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Contents

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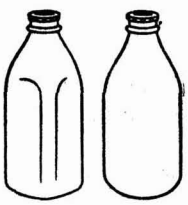

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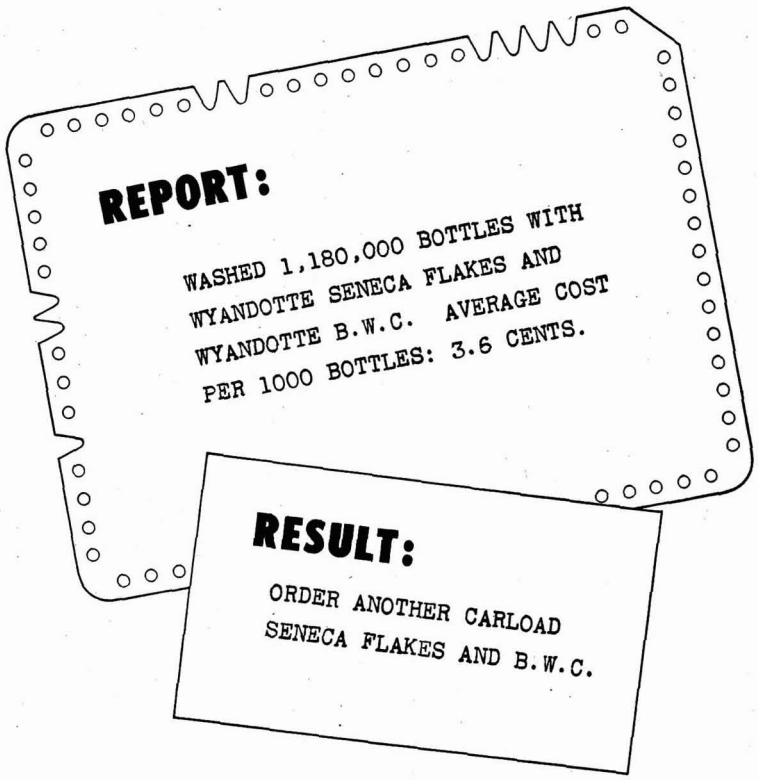

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COMPOSITIONAL QUALITY OF MILK. I. THE RELATIONSHIP OF THE SOLIDS-NOT-FAT AND FAT PERCENTAGES

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Economists, nutritionists, regulatory officials, processors of dairy products and others need to know the percentage concentration of the main constituents in milk in order to evaluate it properly for any specific use. The dairy breeder and the producer, in the past, have measured the worth of the dairy cow on the basis of the production and the fat content of her milk. But unless the true value of milk, as determined by its composition and cost of production, is made the basis of pricing plans, it would seem impossible to set up an entirely equitable method of paying for it.

Price structures, based on the fat and the skim solids percentages, the latter calculated from the fat percentage by means of equations, are criticized as being unfair to the milk of one breed or another. There is justification for this criticism. Equations showing the relationship between fat and solids-not-fat are seldom in agreement and the view is developing that no one equation is adequate for milks of widely different fat contents.

The wide variability in the percentage composition of cow's milk is recognized universally. That the specific and perhaps the significant value of milk may reside in the non-fat solids is a more recent recognition. Most legal definitions of milk include a statement of minimum fat, total solids and/or solids-not-fat. A wide disparity exists in these standards; some of them are quite illogical.

Milk fat, being easily and reasonably accurately and rapidly determined, has been the most important single unit on which to place an economic value on milk. The standard, or standards, by which to evaluate milk in the modern concept, however, must give consideration to the fact that the ratio of fat percentage to solids-not-fat percentage is not constant for milks of different fat contents.

Tocher (26) using data secured from the analyses of the milks from single milkings of 676 cows, the majority of which were Ayrshires, established regression equations showing the relationship between the various components. This survey revealed "a uniform rise in the average percentage of solids-not-fat with

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ascending values of percentage of butterfat''; the butterfat and solids-not-fat could be represented, however, not by normal curves, but rather by Pearson's type IV curves.

The present status of the problem is illustrated in fig. 1. Curves A-A and

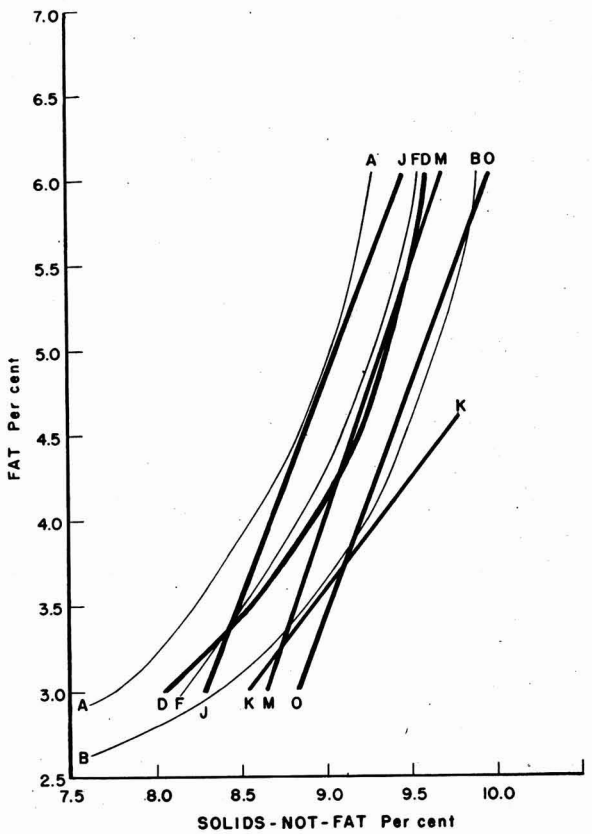

FIG. 1. The relationship between fat and solids-not-fat as shown in some representative previous studies.

Legend for Fig. 1

AA-BB	—zone representing 200,000 samples of shipper's milks (5)
D-D	—from representative means (5)
F-F	—from a recent compilation (6, 17)
J-J	—per cent solids-not-fat = 0.4% fat + 7.07. (12)
M-M	" " " " " = 0.346% fat + 1.597. (16)
O-O	" " " " " = 0.3846% fat + 7.6736. (21)
K-K	" " " " " = 0.7841 (7.8903 + % fat). (13)

B-B are boundaries of a zone within which fell the fat and solids-not-fat analyses of 200,000 samples of herd milks, believed genuine and unadulterated, as reported

by Brown and Ekroth (5). Curve D-D represents their analyses of 1,000 samples of genuine milks from individual cows. This latter is paralleled closely by curve F-F which represents the solids-not-fat and fat relationships tabulated by the Milk Industry Foundation (17) which, in turn, is identical with those proposed to the American Dairy Science Association by the Committee on Standardization of Market Milk (6).

In contrast to these non-linear relationships, the curves J-J, M-M, O-O and K-K, drawn from the respective regression equations, show uniform increases of approximately 0.04, 0.035, 0.038 and 0.078 per cent in solids-not-fat for each increase of 0.1 per cent in fat. As will be shown in fig. 2, Overman *et al.* (21) derived other equations to represent the milks of the major breeds in which the general linearity is not evident. The values for solids-not-fat reported by Jacobson (12) for fat values between 4.0 and 6.0 per cent coincide closely with those reported by Haecker (9). The latter reported lower values corresponding to fat values below 4.0 per cent than those established by Jacobson.

In compositional studies of the nature indicated, as well as in the several others to which reference has not been made, comparatively little attention seems to have been given to the role of abnormal udder tissue and heredity. In a recent report, Rowland (24) placed emphasis on feed and breed family strain and minimized the role of mastitis. Kay (14), however, earlier attributed about 80 per cent of their poor quality milks to mastitis. This latter conforms closely to the authors' data (unpublished). Moore and co-workers (18, 19) obtained evidence that fat and solids-not-fat are inherited separately and that the daughters of a given sire may produce milk higher, lower or unchanged from that of their dams. Nicholson and Lesser (20), however, from the results of a 3-yr. study of nearly 5,000 samples from one herd and over 600 from another herd, the former being given partial statistical analysis, reported for one herd that it was not possible to trace the low level of solids-not-fat to any particular bull. They failed to account for the fact that the incidence of low solids-not-fat was higher for one herd than for another of the same breed. Although the milks normal in solids-not-fat were not restricted to cows not reacting to tests for mastitis, the incidence of mastitis among the low solids-not-fat animals was high. These authors stated, "Damage to the mammary glands resultant from previous disease or to an existing condition of mild or chronic mastitis might be considered as a possible explanation of the abnormal composition of some of these milks". Low solids-not-fat were associated with high chlorides. Milks of abnormal composition have been reported for cows with no history of mastitis (10, 11).

Although this discussion of the literature is by no means inclusive, mention should be made of a recent report from Sweden. Bonnier *et al.* (4) subjected to statistical treatment the analyses of 2,152 samples of milk, collected under supervision. They found no linear or quadratic relationship between the percentage of protein or lactose and that of fat except within intervals of 0.6 per cent fat. This suggests that linear-regression equations relating solids-not-fat to fat percentages should be used with caution. This especially is true for certain herd milks (1).

The current interest in milk marketing plans, some of which give consideration to solids other than fat and which assume that the percentage of non-fat-solids rises uniformly with an increase in the percentage of fat, prompts the publishing of data secured in 1935. Some of these cows were screened for mastitis and all were subjected to the climatic conditions of California.

EXPERIMENTAL

Herds. Herds were selected on the basis of size, accessibility and availability of accurate feeding, breeding and production records. Herd *A* provided from 10 to 16 purebred Holsteins and from 14 to 18 purebred Jerseys per month throughout the year. Three-day composites (proportional aliquots) of the milks of individual cows were collected each month. Herd *B* provided approximately 80 purebred Holsteins. Personally supervised single milkings of each individual cow were taken at irregular intervals. Herd *C* consisted of approximately 80 purebred Holsteins. Carefully supervised single milkings of individual cows were collected twice during the year. As time permitted, additional samples of single milkings of individual cows were collected from selected herds of purbred and grade Ayrshires and of purebred Holsteins.

Incidence of udder abnormalities. Initially, it was planned to secure sufficient data on sire-daughter relationships to permit statistical treatment. Early results brought out irregularities and abnormalities and suggested the possibility of mastitis as a causal factor. Tests revealed this to be the case and prompted curtailment of the number of herds tested as well as the frequency of testing. Tests for latent mastitis or for abnormalities usually associated with mastitis were considered positive if the foremilk reacted abnormally to two or more of the following tests in one or more quarters bromthymol blue, chloride, leucocyte count and the presence of long chain streptococci (22). The merely suspicious reactions were included with the negative groups. It is to be expected, therefore, that the reported incidence of abnormal udder tissue is conservative.

Chemical tests. The milks were analysed for fat by the Babcock method, for total solids by the Mojonnier procedure; solids-not-fat were obtained by difference. The analyses for protein, lactose and ash will be reported in a later paper.

RESULTS

Analyses for fat and solids-not-fat were made on 717 samples of Holstein, 231 of Jersey and 100 of Ayrshire milk. Table 1 shows the data grouped according to fairly narrow extremes of fat percentages and screened for abnormalities by using the usual biochemical and bacteriological tests for mastitis. In fig. 2, curve C-C_4 was constructed from the normal milks and curve P-P from the abnormal milks. If the data for cows, 20 to 25 per cent of which are abnormal (mastitic), are similarly plotted, the curve will closely parallel the C-C_4 curve but will be on the left of the latter. For purposes of comparison, the curves erected by Jacobson (J-J), Brown and Ekroth (D-D) and by Overman *et al.* for Holsteins (O_1-O_2) and for Jerseys (O_2-O_3) have been included. Spot values are shown for herd milks reported by Davis *et al.* (8) for Holsteins (T_1), Guernseys

(T_2), Jerseys (T_3) and Mixed (T_m). Also shown are spot values for Holstein (I_1) and Jersey (I_2) milks reported by Shaw and Fourt (25), for 74,000 samples of producers' milks received by San Francisco during the period 1939–1947 (SF) as reported by Geiger (2) and for Holstein milk from herd *F*, table 3.

