swiss Cheese Rind in Process Cheese.** SIMON BRICKNER, Dairy Chemist, Brooklyn, N. Y. Natl. Butter and Cheese Jour., *33,* No. 3: 28. March, 1942.

See preceding abstract. W.V.P.

CHEMISTRY

373. **The Pennsylvania Method for Determining the Percentage of Fat in Dairy Products.** W. D. SWOPE. Pa. Agr. Expt. Sta. Bul. 412.

A method was developed primarily for determining the fat percentage

in dairy products to which sugar has been added. Twenty-five reagents in varying amounts and combinations were tried. It was found that 2 milliliters of ammonium hydroxide (28 to 29% NH_3), 3 milliliters of butyl alcohol (B. P. 117° C.) and 17.5 milliliters of sulphuric acid (sp. gr. 1.72 to 1.74) gave results which checked favorably with the Mojonnier Method. Of 529 fat determinations made by the Pennsylvania Method on ice cream, ice cream mix, sweetened condensed milk, and chocolate milk, 84.3% were within $\pm$ 0.19% of the Mojonnier method. Author's Abstract.

374. Vitamin Methods. I. An Improved Procedure for Estimating Vitamin B_1 in Foodstuffs and Biological Materials by the Thiochrome Test Including Comparisons with Biological Assays. LESLIE J. HARRIS AND Y. L. WANG, Dunn Nutritional Lab., Cambridge Univ. and Med. Res. Council. Biochem. Jour., *35*, No. 9: 1050. 1941.

An accurate procedure, based on the method of Wang and Harris (1939) for urine, has been worked out. This method has been tested with dairy products as well as numerous other foodstuffs.

Special features include: (a) A preliminary process of extraction, (b) digestion with papain and takadiastase, (c) washing of the digest with isobutanol, (d) omission of adsorption, (e) conversion into thiochrome in presence of methanol, and with addition of the $K_4Fe(CN)_6$ before the NaOH, (f) washing of the thiochrome layer with water, (g) visual comparison of fluorescence with the aid of light filters and blank controls. V.C.S.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

375. Preventing Off-flavors in Dried Whole Milk. E. L. JACK AND J. L. HENDERSON, Davis, California. Food Indus., *14*, No. 3: 50–51. 1942.

Although dried whole milk represents the greatest degree of concentration of any milk solids product, its production is much less than other less highly concentrated milk products. The main reason is that up until recently it could not be produced with satisfactory keeping qualities.

It was found that oxidation caused the off flavor, and that it could be corrected for a period of two years by using the "atmospheric roller dryer" process when the milk was preheated to 175° F. for 15 minutes. J.C.M.

376. From Cow to Cloth. ANONYMOUS. Food Indus., *13*, No. 12: 47. 1941.

An important new by-product of the dairy industry is "Aralac," a translucent cloth made from casein which is extracted from skim milk. This fiber can be blended with wool, mohair, cotton, rayon, or fur in varying proportions.

This development is significant to the food industries in that it provides a new outlet for skim milk that may reach important proportions. J.C.M.

DISEASE

377. Studies on Brucellosis in Mexico. Comparative Study of Various Diagnostic Tests and Classification of the Isolated Bacteria. M. RUIZ CASTANEDA, RAUL TOVAR, AND RAFAEL VELEZ, Dept. Med. Res., General Hospital and Public Health Service of Mexico, Mexico City. Jour. Infect. Dis., *70,* No. 2: 97–102. Mar.–Apr., 1942.

Over a 4-year period 200 human cases of brucellosis were studied. Clinical diagnoses were supplemented with blood cultures (both with increased CO_2 tension and in ordinary atmospheres), agglutination tests, intradermal tests, and opsonic tests. Of the 200 cases, 93% gave positive agglutination reactions, 84% positive blood cultures, 80% positive intradermal tests, and 60% positive opsonic tests. The classification of 150 strains of the organisms showed that 143 were *Brucella melitensis,* 5 *Br. abortus,* and *2 Br. suis.* The high prevalence of *Br. melitensis* infections is accounted for by the considerable use of goat's milk and goat's milk products in Mexico. J.F.C.