TABLE 1

Average values for fat and solids-not-fat for milks grouped according to fat contents and screened for mastitis

Range of fat	No. of samples	Fat (av.)	(Av.) Solids-not-fat
(%)		(%)	(%)
2.50–3.15			
Neg.	72	2.98	8.31
Pos.	26 (26.5%)	2.91	7.86
Av.[a]	98	2.96	8.19
3.00–3.50			
Neg.	157	3.28	8.40
Pos.	52 (24.9%)	3.30	8.11
Av.	209	3.29	8.33
3.60–4.20			
Neg.	136	3.89	8.82
Pos.	62 (31.3%)	3.79	8.21
Av.	198	3.86	8.63
4.00–4.30			
Neg.	39	4.15	9.01
Pos.	19 (32.8%)	4.14	8.33
Av.	58	4.15	8.79
4.25–5.00			
Neg.	96	4.62	9.23
Pos.	34 (26.2%)	4.65	9.00
Av.	130	4.63	9.17
5.10–5.80			
Neg.	54	5.48	9.50
Pos.	18 (25.0%)	5.32	9.39
Av.	72	5.44	9.47
5.75–6.25			
Neg.	35	6.00	9.72
Pos.	9 (20.5%)	6.02	9.44
Av.	44	6.01	9.70
6.00–8.00			
Neg.	56	6.60	9.83
Pos.	12 (17.6%)	6.74	9.45
Av.	68	6.62	9.76
Holsteins (over-all)			
Neg.	361	3.61	8.58
Pos.	161 (30.8%)	3.54	8.15
Av.	522	3.59	8.45
Jerseys (over-all)			
Neg.	179	5.50	9.55
Pos.	54 (23.2%)	5.50	9.44
Av.	233	5.50	9.53
Holsteins (over-all, not screened for mastitis)			
Av.	717	3.63	8.44
Jerseys (over-all, not screened)			
Av.	231	5.55	9.54
Ayrshires (not screened)			
Av.	100	3.96	8.74

[a] All average values were weighted according to the no. of samples.

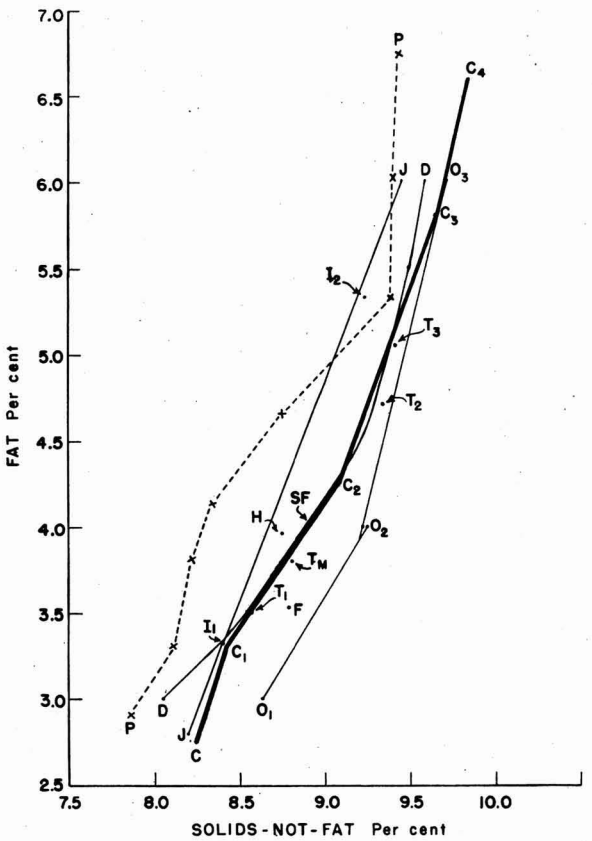

FIG. 2. A comparison of the relationship between fat and solids-not-fat for normal milks (table 1) with some representative published values.

Legend for Fig. 2

Curve D-D —from median values (5)
J-J —per cent solids-not-fat = 0.4% fat + 7.07. (12)
C-C_1 " " " " " = 0.3151% fat + 7.3672. (table 2)
C_1-C_2 " " " " " = 0.7% fat + 6.1. (table 2)
C_2-C_3 " " " " " = 0.3846% fat + 7.44. (table 2)
C_3-C_4 " " " " " = 0.2457% fat + 8.2340. (21)
O_1-O_2 " " " " " = 0.6138F% fat + 6.7917. (21)
O_2-O_3 —same as C_3-C_4 (Jersey) (21)
P-P —for milk from mastitis-positive cows
I_1, I_2 —average for Holstein and Jersey milks (25)
T_1, T_2, T_3, T_{in} —average for Holstein, Guernsey, Jersey and mixed herds (8)
F —an inbred Holstein herd
SF —average for over 74,000 samples of producers' milks (2)
H —average for 100 samples of Ayrshire milk

It is apparent that although the solids-not-fat increase with increasing fat concentrations, the relationship is not linear except for fairly narrow fat limits. This is in harmony with the views of others (4, 26). In the milk from mastitis-positive cows the proportion of solids-not-fat to fat is lower than in normal milks. For low fat milks these data for solids-not-fat agree with those reported by Jacobson but are somewhat higher than those arranged by Lythgoe, as reported by Brown and Ekroth. For milks above 3.3 per cent fat, the Jacobson values appear too low. The Overman *et al.* values for solids-not-fat for milks below 4.5 per cent fat are higher than for the milks of this study. As the milks increase in fat, agreement increases until the Overman equation for Jerseys is in complete agreement. The relationships shown by curve C-C_4 agree with those of Brown and Ekroth (5) and, therefore, with (17) (see fig. 1) in the range of 3.3 to 5.25 per cent fat, with those of Davis *et al.* (8), of Shaw and Fourt (25) for Holsteins and with those reported by Geiger (2). The lack of agreement of I_2 possibly may be due to the high incidence of mastitis reported for this herd. The position of F may suggest that heredity is responsible for the high values of the single herds of Holsteins studied by Overman *et al.* (21) and by Kahlenberg and Voris (13) (see fig. 1).

That the relationship between fat and solids-not-fat shown by curve C-C_4, fig. 2, may be considered to apply generally is given further confirmation by the agreement with the results reported by Nicholson and Lesser (20) for 4,816 samples of Friesian milk, by Bakalor (3) for 2,808 samples of herd milk, by Cranfield *et al.* (7) for 131 samples of Friesian herd milk, by White and Judkins (29) for Holstein and Ayrshire milks, by Tocher (26) for 676 samples of Ayrshire milk and by Lampert (15) for computed average values. It should be pointed out, however, that this relationship disagrees with those reported by Haecker (9), whose average values conform to those reported by Jacobson (12), by White and Judkins (29) for Jersey and Guernsey milks and by New York State (1) for genuine milks from "suspected" herds.

To further test the accuracy of the C-C_4 curve (fig. 2), weighted average values of fat and solids-not-fat were calculated for 1,616 samples of Holstein milk and for 916 samples of Jersey milk, collected under supervision and representing mostly 1- or 3-day composites, from the Arizona (8), Idaho (25) and the California cows. The ratio of fat to solids-not-fat of 3.5 to 8.47 for the Holsteins and of 5.29 to 9.38 for the Jerseys in each case is higher than that shown in the curve for normal milk. The values for solids-not-fat do correspond closely to the values calculated from the appropriate equations for abnormal milks (table 2). It may be assumed that at least 20 per cent of the cows were mastitis positive (28).

The equations of table 2 for the four segments of the curve C-C_4 of fig. 2 and for a similar curve drawn to represent the average values (table 1) serve to calculate the solids-not-fat, and therefore the total solids, of normal milks and those from cows 20–25 per cent of which are mastitis positive. The latter equations may be of greater practical significance in view of the high national incidence of mastitis of at least 20 per cent (28). It would be presumptuous, how-

ever, to believe that calculations can replace chemical determinations, or that the percentage of mastitis-positive cows in a herd can be calculated from the fat and solids-not-fat relationship. Equations may be a useful tool for the routine

TABLE 2

Equations showing relationship of fat and solids-not-fat for various intervals of fat content

Fat range (%)	Equation
	For normal milk
2.75–3.30	Per cent solids-not-fat = 0.3151% Fat + 7.3672
3.30–4.25	Per cent solids-not-fat = 0.70% Fat + 6.10
4.25–5.85	Per cent solids-not-fat = 0.3846% Fat + 7.44
5.90–6.75	Per cent solids-not-fat = 0.2457% Fat + 8.2340
	For abnormal milk—20 to 25% of cows mastitis positive
2.75–3.30	Per cent solids-not-fat = 0.35% fat + 7.18
3.30–4.25	Per cent solids-not-fat = 0.7041% Fat + 6.0056
4.25–6.00	Per cent solids-not-fat = 0.4007% fat + 7.2936
6.00–6.75	Per cent solids-not-fat = 0.0959% fat + 9.1248

predicting of the composition of producers' milk; they cannot be used for milk standardized by either the removal of cream or the addition of separated milk, unless the fat contents of the original milks are known (23). Blended milk also may be irregular.

THE INFLUENCE OF HEREDITARY FACTORS IN DETERMINING THE RELATIONSHIP OF FAT AND SOLIDS-NOT-FAT

Table 3 shows the results of the analyses of the milks of daughters of indi-

TABLE 3

Analyses of the milk of daughters of individual sires

Herd	Sire	No. of daughters	No. of samples	Fat	S.N.F.	Herd av.	
						Fat	S.N.F.
				(%)	(%)	(%)	(%)
D	1	12	14	3.50	8.61 (8.55)[a]	3.42	8.50 (8.49)[a] (36 samples)
	2	6	7	3.61	8.56 (8.63)[a]		
	3	3	5	3.39	8.68 (8.47)[a]		
F	4	18	42	3.68	8.97 (8.68)[a]	3.53	8.77 (8.57)[a] (93 samples)
	5	11	22	3.31	8.55 (8.42)[a]		
N	6	15	31	3.60	8.55 (8.62)[a]	3.63	8.47 (8.64)[a] (157 samples)
	7	13	27	3.45	8.67 (8.51)[a]		
	8	5	10	3.50	8.77 (8.55)[a]		
	9	6	13	4.16	8.61 (9.01)[a]		
M	10	24	42	3.67	8.29 (8.55)[a]	3.78	8.47 (8.67)[a] (157 samples)
	11	24	37	3.87	8.59 (8.73)[a]		
	12	17	32	3.56	8.43 (8.51)[a]		
	13	15	27	3.98	8.49 (8.81)[a]		

[a] The values within brackets, calculated from the appropriate equation (table 2), are included for comparison of the observed with the expected values.

vidual sires in four purebred herds. All the daughters were mastitis-negative with the exception of herd *M* which, as a basis for calculation, is assumed to have been 20 per cent positive.

The daughters of sires 1, 3, 4, 5, 7 and 8 produce milk with solids-not-fat higher than the values calculated from the appropriate equation in table 2. The milks of all of these daughters, with the exception of those of sire 5, are higher in solids-not-fat than their herd average, and also are higher than the values calculated from the average fat for the herd. It would appear that the incidence of mastitis in herd *M* was higher than the assumed 20 per cent.

Special attention is called to herd *F* (fig. 2). This herd is rather highly inbred and, at the time of sampling, was practically mastitis free. Sire 4 of this herd, and also sire 3 of herd *D*, transmit solids-not-fat relative to fat approaching the values found by Overman *et al.* (21) and Kahlenberg and Voris (13), both of whom reported on samples from single herds.

While the data are too few to establish that the secretion of solids-not-fat is inherited separately from that of the fat, they do lend support to the findings of others previously mentioned, and to the assertion by Van Rensburg (27), as a result of studies with a mastitis-free experimental herd, that the persistent secretion of milk low in non-fat solids is of hereditary origin.

SUMMARY AND CONCLUSIONS

A fairly comprehensive survey of the literature dealing with the relationship between the fat and of solids-not-fat contents of milks from cows within breeds and among breeds has revealed a great lack of agreement. This latter involves differences as to absolute values, but of equal or greater significance are the opposing views with respect to the differential increases of the solids-not-fat for a stated fat increment. Some of the regression equations designed to express these relationships are shown in fig. 1, in which two schools of thought, the linear and the non-linear, are exemplified.

The data presented were obtained by analysing for fat and solids-not-fat 717 samples of milk from five herds of purebred Holstein, 100 samples from two herds of purebred Ayrshire and 231 samples from one herd of purebred Jersey cows. Of these, 157 samples of Holstein and all samples of Jersey milk were 3-day composites. The collection of all samples was supervised. Of 522 samples of Holstein milks and 233 samples of Jersey milks, 20.8 and 23.2 per cent, respectively, were from mastitis-positive cows. These data have been presented in table 1 and those representing normal milk are presented in fig. 2 by fat increments in juxtaposition to representative published data.

The relationship between fat and solids-not-fat in both normal and abnormal milks does not appear to be linear except within restricted limits of fat percentage. No consistent relationship exists for milk from mastitis-positive cows. It already has been pointed out that the results agree very favorably with those of many workers, but are higher than those reported by Jacobson (12) except for low fat milks. They are lower than those reported by Overman *et al.* (21), especially in the normal fat range for Holstein milk.

Equations for calculating the solids-not-fat percentage from the fat percentage, within practical limits of fat concentration, have been established from the data and are shown in table 2. A separate set of equations for milks from herds containing 20 to 25 per cent mastitis-positive cows also is shown.

Analyses of the milks of mastitis-negative daughters of nine bulls support the belief that an hereditary factor is involved in the secretion of non-fat solids. A liberal interpretation of the data showing the role of the sire in transmitting high or low solids indicates that it may be possible to influence the compositional quality of milk by the use of sires "proven" with respect to solids-not-fat. By choosing bulls shown to transmit the factor for high solids-not-fat values, and at the same time limiting the ravages of mastitis, it should be possible to improve the compositional quality of the milk supply. Additional carefully obtained data are required to establish the significance of these results. It is suggested that this might be given consideration when organizing an artificial insemination program, as well as when selecting the herd sire. It also is suggested that the factor of inheritance, coupled with a varying incidence of mastitis, may be responsible for the divergence in the regression equations erected from data obtained from individual herds. This may account for the unusually high quality of the Holstein milk studied by Overman *et al.* (21).

To avoid additional confusion arising from studies of this nature it is recommended that: (1) care be exercised in securing representative and genuine samples at the source; (2) the cows be tested for udder abnormalities; (3) the milk of cows physiclogically disturbed not be used; (4) the inheritance factor be given additional study; (5) regression equations be limited to comparatively narrow limits of fat contents.

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INHERITED NON-LETHAL ANATOMICAL CHARACTERS IN CATTLE: A REVIEW[1, 2]

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From the early realization that some families more than others consistently produced show-ring winners, the trend towards identifying the action of individual genes or groups of genes has been directed toward the herd-classification analysis of the different body parts and the relative influence of inheritance and environment in causing physical differences. The action of specific genes has been studied for certain characters.

When the over-all type is measured against the herd classification standard, a heritability estimate of approximately 30 per cent was found in Ayrshires by Tyler and Hyatt (100). The stability of type classification ratings, when measured by the repeatability with which individual officially recognized judges gave the same rating at a subsequent inspection, was found by Johnson and Lush (57) to be 0.34. The repeatability was 0.55 when a committee from the station made the ratings. The repeatability of individual inspectors, on consecutive ratings of the same cows, was found by Hyatt and Tyler (49) for 80 Ayrshire cows with an average of five type ratings to be 0.73, 0.82 and 0.62, respectively, for three different official inspectors. The correlation between the ratings given the same cows by different inspectors was 0.55. Of this group of cows, all of which had calved, 67.5 per cent had a range in ratings of one grade or less and 32.5 per cent ranged over three grades. High ratings were placed on cows if they were old or in the first 3 or last 2 mo. of their lactation. Hyatt *et al.* (50) tested the validity of requiring a female to calve before she is eligible to be classified. For 102 Ayrshires they compared the type ratings made by official inspectors before calving with the ratings made after calving. The per cent of animals varying zero, one, two and three grades, respectively, between ratings was 4.9, 51.0, 38.2 and 5.9. A low correlation appeared to exist between the ratings made at 6 and 18 mo., while the highest correlation existed between ratings made at either 18 or 24 mo. and those made at 30 mo. When the precalving ratings were divided into four groups from low to high, the group averages were in the same order when the postcalving records of the same animals were compared. However, the postcalving averages usually were closer to the general average.

With this progress there has been a slowly developing body of literature dealing with the role of individual genes in shaping body type.

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The material is presented according to the division of systematic anatomy primarily involved, *i.e.*, skeleton, integument, sense organs, reproductive organs, muscle.

Shape of skull. Certain characteristics of the skull have been so definite that selection preference has fixed certain shapes and sizes of heads as breed characters. Thus, the preference in Jerseys (*Bos longifrons*) is for a double-dish which refers to an incurving between the eyes and to the angle at which the nasal bones set onto the frontal bones giving a pronounced stop. The work of Stockard (96) on dogs indicates this condition might be caused by an achondroplasia of the basiophenoid and basiocipital bones. This condition and a cranial crest are associated with a characteristic histological pattern of the thyroid and anterior hypophysis. The eye sockets are pronounced and the forehead is wide. The skulls of *Bos primigenus* are longer and flatter across the forehead with less prominent eye sockets than typical skulls of *Bos longifrons.*

In general, three pairs of words serve to characterize the heads within the breed and, therefore, to describe some characters, presumably inherited, in addition to those just reviewed: strong versus weak; refined versus coarse; and character versus lack of character (plain). While these terms are all relative, their meaning is definite enough to one familiar with cattle for them to have real value. Very little has been done to work out the number of genes involved in head characters and their specific effects. However, among persons familiar with cattle type, the head characters often are so pronounced that daughters of a particular bull or cow can be picked out on that basis. The work of Hurst reviewed by Gowen (40) and the observations of Cole and Johansson (17) indicate that the length of head is affected by different genes and that the long narrow (*primigenus*) head is dominant to the short head. The narrow width of Yak skulls is dominant to the wide skull of *Bos taurus* (1a).

Prognathia (undershot jaw). Cattle with the lower jaw projecting beyond the upper jaw have been referred to by Darwin in 1909 (27) as also having a short broad forehead. The inequality of the jaws was so great that it was impossible to close the "lips." The observations in sheep by Nordby *et al.* (80) and in dogs by Stockard (96), showed that prognathia can result from a normal upper jaw and abnormally long lower jaw; a short upper jaw, associated with a short face or skull base, with a normal lower jaw; or to a short upper jaw and an exaggerated lower jaw. Liddell (65) showed that thyroidectomy caused shortened nasal and frontal bones, but had no effect on mandibular growth. Cattle in this country answering the same general description as those observed by Darwin, but less extreme, have been observed by Becker (7) in grade Jerseys and the reviewer in a grade Holstein. The observations by Becker indicate that the inheritance involved a single recessive autosomal gene.

Brachygnathia (parrot mouth, overshot jaw, pig jaw, bird face, micrognathia). In some cattle, the lower jaw is shorter than the upper. Brachygnathia has been observed by the reviewer in Guernsey, Holstein and Jersey cattle, although it may exist also in other breeds. Limited observation in cattle and the sheep studies of Nordby *et al.* (80) indicated an inherited basis but that it is caused by several genes, some of which are dominant and some recessive.

To the various types of subnormal development of the head (including brachygnathia), Wright (111) applied the term otocephaly. The different otocephalic monsters arising in certain lines of his guinea pig stock represented the activity of genes taking place in cells of different stages of development. Using cases from both cattle and sheep, parallelisms have been noted for six of the 17 degrees of severity observed in guinea pigs as follows: (a) Slight to considerable (3 in.) reduction in lower jaw in cattle by Gilmore (35) and in sheep by Nordby *et al.* (80). (b) Mandible lacking (agnathia) observed in cattle by Ely *et al.* (28). (c) Jaws abnormal, external ear openings and eyes lacking as in a Holstein-Friesian calf carried over term with malformation of lower jaw, snout-like muzzle, and nostrils not patent observed by Gilmore (35). (d) Fused nostrils; Illancic (54) observed this same character in cattle. (e) Headless except for single small median external ear. A faceless lamb was reported by Winters and Kernkamp (106) and a headless lamb by Fasten (30). Recessive genes have been suggested for (b) and (e), with a dominant lethal inhibited by a recessive gene postulated by Krallinger (63) for (d).

Horns. The exceptional cases in which horned or scurred offspring result from the mating of horned cattle with those presumed to be homozygous for the polled character and the sex difference in the appearance of horns from horned parents as noted by Churchill (14), brought out the need for an interpretation more adequate than a single allelic pair. The interest in breeding polled cattle has been increasing. Registerd herds of polled Ayrshire, Guernsey, Hereford, Holstein-Friesian, Jersey and Shorthorn cattle exist, in addition to those of the established naturally-occurring hornless breeds. Apparently, polled Brown Swiss are rare. In some breeds the registration is separately maintained for polled cattle. The current interest in polled cattle is indicated by the formation in February, 1949, of the National Polled Cattle Club, which was formed to develop interest in hornless cattle (26).

The horns of cattle are sheathed as contrasted by Auld (4) to animals with solid horns, either persistent (giraffe) or deciduous (deer) and to hornless species of several genera including the camel, llama, alpaca, guanaco, chevrotain, water and musk deer. Cattle share the peculiarities of sheathed horns with antelope, goats and sheep. The complexity of horn inheritance is shown by the fact that in sheep, Ibsen (51) required eight different pairs of alleles to explain all conditions of horns, scurs and hornlessness reviewed by him.

To explain the results of recorded matings with reference to horns in cattle, White and Ibsen (105) postulated the presence of four pairs of alleles. The dominant gene *H* is assumed to be present homozygously in all cattle. The symbol *P* is retained to denote the gene for polled. It is completely dominant to its allele *p* and completely epistatic to *H*.

Next is postulated a second gene for horns, *Ha,* the *a* referring to Africa, but logically it also might refer to Ayrshire. In addition to being found in the Ayrshire breed, it is found in other horned breeds such as the West Highland, Hereford, Holstein-Friesian, Guernsey and Jersey. Its incidence in the dairy breeds seems to be low. The presence of this gene in these breeds became evident when cows produced some horned sons to the service of Angus or Red Polled bulls.

The gene *Ha* is epistatic to *P* in the bull. An *HH, Pp, Haha* heifer is polled, but the relation of *HaHa* to *P* remains undetermined. The relationship of *H* to *Ha* is not known. Ibsen (52) assumed close linkage between *P* and *ha* to account for the lack of horned individuals appearing in the Aberdeen-Angus breed.