378. A Study of Hemolytic Streptococci from a Horse Treated with Sulfanilamide after Streptococcal Bacteriemia Developed during Immunization. JESSIE L. HENDRY, N. Y. State Dept. Health, Albany. Jour. Infect. Dis., *70,* No. 2: 112–118. Mar.–Apr., 1942.

Blood taken the day before death from a horse that had been under treatment for ten days with sulfanilamide yielded hemolytic streptococci which were more resistant *in vitro* to the action of sulfanilamide than was the standard culture with which the horse was orginally inoculated. There was evidence that the resistance to sulfanilamide increased progressively during therapy. After 14 mouse passages there was no apparent decrease in resistance to the drug. Sulfanilamide-inhibiting activity was demonstrated in broth filtrates of both the standard strain and strains obtained from the blood and organs of the horse, but the inhibiting activity was produced sooner by the drug-resistant strains. J.F.C.

FEEDS AND FEEDING

379. Legume Silage in Dairy Feeding. S. I. BECHDEL, R. W. STONE, P. S. WILLIAMS, AND F. R. MURDOCK. Pa. Agr. Expt. Sta. Bul. 411.

Results of four feeding trials with dairy cattle revealed that legume silage makes possible the feeding of smaller amounts of concentrates for milk production, and also concentrates with a relatively low percentage of protein. Alfalfa silage should be fed in connection with some hay and also

with corn silage if it is available. Alfalfa-molasses silage and alfalfa-phosphoric acid silage are equal in feeding value for milk production. Milking cows tend to go "off feed" when fed heavily on phosphoric-acid legume silage. The feeding of pulverized limestone with this silage is advised. Eighty pounds of molassees or 18 pounds of 73% phosphoric acid per ton of green alfalfa are considered the optimum amounts of preservative to use.

Author's abstract.

FOOD VALUE OF DAIRY PRODUCTS

380. The Effect of Fortifying the Infant's Diet with a Cereal Enriched by Iron, Calcium, and Vitamin B_1. MAURICE L. BLATT, ELLIS HARRIS, HOWARD JACOBS, St. Vincent's Infant and Maternity Hosp., Chicago, Ill. Arch. Ped., *58*, No. 2: 694. Nov., 1941.

The minimum daily requirements of the pre-school child are 0.75 grams of calcium, 0.75 grams of phosphorous, 7.5 milligrams of iron and 125 International units of thiamine. A quart of milk contains approximately 1.06 grams of calcium, 0.80 grams of phosphorous, 0.62 milligrams of iron and 143 International units of Vitamin B_1. On the basis of feeding 2 ounces of milk per pound of body weight a quart per day is not consumed until about the sixth month when the infant weighs approximately 16 pounds. It is not until the sixth month, therefore, that enough milk is ingested to supply the daily need of phosphorous and Vitamin B_1 and a positive iron balance is never attained on milk alone. A farina cereal enriched by the addition of iron, calcium, phosphorus, and stabilized wheat germ was fed as a part of the dietary of a group of institutionalized infants and young children. A second group in the same institution concurrently was fed a mixture of three unfortified farinas purchased in the open market. A comparative study was made of the growth and development of the two groups of children and their tolerance for the cereals. The authors concluded that farina enriched with iron, calcium, phosphorous and wheat germ was well tolerated by normal infants, in the usual milk diet, did not increase the number of stools, nor did it cause constipation. The increase in weight and red blood count was superior to the group fed ordinary farinas. The height of the children fed the enriched farina showed a superiority over those fed control farinas, but the significance of this trend was not established.

J.J.S.

MILK

381. Dairy Industry in the National Emergency. C. E. WYLIE, Univ. Tenn., Knoxville, Tenn. Mimeograph Report No. 68. February 20, 1942.

This report reviews the situation in regard to the following materials

used in the dairy industry: burlap, tin, vanilla, sugar, cattle, molasses and rubber. It includes adjustments in marketing; milk requirements for the nation and for Tennessee. The goals of milk production are shown for each Tennessee county with suggested methods for increasing production. Factors favoring and handicapping this increased production are listed.

Author's abstract.

382. "Quick-time" Pasteurization of Milk. A. C. DAHLBERG, R. F. HOLLAND, AND R. K. MINER, Geneva, N. Y. N. Y. State Agr. Expt. Sta. Tech. Bul. 261. 1941.

It was shown in laboratory experiments published last year that certain advantages in the pasteurization of milk might be secured at temperatures higher than those now used. The present experiments were conducted under commercial conditions to try the new heat treatment of milk under controlled factory conditions.

The term "quick-time" pasteurization was used to designate the heat treatment given the milk. It consisted of a controlled time above 140° F. (60° C.) during which the milk was heated to the desired temperature and cooled again below 140°. There was no holding at the highest temperature attained.

Milk was successfully quick-time pasteurized at 177.5° to 169° F. (80.8° to 76.1° C.) with the time interval above 140° varying from 5 to 24 seconds. For example, milk was successfully pasteurized at 170° F. (76.6° C.) with 12 seconds total time to heat and to cool. At these higher temperatures the variation in the highest temperature attained could be greater than the present accepted pasteurization standards and still show proper pasteurization. There was a tendency toward a slightly better milk as produced by quick-time pasteurization. No data were secured with pathogenic bacteria.

Author's abstract.

383. The Nation's Milk Supply in War Time. NORMAN C. WRIGHT, Hannah Dairy Res. Inst., Kirkhill, Ayr. Milk Indus. 22, No. 1: 33. July, 1941. (Review of the original article published in full in Roy. Agr. Soc. Jour., England, Vol. 101, Part II, 1941.)

The author discusses some of England's wartime requirements for milk and milk products, the best methods of utilizing the available supplies of home-produced milk and methods by which such supplies can be maintained at an adequate level. During 1938 sales of milk and cream were remarkably constant, manufacture of milk products was seasonal, and over twice as much milk was used for butter as for the production of cheese or the manufacture of condensed and dried milk. For wartime use of liquid milk, expectant and nursing mothers, children under 5 years, and hospital patients are allowed 1 pint of milk daily. School children are allowed two-thirds of

a pint of milk daily while the remainder of the population is allowed one-third of a pint per head. Of the manufactured milk products, first priority has been given to condensed and dried whole milk, second priority is given to cheese, and third to butter. J.J.S.

384. The Resazurin Test. J. G. DAVIS AND D. W. WATSON, Natl. Inst. Res. in Dairying, England. Milk Indus. 22, No. 8: 37. Feb., 1942.

The authors suggest using an incubation temperature of 18° C. instead of 37° C. for the resazurin test for the following reasons: 1. It is easier to maintain a large sink of water 18° C. than at 37° C. over a period of several hours. 2. The resazurin test at 18° C. is on the average three times slower than at 37°. Since the recognized standard time for the resazurin test at 37° C. is one hour, a suitable time for the test at 18° C. is 3 hours. 3. A temperature of 18° C. is a fair criterion for the assessment of the keeping quality of milk which is usually maintained in the household at about this temperature. 4. Time lag errors which may be serious in short time (*e.g.*, one hour) tests can be ignored in a three hour test.

The writers believe that the temperature of 18° C. could be adopted as a standard for keeping quality tests, not only of milk but of milk products. J.J.S.

385. Farm Milk Cooling Important in War-Time Program. RICHARD MARKLEY, JR., Wilson Cabinet Co., Smyrna, Del. Refrig. Eng., *43*, No. 3: 154. March, 1942.

The automatic maintenance of high water level on cans is indicated to be the efficient method for cooling and storing night's milking to be followed by cooling, or cooling and storing morning's milking. Diagrams illustrating how this is accomplished with the compartment and pump design of the wet storage tank accompany the article. It is emphasized that ample water to milk ratio is more efficient in utilizing compressor capacity than is the case where a small ratio is used and an ice bank on the evaporator is needed to hasten cooling of the milk. L.M.D.