The fourth gene postulated by White and Ibsen is responsible for scurs when dominant, *i.e., Sc.* As compared to *Ha,* a relatively large number of cattle in the horned dairy breeds carry *Sc. Sc* has the same relationship to *P* as does *Ha.* However, in horned animals, *pp, HH* is epistatic to *Sc.* That sex modifies the expression of one or more of the genes involved is verified by Cole and Johansson (17) who found it questionable if any F_1 steers were clean polled in their crosses between Angus and either Jerseys or Holstein-Friesians.

Further explanation is needed to account for the long horn of the Ayrshire, Hereford and Highland cattle and for other breed differences not noted above. Limited observations indicate horn length to be intermediate in various crosses with Ayrshires (36). Black (9) observed scurred or horned sons in all cases and horned females in three-fourths of the offspring of Angus × Indian cattle crosses. In Holstein-Friesians, Jerseys and Shorthorns, the horns are incurving, while in Brown Swiss, the horns curve slightly upward. Indian breeds and water buffalo present still other horn characteristics. In crosses between Indian cattle and Yak, Zawadowsky (114) considered at least two pair of alleles involved. Evidence is cited by the above authors for believing that early cattle were polled and that the original mutation was *P* to *p.* For polled animals to have appeared spontaneously in most horned breeds fairly recently, this reverse mutation, *p* to *P,* must occur rather frequently. The frequency of this mutation has been estimated at 1 : 20,000 by White and Ibsen (105).

Two centers of ossification in true horns were found by Dove (25), one in the derma and the other in the periosteum of the skull at the point where the horn is located. The bony core (os cornu) arises from the first of these centers. In the early stages of development, this bud fuses through the frontal periosteum to the frontal bone with an accompanying formation of a supporting boss. If fusion does not take place, a scur results which is movable with the skin. The scur is considered by Dove usually to contain a horn core. Whether the small size of the horn core in scurs is due to a less adequate blood and nerve supply than would be the case if it fused to the boss in normal horn formation, appears not to have been determined. However, Wislocki and Singer (107) found that deer antlers denervated just before growth started became dwarfed and deformed as compared to the normal antler.

The action of all four specific genes postulated by White and Ibsen (105) has not been entirely reconciled with the histological findings of Dove (25). However, the latter concluded that the presence of horns, *pp,* is controlled by a single factor, the horn core, which also causes the development of the horn sheath or shell. The polled condition, *P,* therefore, would be the inhibition of horn core formation. There remains to be explained the relationship of *Sc, H* and *Ha* to the formation of the boss and to the ossification process. That the boss may occur without horns has been observed by Dove in Jersey or Holstein ×

Angus crossbreds. The reviewer has observed them also on naturally polled Ayrshires. Dove suggested that the frontal eminence (poll) of horned and polled breeds differed, not because of gene interaction, but because of the secondary action of the genes causing (permitting) horns that cause a physical accommodation of neighboring parts. The work of Curson, according to Cole and Johansson (17), indicated that debudding young calves causes a pronounced change in the shape of the skull. However, from pictures of animals published by the respective breed associations, both the gothic (high) and Roman (flat) poll can be observed on both Red Poll and Aberdeen-Angus cattle, whereas, Galloway cattle are characterized by their flat poll. Auld (5) showed pictures of both kinds of polls in hornless skulls. In the horned breeds, Ayrshire and Shorthorn have a flatter poll than Holstein-Friesian and Jerseys.

Feet and legs. That there are breed differences in straightness of legs is indicated by Brown Swiss and Shorthorn, generally conceded to be the straightest. The observed differences within breeds also lend much support to the importance of inherited influences, but the exact extent and nature of the genetic influences are not known. The present tendency is to increase the emphasis on feet and legs up to eight points out of 100 on the judging score card.

The feet and legs are considered to include all of the parts of the apendicular skeleton anatomically considered as fore and rear limbs. The fore or thoracic limb consists of the shoulder girdle, the arm or humerus, the forearm (radius and ulna) and the manus ("foot"). The manus consists of the carpus, metacarpus and phalanges. The rear or pelvic limb consists also of four parts, the pelvic girdle (ox coxae), thigh (femur), leg and "foot" (pes). The pes consists of the tarsus, metatarsus and phalanges (92).

Some general defects resulting from poor care generally are recognized. Keeping bulls in muddy pens is associated with long, turned up hoofs and weakened pasterns. Standing platforms have been associated with faulty legs in cows. In both cows and bulls, toeing out in front has been considered to be caused by grazing or pulling in hilly or uneven ground. This abnormality is assumed to develop in response to the animal turning its legs to distribute the body weight more uniformly on the bottom of the hoof.

Toeing out. The divergence of the cleft between the toes from a line parallel to the body has been used to measure the degree of severity. Cases affected so severely as to show a toeing out of 70 degrees have been reported by Kappeli (62). In this study the legs were considered normal unless the angle was more than 15 degrees.

In spite of possible non-inherited influences, there appears to be some definite inherited cause for this condition. While it is present at an early age, it develops still further with advancing age. It is associated with a narrow chest floor. In Switzerland, toeing out appeared more in Simmental cattle than in cattle of other breeds grazing on similar mountain pasture. In a case of close observations on animals confined to even meadows, severe toeing out was found to be transmitted by the bull, Zar (40 degrees), through both a son (70 degrees) and a daughter (40 degrees) to a double grandson (70 degrees).

Short leggedness (duck-legged, compact). The short-legged Herefords found in Texas by Lush (68) were not distinguishable from normal Herefords except for the short legs. There was no dwarfness of other parts of the body. Only the long bones of the limbs (metacarpus, radius-ulna and humerus of the fore limb and metatarsus, tibia and femur of the hind limb) appear to be affected. The Shorthorns described by Stonaker and Tom (97) in Colorado, Nebraska and Kansas having this or a similar character were compact and thick in the neck and in body fleshing. Whether or not these breed differences are due to modifiers, the variable expression of the gene or to differences in describing observations remains unknown. Short leggedness can be identified at birth and is distinct throughout the life of the animal. In balance trials and carcass analyses by Washburn *et al.* (103) short-legged or compact Shorthorns were found to be less efficient during growth than the normal in the utilization of digested dry matter. The compact type required 70 days less time in the fattening lot to reach a finished condition. The carcasses of the normal steers were relatively light in bone and carried more fat in the carcass cuts. Short-leggedness is inherited as a single autosomal dominant.

Proportionate dwarfism. Although the birth weight, height at withers and heart girth average somewhat less at birth than do normal calves, dwarfism cannot be detected at birth because individual calves lie within the normal range. At 12 to 14 mo. of age, however, the differences are great enough to permit diagnosing whether the calf is dwarf or normal. As the name indicates, all body parts are dwarfed in proportion to their size. This characteristic distinguishes it from short leggedness. Lactation in the dwarfs was normal in proportion to body size but reproduction was at a lower level. This character apparently parallels that of pituitary hypoplasia in goats (Epstein, 29) and dwarfism in mice (Smith and MacDowel, 95) in which latter case no acidophiles are found in the anterior lobe of the hypophysis. DeBeer and Gruneberg (21) found no acidophiles in dwarf mice at 7 days, although they did not stop growing until 17 to 21 days. Due to the production of dwarfs from related parents and because they were uniform with no intermediate types, the character appears to be due to a single gene on one of the autosomes with complete dominance of the allele. In cattle, this type of dwarfism was found in the University of California inbreeding experiment with Jerseys by Mead *et al.* (73).

Flexed pasterns. This involvement of the ligaments of the pastern (phalangeal bones) causes an afflicted calf to stand on its toes during the first few days to a week of its post-natal life. In severe cases, the toes are turned completely under. The fore pasterns are always involved and frequently also the rear pasterns. The autosomal recessive gene responsible for flexed pasterns was found in Jerseys in California by Mead *et al.* (74). The same characteristics have been observed in a Gir bull calf by Khare (59).

Bowed pasterns. The affected pasterns are found on the rear legs. No cases are known in which the pastern was dissected to show the exact nature of abnormality. The pastern is incurving as though one or more of the lateral phalanges were longer than the corresponding medial phalange. There is much variation

in the extent to which different affected pasterns are bowed. This abnormality was found in both Jerseys and Holstein-Friesians by Atkeson *et al.* (2), but the mode of inheritance is not known.

Sickle hocks. This abnormality refers to the angle at which the tibia and metatarsus are set at the point of the tarsus or hock. The approved show standard requires a slight set or angle and discriminates against legs that are too straight, or posty and those that are set at such an angle that the metatarsus, or cannon bone, extends far under the belly, giving a rounded or sickle appearance from a side view. There is a wide variation between individuals and some difference between breeds.

Some difference has been noted in the ability of cattle to withstand concrete platforms, with preference given to the breeds with straighter legs (Clapp, 15). Cases were noted in which the cow's rear legs were so sickled that difficulty was encountered in natural breeding. Sickle hocks are especially objectionable where combined in the same animal with toeing out and weak pasterns. In horses, Wriedt (110) pointed out that sickle hocks was caused by a relatively long femur, although this appears not to be the obvious case in cattle (35).

In Ayrshires, Habel (43) found that 244 cows of varying ages from 2 to 16 yr. had an average inclination at the hock of 78.7 degrees from the horizontal plane. No correlation was found between unrelated members in the same herd, thereby indicating environment was not the cause. On the other hand, a correlation of 0.41 existed between 37 daughters and their dams. It was concluded that the amount of metatarsal inclination is affected by multiple genes, some of which are thought by Ibsen (53) to be dominant.

Polydactylism. Extra toes were found in a family of Holstein-Friesians in Illinois by Roberts (89). A cow, her daughter and three grandsons each had three toes on the fore legs. One of the grandsons had four toes on one rear leg and five on the other. The other four affected animals each had three toes on the rear legs. Severson (91) reported a case in which an extra digit extended from the splint or cannon bone. The cannon bone is normal with a fusion of the third and fourth metacarpal (metatarsal) bones. The first, second and/or fifth metacarpal (metatarsal) bones apparently are not always prevented from developing. The corresponding phalanges, or toes, also are present. The evidence presented indicates dominant inheritance for the presence of extra digits. This would indicate that the original mutation to the "normal" number of two digits was a recessive and that the reverse mutation also occurs. Polydactylism also occurs in poultry and cats (Danforth, 20), guinea pigs (Wright, 112) and man (Pipkin and Pipkin, 84), where the expression is variable. Sometimes it behaves as if it were due to a dominant gene. A sex-linked recessive gene for polydactylism in mice, that expresses itself with about 25 per cent penetrance, was reported by Chase (13).

Polydactylism in cattle has been reported by Morrill (76). An extra toe appeared on each front foot. The affected calves were able to function normally at first but became tender and lame as they approach a weight of 600 to 800 lb. The appearance of the abnormality among males only of one Hereford cow fam-

ily suggested to this investigator that sex-linkage might be involved (91a).

Misshapen feet. A digital anomaly involving a spreading of the hoof phalanges was concluded by Mead *et al.* (74a) to result from faulty muscles and ligaments. Affected calves became lame from 2 to 4 mo. of age and became progressively worse until at 18 mo. obvious discomfort was caused by standing or walking. The appearance of this character in a herd of registered Jerseys was concluded to be conditioned by a single autosomal gene.

Angle of rib. Smith (94) cited the work of Duerst, who studied the angle of the last rib with the horizontal. In several strains of cattle a close relation existed between the angle of rib possessed by daughters and their sires and by sons and their respective dams. This suggested sex-linked inheritance has been checked by several investigators according to Smith, but they have not reached a unanimous conclusion.