MISCELLANEOUS

386. Canning and the Far Eastern Situation. ANONYMOUS. Food Mfg., *17*, No. 3: 57–59. 1942.

The entry of Japan into the war and the subsequent loss of Malayan tin are likely to have far-reaching effects on the British canning system.

This article brings forth just why tin is used in canning. It also discusses several means of cutting down on the tin used, in order to make the limited supply last longer. Methods such as using iron-lacquered cans for dry foods, glass jars for fruits, and a thinner tinplate are discussed. J.C.M.

387. The Revolving Fund Method of Financing Co-operatives. MARVIN A. SCHAARS, Univ. Wis., Madison. Natl. Butter and Cheese Jour., *33,* No. 4: 9. April, 1942.

When co-operative organizations lose the patronage of their owners they cease to be co-operatives and lose exemption from income taxes and certain borrowing privileges. Under the revolving capital plan each patron must contribute to the capital structure a small sum per unit of product handled by the co-operative for him and for which he receives a certificate of equity in the organization. These retains are used to retire indebtedness, capital investments and certificates. When the association has acquired sufficient capital then certificates are redeemed in the order of issue. This plan tends to increase membership loyalty, interest and responsibility, and sounder business methods. W.V.P.

388. How to Make Your Equipment Last Longer. PAUL H. MANDT, Assoc. Ed., Natl. Butter and Cheese Jour., Milwaukee, Wis. Natl. Butter and Cheese Jour., *33,* No. 4: 12. April, 1942.

To conserve equipment: Keep it clean and dry; repair leaks, cracks or breaks immediately; keep electric motors dry; don't use steel wool for cleaning; avoid denting equipment; lubricate moving parts; don't throw things into unused equipment; keep equipment properly painted or varnished. W.V.P.

389. Notes on Methods of Chemical Treatment for Corrosion Control in Refrigerating Brines. K. M. HOLADAY, Chemical Engineer, Anheuser-Busch, Inc., St. Louis, Mo. Ice and Refrig., *22,* No. 4: 304. 1941.

Increasing the density of a brine solution decreases its corrosiveness. The greater the density of a brine solution the lower will be the solubility of oxygen in the solution. Since calcium chloride brines with a given freezing point have greater density than sodium chloride brines of the same freezing point, this may account for the greater corrosive properties of sodium chloride brines.

A corrosion committee of the A. S. R. E. has recommended the addition of approximately 540 p.p.m. of chromic acid to calcium chloride brines and 1080 p.p.m. to calcium-magnesium chloride or sodium chloride brines, and 30 p.p.m. to cooling waters. Caustic soda is recommended for adjusting the pH value after treatment so that the brines will be slightly alkaline, but pH values above 8.5 should be avoided in order to prevent damage to galvanized iron surfaces.

Some later recommendations call for as low as 20 p.p.m. of chromic acid, but such low concentrations are to be recommended only where dilution or loss of brine is impossible.

Treatment with chromic acid is favored over the use of sodium dichromate because the total cost is less, and it is more convenient for neutralizing small ammonia leaks. Graphs indicating corrosiveness of brines of varying densities, and of varying pH values are included. L.C.T.

390. A New Type of Frozen Foods Locker. F. W. KNOWLES, Northwest Baker Ice Machine Co., Inc., Seattle, Wash. Refrig. Eng., *43*, No. 3: 157. March, 1942.

The lockers described are like a subdivided filing cabinet accessible from both ends. Each locker unit, 16 ft. long, is divided into six 6-cu.-ft. lockers. These long locker units or drawers roll out on ball bearings, and as the locker unit does not roll out quite half way, it is overbalanced generally on the end within the cold space. Unfilled lockers at either end may have temporary weights placed in them if empty or lightly loaded with frozen foods to prevent over-balance when pulled out. Swing doors on the side admit the patron to his locker space. The ends of the locker units act as insulated plugs to the cold space. The principal advantage lies in the fact that the locker patron does not have to enter a low temperature room to gain access to his stored goods. L.M.D.

391. Conservation of Freon. F. H. FAUST, Refrig. Eng., *43*, No. 3: 149. March, 1942.

The minimum estimate for Freon in 1942 is set at 13,357,000 lb., with a "probable" estimate of 15,568,000 lb., calling for 21,800,000 lb. of carbon tetrachloride as the chief raw material. It is concluded that a Freon conservation program be instituted and that the raw materials needed be made available. The industry sub-committee suggested a program of conservation divided into three categories: Equipment Manufacturer, Sales Engineering and Specifications, and Installation Service. The points brought out in the latter should be musts for all users of Freon refrigerating equipment and are as follows:

"1. Check all joints and points of possible leakage with 'halide torch.' It takes time, care and patience to find small leaks. 2. Do not recharge a system unless the leak has been found and repaired. 3. Weigh in exact charge of refrigerant specified and use the minimum charge required. 4. Discontinue practice of blowing out evaporators, lines, etc., with refrigerant. Use another medium such as dry air, nitrogen or carbon dioxide. 5. Exercise care in purging air from condenser; a lot of refrigerant can be saved in this procedure. 6. Exhaust and reclaim refrigerant from systems to be replaced or repaired. 7. Exhaust and reclaim refrigerant from supposedly empty refrigerant drums or service cylinders. 8. Pump down and lock refrigerant charge of all seasonal operation jobs in liquid receiver. Carefully check system for leaks before releasing liquid and resuming opera-

tion at beginning of season. 9. Use minimum size dehydrator that is feasible for permanent dryer. 10. Return empty refrigerant cylinders to supplier as soon as possible. 11. Service cylinder fittings, valves and connections should be replaced when worn, or damaged. They should be protected when not in use. 12. Replace all leaky shaft seals and gaskets on compressors.''

Comment: These would seem to be reasonable procedures even under conditions of normalcy. L.M.D.

392. Scale and Corrosion Control in Water and Brine Systems. J. A. HOLMES, National Aluminate Corp., Chicago. Ill. Refrig. Eng., 43, No. 3: 145. March, 1942.

In treating water for condensers, heat exchangers, etc., three possibilities may have to be met, these being scale, corrosion, and algae or slime. Molecular dehydrated poly-phosphates are recommended for scale prevention, especially where water is recirculated and cooled by a spray pond or tower, added in the make-up water at the rate of one to five parts per million. Over-concentration of the hardness in the system must be prevented to avoid precipitation. Organic materials also are used to prevent scale formation through their development of a coating over crystals which remain suspended in the water never growing large or strong enough to form scale. Combinations of organic materials and phosphates are effective in that the organic matter besides stabilizing the water also stabilizes the phosphates so that they remain in the molecular dehydrated condition.

The prevention of corrosion in recirculating cooling systems can be effected by the use of chromates, the use of alkaline materials, the use of the molecular dehydrated phosphates in heavy dosages. The use of an alkali with the phosphate is better if the water is very corrosive or acid.

When cooling towers and spray ponds are bothered with algae and other slime growths, treatment with chlorine, copper sulfate, and potassium permanganate may be followed, but the chlorophenate type of treatment has been very effective, using 1 lb. per 5,000 to 15,000 gal. of water two or three times per week. Alternate treatment with chlorophenate and copper sulfate is good where different types of algae are found.

Slime formation in condenser systems from the presence of iron bacteria may be controlled either by chlorphenates or chlorine, the latter being employed if the water is used for ice making.

Water used for air washing in air conditioning can be treated for slime prevention by chlorphenates at the rate of 500 p.p.m. Two dosages a week for light contamination, and three or four where heavy contamination is found are suggested. Such treatment does not prevent entirely bacterial and fungi infection of food materials and room walls from the conditioned air, but eliminates the air conditioning apparatus as a source. L.M.D.

393. Instructions for Pumping Out Ammonia Systems in Case of Air Raids. ANONYMOUS. Refrig. Eng., *43*, No. 3: 165. March, 1942.