Depth of body. That depth of body is inherited is indicated by the results of the crossbreeding work at Maine as reported by Gowen (39). Cattle of several dairy breeds (Guernsey, Holstein-Friesian and Jersey) were crossed with Aberdeen-Angus and gave offspring resembling more the dairy parent with respect to the middle. The depth through the middle generally is considered to be affected by factors other than those affecting depths through the region of the heart. Whether or not there are different factors influencing the depth of the middle has not been determined.

Loin characteristics. The desired loin is long, wide, thin and level. The European breeds from which most cattle in this country originated possessed six lumbar vertebrae in common with the Indian breeds. Some relatives of the domestic cow (Banting) have five lumbar vertebrae (Goodrich, 38), a fact that suggests a mutation in the number of vertebrae for this region has occurred. Whether or not there have been other mutations at this gene-locus is not known. Very few observations appear to have been made in the dairy breeds with this in mind.

The loin sometimes is roached or arched (35). More frequently, however, cattle are low in the loin. While an inherited tendency appears to be responsible, the nature of these structural characters is unknown.

Rump. Few single parts of the bovine anatomy have attracted the fancy of dairy cattle breeders as much as the rump, which preferably is long and wide. The top line should be level and the tail head neatly attached. The levelness from hooks to pins apparently differs between breeds. The thurl should be wide and full. Presumably, each of the characteristics is governed by different genes. The European breeds have five sacral vertebrae while the Indian cattle have four (38, 4). Whether or not similar differences exist within each species and breed appears to be unknown. The lack of a level rump has been particularly discriminated against in selection, partly because it was considered unsightly and partly because it was thought to be correlated with an inclined udder floor. The latter has been found by Leighton *et al.* (64) not to be the case. Neither is there any correlation with total milk production. The sloping of the rump is

least up to 5 mo. and increases progressively up to 5 yr. The inheritance is thought to be that of a quantitative character. It is found in all breeds.

Wrytail. This malformation of the sacral vertebrae appears upon casual inspection to consist of a distorted tailhead that sets at an angle laterally to the vertebral column. The degree of distortion varies greatly, with cases approximating 45 degrees having been observed. By the use of X-ray analysis it has been found by Gilmore and Sellers (37) that the declination is caused by longer growth on one side of the body of sacral vertebra, along with a greater intervertebral distance than that occurring on the other side. This malformation has been seen in young heifers but no cases of its being present at birth have been reported. The presence of wrytail was found by Atkeson *et al.* (3) to be conditioned by an autosomal recessive gene. It is found in the Jersey, Brown Swiss (20 per cent of 505 animals in 34 randomly selected herds), Guernsey, Holstein (20–30 per cent), Ayrshire and Red Polled breeds. If it occurs in the beef breeds, it apparently has not been detected or it occurs less frequently than in the dairy breeds.

Screwtail. Screwtail resembles wrytail except that it is more severe and occurs in the posterior coccygeal region. There is a fusion of one or more pairs of adjacent vertebrae that involve a twisting as well as shortening of the vertebrae. Therefore, while it is apparent at birth, the fusion may not be completed for several weeks thereafter. No cases in cattle have been reported to involve more than two pairs of vertebra. In mice affected by a similar (or identical) condition, the beginning of the abnormality was noted in the fourteenth day of gestation. The tissue that is to develop into the disks between the vertebrae fails to form normal fibrous tissue on the side of the kink. MacDowell *et al.* (69) found the pleiotropic effects of the responsible gene in mice to include the pelvis, vertebrae anterior to the coccygeal region, sternum and head parts. The gene causing screwtail is inherited as a recessive and has been found in inbred Red Polled cattle by Knapp *et al.* (61) in Florida. It also has been observed in an inbred beef Shorthorn cow and her inbred son in Minnesota. Furthermore, screwtail has been observed in Holstein-Friesian and Jersey cows but no evidence that it is inherited in the last two breeds is known to have been produced. The same condition has been found in swine by Nordby (79), in different species of mice by Huestis and Barto (48) and in dogs by Stockard (96), where it also is inherited as a recessive. In dogs the allele of the gene for screwtail did not exhibit complete dominance.

Vestigal tail. Sometimes calves are born with only 4 to 6 in. of tail, corresponding approximately to six coccygeal vertebrae. The tail stub may curl to one side. Other abnormalities may include a malformed loin. Information on the existence of this abnormality has been obtained from Norton (81) and observations of different calves by Brandt (10), Salisbury (90), Green and Fenstermacher (41) and the reviewer. All known cases were Holstein-Friesians, Shorthorns, Angus or calves of mixed breeding. Salisbury observed several cases that resulted from using a bull on his paternal half sisters. It may be concluded tentatively that a recessive gene is responsible.

Notched ear 1. The first ear character of this name was described by Yamane (113) in Japanese Ayrshire cattle imported from the United States and in a California herd from which foundation cows were exported to Japan. The notch or nick occurs symmetrically in both ears at the distal extremity. Incomplete dominance of a single autosomal gene is the suggested mode of inheritance. In the homozygous dominant condition, the ear is reduced to one half its normal size, while in the heterozygous condition, the reduction is slight. In all but one case of the five cows and eight bulls in volumes I and II of the American Ayrshire Record (1876 and 1878), the affected animals trace back to the bull Eglinton, imported in 1859 from Scotland to the United States. This bull sired 21 calves with notched ears. The affected Japanese Ayrshires traced back to Express 4503, purchased in California. Express descended from Eglinton and sired 35 offspring, all of which were notch eared. A similar form of notched ear in Ohio Ayrshires has been found by Heizer (Snyder, 98).

Notched ear 2. This is similar to the heterozygote of the first type. Both ears are always the same with a length of 5 in. compared to a normal ear of 7 in. The heterozygote varies from short to normal. This type of notched ear is found in Norwegian cattle (Wriedt, 108).

Notched ear 3. The third pattern of notched ear has the missing part on the lower edge of the ear. Both ears may not be notched to the same extent. There is a doubling of the skin of the projection at the medial border with deep notches. This character was found in the descendants of two registered Jersey bulls in Texas by Lush (66). One notch-eared calf by an affected sire and from a cow with no Jersey breeding indicates the absence of interacting "Jersey" genes. It is inherited as a simple autosomal dominant.

Double ears. The fourth ear abnormality is the presence of a flat piece of ear tissue that grows on to the upper rear portion of the ear (Lush, 67). It extends from the base of the ear to a point about halfway from the head attachment to the outer edge. The doubling in this case should be distinguished from the doubling occurring in Jerseys (Notched 3), in which the doubled projection is in the under edge. Both ears are affected the same. All the information available indicates that the inheritance is due to a single dominant gene that traces back to a single bull imported in 1906 from the Krishna Valley, India.

Drooping ears. Incomplete evidence from crossing Indian breeds with European breeds in Texas, by Nabours (78), indicates the inheritance of the latter type to be dominant.

Sweat glands of the ear. Four types of sweat glands have been found in the auricle of the ear by Kalmykov (58) and Stakalic (95a). The possible significance of this finding rests with the positive correlation between production and the number of these sweat glands. The relationship was not altered with age and the glands were not well-developed in the bull.

Muzzle pattern. The first to suggest an inherited basis for muzzle or nose patterns in cattle appears to have been Boehme in 1910 (Gowen, 40). Petersen (82) investigated the use of muzzle prints for the positive identification of cows on official test. The belief in an inherited basis for this pattern rests largely

with the individuality of the animal with respect to a particular print. As with human fingerprints, no two cows have exactly the same print. It is characteristic throughout life. Identical twins have very similar patterns but marked differences are found when one pair of identical twins is compared to another. The muzzle is formed by the fiftieth day of embryonic life according to Habu (44). The nose pattern is clearly evident at 58 days. Muzzle patterns may be roughly grouped in the following order with the most frequently occurring patterns listed first:

(a) Median line extending from lower to upper edges of muzzle. Lines radiate from this line. Pattern may or may not be essentially symmetrical. (b) Median line extends from lower edge of muzzle part way to upper edge. Radiating lines give a Y-shaped pattern. (c) Radiating lines converge at a point near lower edge of muzzle giving a V pattern. (d) Irregular lines forming a greater complex than above. Some lines may run horizontally. The mode of inheritance is not known. Habu concluded that sex linkage was not involved.

Semi-hairlessness. This also is called hypotrichosis, which means subnormal hair development. This term, however, has been used to refer to a rather completely hairless lethal condition. Semi-hairlessness is not lethal, although affected animals do not grow as well as other animals. They are mild in temperament. The affected calves are born normal but are thin in flesh. The involved gene probably affects cysteine metabolism (Martin and Gardner, 71). As feeding this amino acid to congenital hairless rats caused a stimulating growth of the hair that lasted throughout a 30-day experiment, the cysteine was concluded to act through the sulfhydryl group to stimulate the hair follicle, thus resulting in a trichogenic action. The difference between the semi- and completely hairless condition has not been differentiated by this method. In addition to thinning out the hair, it also is curly. A recessive gene is responsible and was found in polled Herefords by Craft and Blizzard (19) in Oklahoma. A similar condition was found in Wisconsin Holstein-Friesians by Cole (16), except that affected animals approached the normal condition with age. Inherited semi-hairless conditions have been described also in the goat, sheep, pig, horse, dog, cat, rabbit, mouse and rat (Kislovsky, 60).

Escutcheon. Much attention has been given to this characteristic since Guenon (42a) associated it closely with milk yield by devising an elaborate system which involved dividing all cows according to size into large, medium and small. The escutcheons of each group were grouped into classes and orders. Numerous workers have studied further the relationship between the escutcheon patterns and such characters as body dimensions and milk yield (Brun, 11). Diverse results have been obtained. Brun found a positive relationship between escutcheon pattern and milk and fat yield, while Hooper (47) found no such relationship to exist. Most authors have classified the patterns into relatively few classes, however. That genes definitely influence the shape of the escutcheon is evident from the reported observations and from the extreme similarity found between identical twins as compared to the wide variation found between twin pairs noted by the reviewer.

Curly hair. At birth the hair in the Ayrshires described by Eldridge *et al.* (27a) was curly because of restrictions in the hair rather than because the hair was flat. Affected adults have a wooly appearance, like that of a newborn Karakul lamb. These workers agree with Johansson (55) who concluded from limited data on Swedish polled cattle that a dominant gene is responsible. Recessive curliness has been described in the Tuxer, Simmentaler and Pinzgauer breeds by Adametz (1). The type of curly hair in the Galloway was found by Pratt (86) to be recessive to the normally occurring straight hair of the Holstein-Friesian.

Macrotrichosis. The large hair or hairs that distinguish this character may be present in various locations on the mandible or maxilla, usually in an area more or less under the eye (Gilmore, 35). However, this also may be found underneath the lower jaw between the right and left mandible. A papilla varying in size up to a centimeter in length sometimes is associated with it. In no case yet observed did this papilla become "wattle like." In several cases it appeared on a calf without either parent having had it, thus suggesting recessive inheritance.

Smooth tongue (epitheliogenesis imperfecta lingua bovis). With many similarities to hereditary hypochromic anemia in man, the most striking feature in cattle is the smoothness of the tongue, as described by DeGroot (22, 23). The filiform papillae are normal in length but very thinly spaced. The mucous membrane is thickened. There is persistent salivation, eczema, alopecia, folding of skin and defective hair growth. The red blood cells are normal in number but abnormal in diameter. The iron content of the blood serum is low. This abnormality is widespread in certain lines of cattle in Holland in which 350 affected cattle of both sexes all trace back to one bull within 10 generations. It is conditioned by a single autosomal recessive gene.