In case of air raids, it is desired to confine the ammonia in the smallest space in order to offer the minimum size target to bomb hits. Receivers, condensers, and brine coolers fall into this category.

"1. When the air raid alarm is sounded, the king valve on the liquid line from the receiver shall be shut, cutting off distribution of liquid to the plant. 2. All available compressor capacity shall be started, in order to pump down the system as quickly as possible. 3. The engineer should make a complete round, closing all of the expansion valves except one, in order to minimize any back-flow in the case of a break in some part of the ammonia system. He should carry an ammonia mask ready for instant adjustment in position. Masks should be provided for all men remaining in the engine room. 4. Water hoses should be connected in the engine room ready to be played on any escaping ammonia. 5. In case of interruption of the condensing water supply, compressors shall be shut down immediately. 6. In case the power supply driving compressors or circulating pumps fail, everything shall be shut down. 7. If either 5 or 6 happens, close as many valves on the suction lines as possible, to isolate the ammonia into as many separate systems as possible, so as to minimize the hazard in case of a break in some part of the system. 8. When compressors are shut down, suction and discharge valves shall be closed.

After the 'all clear' is sounded, start system as usual. Keep damaged parts of system isolated until repairs can be effected." L.M.D.

AMERICAN DAIRY SCIENCE ASSOCIATION

INCORPORATED IN THE DISTRICT OF COLUMBIA

Officers

President ..... HENRY F. JUDKINS, New York, New York
Vice-President ..... HERBERT P. DAVIS, Lincoln, Nebraska
Secretary-Treasurer ..... R. B. STOLTZ, Columbus, Ohio
Editor ..... T. S. SUTTON, Columbus, Ohio
Director ..... G. MALCOLM TROUT, East Lansing, Michigan
Director ..... J. C. KNOTT, Pullman, Washington
Director ..... HOWARD B. ELLENBERGER, Burlington, Vermont
Director ..... ARTHUR C. DAHLBERG, Geneva, New York
Director ..... C. N. SHEPARDSON, College Station, Texas
Director ..... FORDYCE ELY, Lexington, Kentucky
Director ..... HARRY W. CAVE, Stillwater, Oklahoma

Officers of Sections

DAIRY PRODUCTION SECTION

Chairman ..... H. A. HERMAN, Columbia, Missouri
Vice-Chairman ..... K. L. TURK, College Park, Maryland
Secretary ..... DWIGHT L. ESPE, Ames, Iowa

DAIRY MANUFACTURING SECTION

Chairman ..... L. H. BURGWALD, Columbus, Ohio
Vice-Chairman ..... R. WHITAKER, Baltimore, Maryland
Secretary ..... KENNETH G. WECKEL, Madison, Wisconsin

DAIRY EXTENSION SECTION

Chairman ..... GLEN W. VERGERONT, Madison, Wisconsin
Vice-Chairman ..... J. F. KENDRICK, Washington, D. C.
Secretary ..... E. C. SCHEIDENHELM, East Lansing, Michigan

Officers of Divisions

SOUTHERN

Chairman ..... R. B. BECKER, Gainesville, Fla.
Vice-Chairman ..... J. P. LAMASTER, Clemson, S. C.
Secretary-Treasurer ..... F. H. HERZER, State College, Miss.

EASTERN

Chairman ..... H. C. MOORE, Durham, N. H.
Vice-Chairman ..... A. I. MANN, Storrs, Conn.
Secretary-Treasurer ..... L. R. DOWD, Storrs, Conn.

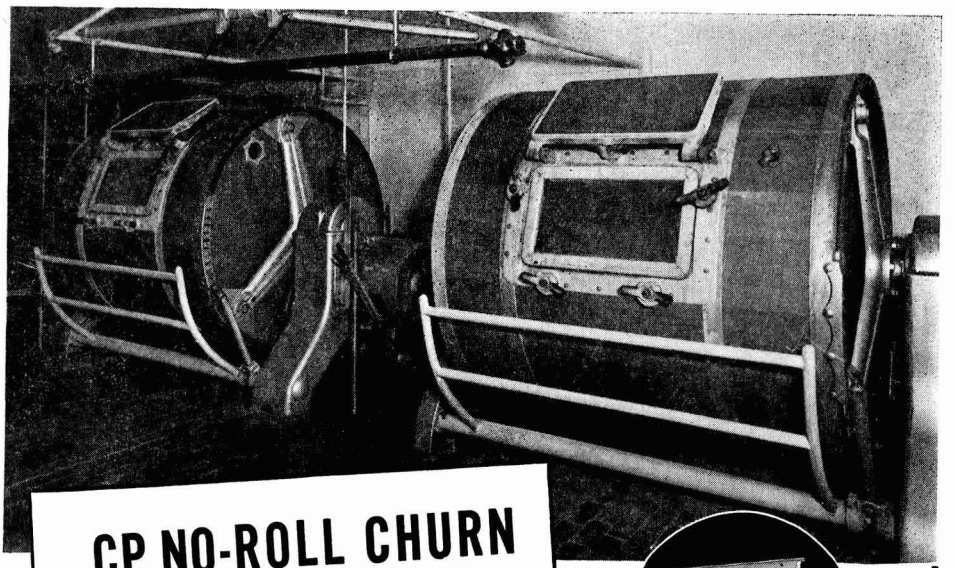
WESTERN

Chairman ..... N. S. GOLDING, Pullman, Wash.
Vice-Chairman ..... S. W. MEAD, Davis, Calif.
Secretary-Treasurer ..... H. P. EWALT, Corvallis, Oregon

The American Dairy Science Association was organized to advance the general welfare of the dairy industry, especially by the improvement of dairy instruction by the stimulation of scientific research in all phases of the subject and by improvement in methods of conducting extension work.

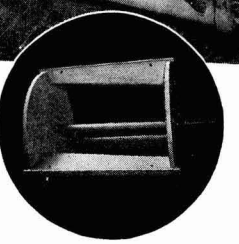
Membership. Any person is eligible to membership who is formally announced by an Agricultural College or Experiment Station, or by the Bureau of Dairy Industry of the United States Department of Agriculture or by the Canadian Department of Agriculture as an instructor, extension worker, investigator, or administrative officer connected with the dairy industry, or any person filling a position of responsibility connected with the dairy industry who has had a college or university training in technical science, or any person filling a responsible position in the dairy industry of a professional character requiring a technical knowledge of dairying of a high order. The membership fee is $5.00.

The dues are $5.00 a year, $3.00 of which is for a year's subscription to the *Journal of Dairy Science.* Correspondence regarding membership and dues should be addressed to R. B. Stoltz, Ohio State University, Columbus, Ohio.



CP NO-ROLL CHURN

Scores High In Efficiency and Economy



Butter made in the CP No-Roll Churn has ranked consistently high in competitive scoring. For excellence of body and texture—for thoroughness of moisture and salt incorporation—for exhaustive churning—it is unsurpassed.

CP No-Roll Churns also score high in those construction features that assure long life and trouble-free operation. Performance proves drum and drive, clutch, brake and bearings are right in every detail to provide maximum sanitation, efficiency and economy.

Built-In **TAPERED-SHELVES**

Sealed-In **TIE-ROD**

CONSTRUCTION

Close-up photo above shows unique construction of CP Built-In Shelves and Sanitary Center Working Bar. Shelves are integral with the staves. There are no cracks or crevices to catch and waste butter, complicate cleaning, and impair sanitation. Tie-rods, sealed in the shelves and center working bar, form the strongest construction possible.

THE CREAMERY PACKAGE MFG. CO.

1243 W. Washington Blvd., Chicago, Ill.

Branches: Atlanta — Boston — Buffalo — Chicago — Dallas — Denver — Kansas City — Los Angeles — Minneapolis — New York — Omaha — Philadelphia — Portland, Oregon — Salt Lake City — San Francisco — Seattle — Toledo — Waterloo, Iowa

Creamery Package Mfg. Co. of Canada, Ltd.
267 King St., West, Toronto, Ont., Canada