Congenital cataract. At birth the eyes may be smaller than normal (Small, 93). The most reliable diagnostic character is the lens, which is opaque and reduced in early calfhood. With advancing age, the cornea (outer layer of anterior chamber) becomes distorted and enlarged. Affected animals are sensitive to strong light as noticed when they face the sun. Total blindness is unlikely, except in extreme cases.

Congenital cataract is inherited as a single autosomal recessive character. It has been found in Holstein-Friesians in Illinois by Detlefson and Yapp (24) and in California Jerseys by Gregory *et al.* (42).

Strabismus (cross eye). This second eye defect is not detectable at birth but is apparent after 6 mo. to 1 yr., with most cases being identified after 12 mo. The eyes are crossed and bulge or protrude abnormally. The condition gets progressively worse with age, vision being greatly impaired in some adult cows. The inheritance of strabismus behaves as other single autosomal recessive characters. It is found in both sexes and was brought to light by inbreeding. So far, it has been reported as occurring only in Jerseys in the California breeding project. However, other cases have been known in Jerseys that are thought to trace to a source that is different from the California herd (Regan *et al.*, 88).

Night blindness. Three Shorthorns in Oklahoma were found by Craft (18) to exhibit a type of vision that was defective at night with less serious effects in the bright moonlight. Presumably, the rods and cones of the retina were defective. Both sexes were involved and all traced in both parental lines to a common ancestor. Two were out of the same dam. If this abnormality is inherited, a single autosomal recessive gene is indicated.

Udder. Most phases of udder development are considered normal and as such have not received the attention from the standpoint of inheritance that certain undesirable characters have. Most of the undesirable characteristics of the udder thought to have an inherited basis have not been worked out in detail. It should be pointed out that between identical twins the similarity of udder size, shape and quality is so striking as to increase the belief that inheritance is a more important factor than ordinarily supposed (Hansson, 45).

Udder slope (levelness). The maximum slope has been found to be at 79 to 90 mo. of age by Leighton and Graves (64). Contrary to popular opinion, the slope of the udder was found not to be correlated to slope of rump. Neither was it related to total milk produced. The inheritance for sloping udder appears to be of a blending nature. It is found in all breeds.

Teat sinus topography. The mucous lining of the teat sinus may be smooth or with different numbers of pouches of varying sizes. This topography, which may not be related to the incidence of mastitis, was found by Murphy (77) to be characteristic of the breed and of the individual. The four teats of a cow, while showing some variation, usually were classified into the same group.

Fused teats. The udder is poorly shaped, possibly as a result of the fusion or partial fusion of the two teats on a side. In some instances both sides are involved. In the male the rudimentary teats are abnormal and are hardly perceptible. This maldevelopment has been reported in Guernseys in Ohio by Heizer (46) and Herefords in South Dakota by Johnson (56). Inbreeding had been followed in several of the herds in which it was found. The inheritance is that of a single autosomal recessive.

With further regard to the number of functional quarters, Black (9) lists udders with four quarters as dominant to udders with two quarters.

Supernumerary teats. That the presence of extra teats is based on the genotype is shown by the high frequency of occurrence in some herds of dairy cattle and the complete absence in others. Marked differences between the daughters by different bulls also has been observed and breed differences have been reviewed by Smith and Robison (94). They may be present between the normal teats, in which case they are called intercalary teats. The other two positions are to the rear of the normal teats and attached to them. Supernumerary teats are found as frequently on the right as on the left side and also may occur on both sides. Gifford (32) found supernumerary teats in 25.8 per cent of 4,831 females and 14 per cent of 135 males observed in Missouri dairy herds. The same worker (33) found no significant evidence that extra teats were associated with producing ability. They may be connected to extra functional glands. Magnusson (70) reported a case of a six-teated cow giving equal quantities of

milk from each of six teats. Supernumerary teats apparently are found in all breeds but the exact mode of inheritance is unknown. It has been suggested that recessive genes are responsible for the intercalary teats. A different autosomal gene probably is responsible for the after teats. It is thought to be dominant. In swine the number of teats is a typical case of quantitative inheritance without dominant genes being involved (Plum, 85).

Testicular characteristics. Although the literature on inherited characteristics causing deviations from the normal is indeed meager, a few statements are important.

In regard to the failure of one or both testes to descend, Barrett (6) noted what appears to be a case of a dominant mutation causing monorchidism. Cryporchidism is known to be inherited in other species. McPhee and Buckley (72) concluded that most cases observed by them in Chester White swine could be accounted for by a recessive gene. Rea (87) pointed out that cryptorchidism is not unusual in humans, as it occurs once in every 500 males.

Carl (12) reported on two bulls by a common grandsire in which the left testis was smaller than the right and lay parallel, instead of perpendicular, to the body.

Umbilical hernia. Hernias are caused by the presence of abnormal openings through which other tissue can protrude. The umbilical ring is the opening through the abdominal wall that accommodates the umbilical stalk during fetal development. Its failure to close after birth may permit the omentum and intestine to protrude. The hernia may appear during the first month of post natal life and persist for varying lengths of time. They have been observed to persist up to 8 mo. in bulls and 18 mo. in females without receding. Calves closely related to affected animals have been observed in which the muscles of the umbilical ring did not close for several months, as detected by palpation, without evidence of hernia. The relation of hernia in bulls to reproductive inefficiency and other contributions to this problem has been reviewed by Gilmore (34). Umbilical hernia has been observed in both bulls and heifers. It may be inherited as an autosomal dominant with low penetrance (Warren and Atkeson, 101). A similar condition exists in rats where both sexes are affected. However, Moore and Schaible (75) concluded that several genes are involved as did Warwick (102) for swine and Phillips and Felton (83) for dogs.

Inguinal hernia. Although inguinal hernia occurs in cattle according to Frank (31) and Tuff (99), it occurs less frequently than in other farm animals. Its mode of inheritance is unknown.

Bulging thigh. Experimental evidence for the existence of inherited differences in the fullness of the thigh between dairy and beef breeds came from the crossbreeding studies at Maine (39). The incurving thigh of the dairy parent, whether it be caused by one or more genes, was dominent to the bulging thigh of the beef parent.

Double muscle (Yorkshire, doppellender, horse rump). Cattle expressing this character are abnormally thick and full in the thighs and loin due to the doubled size of the gluteal muscles, as well as over development of the deltoid

muscle. Deep grooves appear between the muscles. The twist may lack depth and fullness. The keeping quality of the meat is reduced because of the scanty covering of fat on the round which hastens drying out of the lean meat. The lack of marbling and coarseness of grain also decreases the demand for this kind of meat in the United States. In Holland, however, the butchers prefer double muscled carcasses, especially in veal. This character had appeared in the Alba sub-breed of the Piedmont cattle in Italy by 1886 (Paci, 81a) and is associated with greater efficiency of feed utilization than normal (Carbone, 11a). According to Wriedt (109) such calves are less vigorous than normal calves and more subject to rickets. They cause difficult birth. Although in Europe it appears most frequently in Friesians, it has been reported in Ayrshires in Norway, Shorthorns originating in Denmark, Charolais in France and the Piedmont cattle of Italy. In this country, Weber and Ibsen (104) have recorded its presence in Herefords, Aberdeen-Angus and Galloway. It is caused by one or more recessive genes.

Hump. In addition to the muscling in the thigh, another character dealing with muscular tissue is the hump at some location on the top-line characteristic of Indian cattle, *Bos indicus.* Nabours (78) described the large hump on the foreshoulders of the Indian cattle brought into Texas as weighing up 50 lb. and esteemed in India, England, and Russia as a delicacy for the table. Genes responsible for the hump were assumed by Nabours and others (40) to involve incomplete dominance. The observations that in Brown Swiss and Aberdeen-Angus crosses with certain Indian breeds the hump is more completely removed than in cases involving other European breeds, would lend support to the conclusion that several genes are incompletely dominant to the genes responsible for the shoulder hump.

Variations of the hump may be classified according to position, structure and function (19a). Bettini (8) described a typical muscular hump, thoracic in position, occurring in some of the Indian (Zebu) cattle. The inheritance of these differences are not yet known.

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THE EFFECT OF HEAT TREATMENT ON THE PRO-OXIDANT ACTIVITY OF COPPER IN MILK

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It has been known for many years that a trace of copper contamination in milk is a highly active pro-oxidative catalyst responsible for off-flavors (5). Milk as secreted and not subjected to metal contamination contains copper and other pro-oxidant metals which probably act in the same manner as added contaminants. Studies on milk indicate that practically all the copper is in unionized combination with protein and that the protein-copper complex is capable of exerting pro-oxidant effects (14). Usual reasons given for the effectiveness of high temperature treatment in improving the keeping qualities of milk and milk products are the production of reducing compounds, especially sulfhydryl groups and the inactivation of enzymes (10). Heat treatment of milk may increase flavor stability by reducing the pro-oxidant activity of copper through mechanisms independent of sulfhydryl groups or enzymes. Observations made by several investigators indicate that copper in milk is reduced in pro-oxidant properties as the result of heat treatment (6, 7, 9). During sterilization of evaporated milk in tinned containers, the pro-oxidant properties of 1–3 ppm of added copper are entirely eliminated (8). These reports, however, do not include investigations of the mechanisms through which copper is reduced in pro-oxidant properties by heat treatment of milk.

A study of the effect of heat treatment of milk on reducing the pro-oxidant effect of copper depends upon the availability of a method for determining the concentration of copper having this property. Estimation of the concentration of a catalyst is commonly done by determining the rates of a reaction mediated by the catalyst. The oxidation of reduced ascorbic acid by molecular oxygen, a reaction which is strongly catalyzed by copper and does not occur without a catalyst at pH values of less than 7.6 (2), is the reaction used in this work as a method of estimating the pro-oxidant copper concentration in milk. The rate of ascorbic acid destruction has been used as an index of pro-oxidant copper activity in testing the effects of complexing agents (11).

Firm conclusions in regard to the concentration of pro-oxidant copper activity are not possible in a complex medium such as milk, in which heat causes the formation of reducing substances and destroys enzymes which may influence ascorbic acid destruction. However, comparisons of ascorbic acid destruction between samples containing the same amount of added copper and subjected to the same heat treatment at temperatures of heating known to destroy enzymes (85° C. and above) allows tentative conclusions to be drawn.

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The experiments reported here were designed to investigate the reactions which occur during heat treatment of milk and cause a decrease in the concentration of copper having pro-oxidant activity.

METHODS AND PREPARATIONS

All glassware used for treatment and incubation of milk samples and preparation of reagents was rinsed with concentrated nitric acid and then rinsed with tap water, distilled water and water double-distilled from glass. The milk used was obtained daily from a 2000-gal. sample of cooled, unpasteurized skim milk previously processed and stored in stainless steel and tinned copper equipment by the methods commonly employed in milk plants. The average copper content of this milk supply, determined by the method of Bendix and Grabensetter (3), was 0.17 mg. per liter (average of duplicate determinations of three samples). Skim milk samples, free of metallic contamination, were obtained by milking directly into a wide mouth bottle and centrifuging in glass tubes.

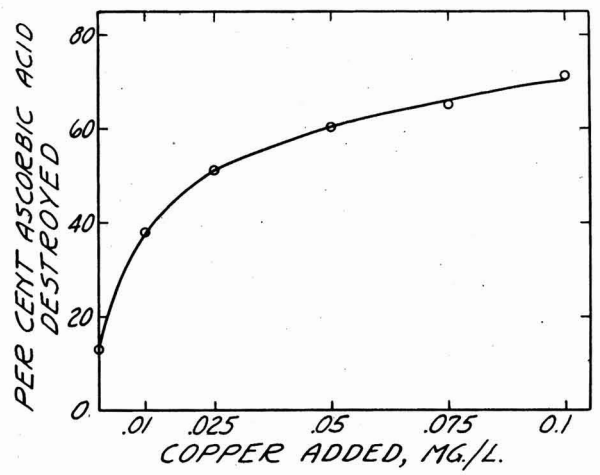

FIG. 1. The effect of copper on destruction of reduced ascorbic acid in aqueous solution during incubation for 2 hr. at 35° C.

Two hundred-ml. samples of milk, with and without added copper, were heated in 500-ml. Erlenmeyer flasks. After cooling to 55° F., copper was added to the required samples. Fifty-ml. aliquots in duplicate were measured accurately and placed in 500-ml. Erlenmeyer flasks. All samples then were placed in a 35° C. incubator until they had reached incubator temperature (about 2 hr.). To each sample was added 5 ml. of ascorbic acid solution, containing 5 mg. of ascorbic acid, and 0.5 ml. of toluene as a preservative. The samples then were shaken gently and allowed to incubate at 35° C. in the dark. Copper was supplied as copper sulfate. Reduced ascorbic acid was determined by the method outlined in A.O.A.C. Methods (1).

Casein was precipitated from skim milk by addition of HCl to pH 4.6. The washed precipitate was redissolved by addition of $NaHCO_3$ solution. The solution, held in Visking casings under toluene, was dialyzed against 0.5 per cent $NaHCO_3$ solution and running tap water for 48 hr. After filtering, the solution was dried by pervaporation and stored in a desiccator. Lactalbumin was prepared in a soluble form by dialysis of the filtrate obtained after precipitation of the casein. After dialysis against running tap water for 48 hr. using the same methods as described above for casein, the solution was concentrated by pervaporation to 0.1 volume, filtered and dried in the same manner as the casein. CP quality lactose was used.

RESULTS AND DISCUSSION

The data shown in fig. 1 demonstrates that, under the general conditions of these experiments, copper may be estimated through the pro-oxidant effect exerted upon the rate of oxidation of reduced ascorbic acid.

Milk samples heated at different temperatures, with copper added at various levels before heating and after heating, resulted in data shown in fig. 2. At each level of copper addition, the only variable was the time at which the copper was added. The data show that less ascorbic acid was destroyed during incubation in the samples to which copper was added before heating at 121° C. for 15 min. or 104° C. for 20 min. In samples heated at 85° C. for 20 min., the effect of the time of addition of copper was reversed.

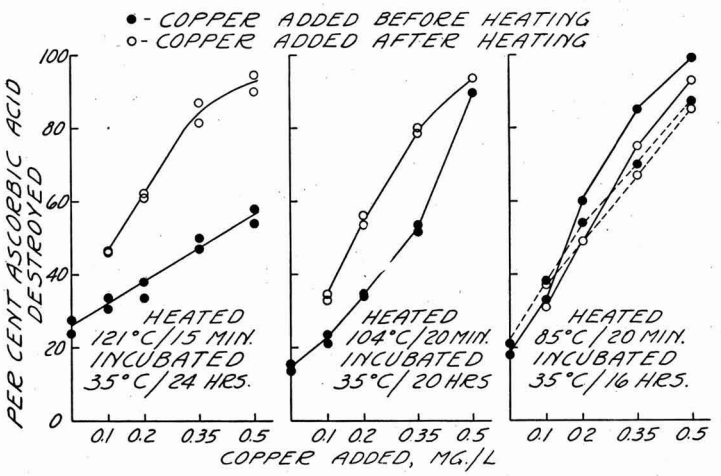

FIG. 2. Destruction of reduced ascorbic acid in milk heated to different temperatures as influenced by time and level of copper addition. Two experiments were performed on different days at each temperature.

Under the conditions of these experiments, the rate of destruction of reduced ascorbic acid was determined in preliminary experiments to approximate closely a first order reaction. To allow a direct comparison of the effects of copper added

to milk heated to different temperatures, the data shown in fig. 2 were recalculated to find the destruction of reduced ascorbic acid which would have occurred after 16 hr. incubation, assuming a first order reaction (fig. 3).

Further information on the difference in the effects of heat treatments can be shown by the following analysis of the data: Let A equal the amounts of ascorbic acid destroyed in samples to which the copper was added after heating, minus the control value (zero copper addition) and let B equal the ascorbic acid destroyed in samples to which the copper was added before heating, minus the control value. Then, if the ratios of A to B are plotted against the amount of copper added, approximate straight line relationships result. The equation of the

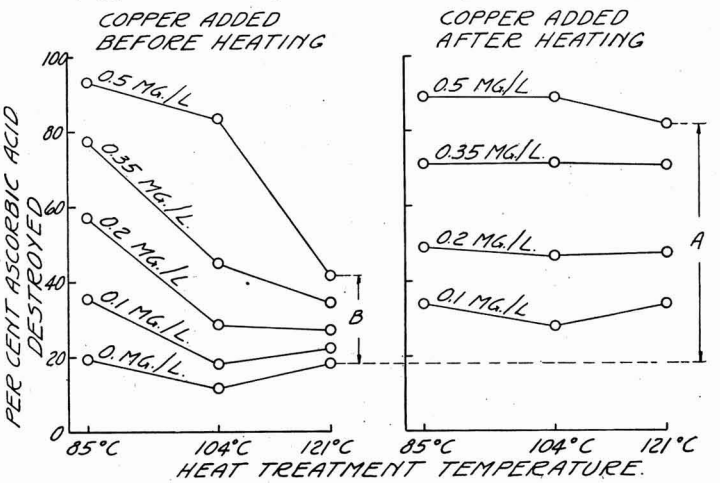

FIG. 3. The effects of heat treatment temperature, level of copper addition and time of copper addition on the destruction of reduced ascorbic acid in milk during 16-hr. incubation at 35° C. Calculated from data shown in fig. 2. The method of obtaining the values A and B (see fig. 4) are shown for one point.

lines is: $A/B = Y + (Cu) \cdot K$, where Y is the extrapolated value of the ratio at zero addition of copper, (Cu) = concentration of added copper in mg. per l. and K = slope of the line. These calculations are shown in fig. 4.

The values of the ratio A/B are highest at all levels of copper addition in the experiments in which the milk was heated at 121° C. for 15 min. Higher values of the ratio are related to the greater difference in the effect of the heat treatment on the destruction of ascorbic acid by copper added after heating as compared to the same amount of copper added before heating. The slopes of the lines obtained at the two higher heat treatments are negative, indicating that the same type of reactions occur at both temperatures. In contrast to the results obtained at the higher temperatures, a value for the ratio A/B of less than one is obtained after heating at 85° C. At this temperature copper added before heating causes more destruction of reduced ascorbic acid than copper added after heating. The slope of the line is slightly positive.

The most probable explanation of the results obtained at the higher temperatures of heating is that heating the milk with the copper causes the copper to be less available as a pro-oxidant in comparison with the pro-oxidant properties of copper added after heating. A less likely possibility is that the presence of added copper during heat treatment causes formation of greater amounts of substances stabilizing reduced ascorbic acid than are formed during heating without copper. As far as is known, no data is available to indicate the possibility of a pro-oxidant metal acting in this way. On the contrary, copper is a catalyst for the oxidation of SH groups (12). However, the data do not preclude the possibility that the less likely mechanism may be operative.

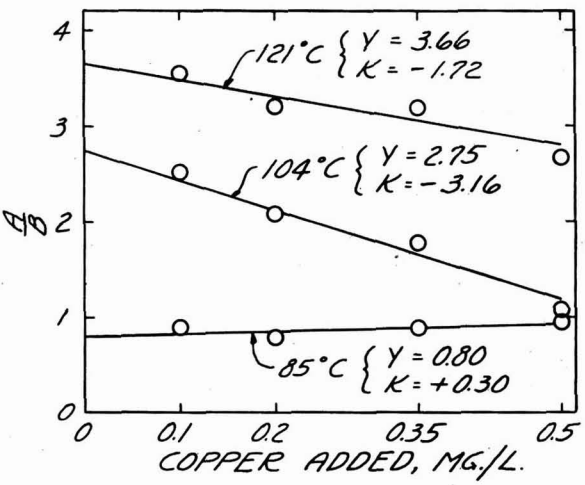

FIG. 4. The effect of temperature and level of copper addition to milk on the ratio of ascorbic acid destroyed due to copper added before heating, to ascorbic acid destroyed due to copper added after heating. Calculated from data shown in fig. 3.

The values obtained may be the result of two opposing types of reactions. At 85° C. a greater destruction of ascorbic acid occurs in samples to which copper is added before heating. This result indicates that copper, heated with milk at 85° C., is not reduced in pro-oxidant properties as compared to copper added after heating but rather causes reactions to occur which effect a decrease in the stability of reduced ascorbic acid and suggests that reactions which decrease the stability of reduced ascorbic acid may occur when copper is heated with milk at the higher temperatures. At 121 and 104° C., reactions responsible for the binding of pro-oxidant copper and hence stabilizing ascorbic acid may overbalance the effects of reactions resulting in a medium in which ascorbic acid is less stable. The difference in the slopes of the curves relating ascorbic acid destruction to temperatures of heating with increasing levels of copper added before heating (fig. 3) also indicate the occurrence of two opposing reactions.

Extrapolation of the lines to zero addition of copper yields values Y which are quantitative estimates of the relative effectiveness of heat treatments in decreasing the pro-oxidant activity of a minute quantity of copper added before heat treatment, as compared to a similar addition after heat treatment.

In order to determine which components of heated milk are responsible for the change in effect of copper on reduced ascorbic acid, the separated components of milk were tested. Solutions of 3 per cent casein, 0.5 per cent lactalbumin, and 5 per cent lactose were prepared. After adjustment to pH 6.8, copper was added to each solution at a level of 2 mg. per l. After thorough shaking and dividing into two equal portions, one set of solutions was autoclaved at 121° C. for 15 min. in sealed glass containers. The precipitates caused by heating were dispersed thoroughly by adding glass beads to the containers and shaking mechanically for 1.5 hr. Casein and lactalbumin solutions were prepared, as described above, and heated at 121° C. for 15 min. without copper. After cooling and mechanical shaking, copper then was added.

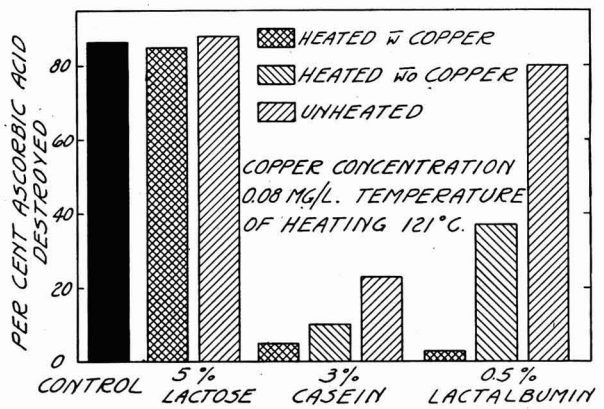

FIG. 5. Destruction of reduced ascorbic acid in 0.015 M acetate buffer, pH 4.6, during incubation for 100 min. at 35° C. as influenced by copper as copper sulfate and copper added with separated milk components.

The effects on oxidation of reduced ascorbic acid in the solutions prepared above were tested by addition of 2 ml. of the samples containing 0.004 mg. copper to 48 ml. of 0.015 M acetate buffer pH 4.6. To the control flask were added 2 ml. of copper sulfate solution containing the same amount of copper as the experimental samples. Five ml. of ascorbic acid solution (1 mg./ml.) and 0.5 ml. of toluene were added and the mixture incubated at 35° C. in the dark for 100 min. The data obtained are shown in fig. 5.

The data supports the interpretation that copper heated with lactose or added to heated lactose is unchanged in activity within the experimental error of the methods used. Copper added to unheated casein forms a copper-casein complex, in which form the copper is lowered considerably in pro-oxidant activity as meas-

ured by destruction of reduced ascorbic acid (23 per cent destroyed as compared to 86 per cent destroyed by the same amount of copper as $CuSO_4$). Unheated lactalbumin reduces the pro-oxidant activity of copper considerably less than casein (80 per cent ascorbic acid destroyed as compared to 86 per cent destroyed in the control). Copper is further reduced in activity when added to previously heated casein solution (10 per cent reduced ascorbic acid destroyed) and lactalbumin solution (37 per cent reduced ascorbic acid destroyed). This further decrease of the pro-oxidant properties of copper added to heated protein, as compared to this property when copper is added to unheated protein, probably is due to the binding of the copper by sulfhydryl groups formed during the heat treatment (4), as sulfhydryl groups have been shown to bind copper (13). A further significant reduction in pro-oxidant activity occurs when copper and proteins are heated together. Copper heated with casein caused 5 per cent destruction of reduced ascorbic acid and copper heated with lactalbumin caused only 3 per cent destruction of ascorbic acid. The results obtained on heating copper with milk proteins confirm the explanation advanced for the loss of pro-oxidant properties of copper added to evaporated milk before sterilization (8). When the copper was heated with casein, only very slight coagulation occurred, indicating that copper-casein complexes of lowered pro-oxidant activity were formed. In the case of copper heated with lactalbumin, coagulation of the protein occurred. Probably at least part of the copper is mechanically removed from contact with the ascorbic acid solution by inclusion in the coagulum.

As a basis for further investigation, a theory is proposed to account for the data obtained. Heating milk at 85° C. or higher causes formation of substances, probably the most important of which are sulfhydryl groups, which reduce the pro-oxidant activity of copper and also may act as reduced ascorbic acid stabilizers. In addition to this mechanism for stabilizing reduced ascorbic acid, heat treatment of milk at 121 and 104° C. results in a further reduction in the pro-oxidant properties of copper through formation of complexes in which the copper is less capable of exerting pro-oxidant effects in comparison with the copper-protein and other combinations present in milk heated at 85° C. or lower temperatures. This inactivation probably is related to lactalbumin denaturation. Opposing these two reactions which stabilize ascorbic acid, the copper present in milk during heat treatment causes an increased rate of destruction of copper binding groups and/or groups stabilizing ascorbic acid which are formed during heating. As a result, reduced ascorbic acid is less stable. The over-all effect observed is the resultant of the effects of these reactions.

As a practical matter, the data (fig. 3) indicate that heat treatment at 104° C. is the optimum temperature of heat treatment for the milk supply used in these studies, as far as maximum stability of ascorbic acid in final products is concerned, though heat treatment at 85° C. is almost as good in this respect. Comparative tests done in this laboratory have shown that the stability of reduced ascorbic acid in milk samples previously heated at 85° C. is greater than in milk samples previously heated to lower temperatures.

To investigate the effect of metallic contamination resulting from contact of

the milk with metallic equipment, the heat treatment at 121° C. for 15 min. was applied to milk samples handled exclusively in glass. As shown in fig. 6, considerably less ascorbic acid was destroyed in all samples tested, as compared to milk subjected to metallic contaminants. The reduced ascorbic acid destroyed is related directly to the copper added before heating, as was found previously at 121° C. with milk handled in metallic containers.

Extrapolation of the straight lines obtained upon plotting reduced ascorbic acid destruction against added copper to zero destruction of ascorbic acid also is shown in fig. 6. This extrapolation is justified if the assumption is made that the

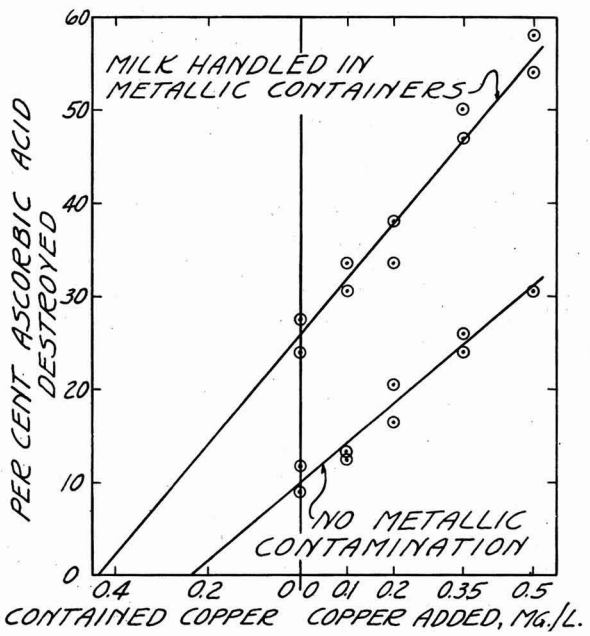

FIG. 6. The effect of adding copper to milk handled in glass and in metallic equipment on destruction of reduced ascorbic acid during 24-hr. incubation at 35° C. The copper contents of the milk samples are estimated by extrapolation.

pro-oxidant metal content of the milk acts in a similar manner to added copper. It is of interest that extrapolation furnishes a value of about two times as much copper in milk previously in contact with metals (0.43 mg./l.) as compared to the milk samples held in glass (0.24 mg./l.). The copper content of the milk previously in contact with metal obtained by this calculation (0.43 mg./l.) is over twice the value obtained by chemical analysis (0.17 mg./l.). Iron, manganese and other metals acting as pro-oxidants in the presence of copper may be the reason for the higher value for copper obtained by the extrapolation. It is suggested that a test based on these observations might be developed for estimation of total pro-oxidant metal activity of milk samples.

SUMMARY

Copper added to milk before heat treatment at 121° C. for 15 min. or 104° C. for 20 min. causes lower rate of disappearance of ascorbic acid on subsequent incubation than is caused by copper added after heating. The reverse effect occurs in samples heated at 85° C. for 20 min.

Approximately straight line relationships are obtained when the amounts of reduced ascorbic acid destroyed above the control value in milk samples to which the copper is added after heating are divided by the amounts destroyed above the control value in similar samples to which the copper is added before heating, and these values plotted against the amount of copper added. Extrapolation of the lines to zero addition of copper affords a quantitative estimate of the effect of slight copper contamination occurring before heat treatment, as compared to the same level of copper contamination occurring after heat treatment.

Casein-copper and lactalbumin-copper mixtures heated at 121° C. for 15 min., when added to ascorbic acid solutions, cause a lower rate of loss of reduced ascorbic acid than do the unheated mixtures. If copper is added to previously heated protein solutions, an effect on reduced ascorbic acid oxidation intermediate between heated and unheated samples occurs.

These data furnish evidence that high-temperature heat treatment of milk reduces the pro-oxidant effects of milk copper and allows an interpretation of the mechanisms to be advanced.

Extrapolation to zero of the straight lines obtained on plotting the percent ascorbic acid destroyed against the copper added to milk samples subsequently heated at 121° C. for 15 min. yields values for copper approximately twice as great as were obtained by chemical analysis.

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A PICRIC ACID METHOD FOR THE SIMULTANEOUS DETERMINATION OF LACTOSE AND SUCROSE IN DAIRY PRODUCTS[1]

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For the determination of lactose in milk, "Official Methods" of the A.O.A.C. (1) recognizes a polarimetric method (Double Dilution) and a copper reduction method (Munson-Walker). With sweetened condensed milk the Munson-Walker method is specified for lactose, while a polarimetric method, requiring readings before and after hydrolysis, is the only procedure mentioned for sucrose. No sugar methods are included for such products as cream, ice cream, and dry milk.

White (18) has developed a procedure based on the Munson-Walker technique which can be used for lactose and sucrose when present together. This method corrects for certain irregularities in the unmodified Munson-Walker method and has been found more accurate and convenient than "Official Methods" for sweetened condensed milk (13, 10).

At best, the recognized methods for lactose and sucrose in dairy products are tedious, lengthy, or require specialized equipment and for this reason sucrose determinations often are avoided.

Colorimetric methods for certain carbohydrates, based on the reduction of picric acid, have been developed and used for many years, particularly for glucose in blood and urine (2, 5, 6, 9, 13, 15), but later for carbohydrates in plant materials (16, 17, 19) and for lactose in milk (3, 10, 12) and other dairy products (3). These methods have proven simpler than the official ones and on the whole quite satisfactory. Most of them, however, were evolved using visual colorimeters (less sensitive and less accurate than present photoelectric instruments) and in many cases the color development was not strictly proportional to the concentration of sugars, thereby necessitating correction factors, standard curves or standard colors close in color density to the unknowns.

In the belief that a satisfactory colorimetric technique, based on the reduction of picric acid, for the simultaneous determination of lactose and sucrose in dairy products would be a very useful tool in dairy products control and in dairy products research, the study reported here was undertaken.

EQUIPMENT AND METHODS

A Klett-Summerson photoelectric colorimeter was used for all color comparisons, employing a no. 52 filter (520 mμ) which was found to be slightly more sensitive than the no. 54 recommended by the maker of the instrument for picric

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creatinine determinations. The scale of this instrument is graduated logarithmically and the readings are proportional to color density and hence to concentration of the substance responsible for the color.

A water bath equipped with a peripheral perforated steam pipe and an overflow made it possible quickly to obtain boiling water at a constant level for heating flasks and tubes. In this bath ($14'' \times 8'' \times 8''$) the introduction of a series of tubes or flasks did not lower significantly the temperature of the water.

In the early studies, flasks (100 ml.) and various tubes were used, as called for by the method or modification under investigation, but later the "sugar tubes" suggested by Meyers and Bailey (14) were adopted because of their greater convenience. These are straight-sided, 200×15 mm. tubes graduated at 3, 4, 10, 15 and 20 ml.

Standard lactose solutions were prepared from dried C.P. lactose monohydrate on which triplicate polarimetric determinations indicated a purity of 99.88 per cent.

Standard sucrose solutions were made from a supply furnished by the National Bureau of Standards (lot 4602, standard sample 17) analyzing less than 0.003 per cent moisture, 0.003 per cent ash and less than 0.002 per cent invert sugar. A portion of this was subjected to twice-repeated crystallization with absolute alcohol from concentrated water solution, followed by vacuum drying over P_2O_5. Samples of the original and "purified" sugar tested by the procedure of Willaman and Davison (19) gave identical readings.

The picric acid employed (Baker's, C. P., Analyzed, Crystalline, Special for blood test) was found satisfactory by the Folin and Doisy test (7).

The first part of the work consisted of a reexamination of the picric acid methods of Myers and Bailey (14), Benedict and Osterberg (2), Bierman and Doan (3) and Willaman and Davison (19) in an effort to select a procedure most satisfactory as a basis for determining lactose and sucrose in dairy products. The methods were modified in various ways (largely by altering the amount and concentration of reagents and by varying the heating periods) in an effort to obtain color development in conformity to Beer's law which none of them exhibited initially.

The second portion of the work consisted of comparative determinations of lactose and of lactose and sucrose in milk, lactose adjusted milk, simulated sweetened condensed milk and ice cream mix. The methods compared were the official Munson-Walker, the official polarimetric and the picric acid method developed in this study, where lactose alone was being determined. Where lactose and sucrose were being determined, White's (18) copper reduction method only was used as the standard for comparison with the picric acid method. Ten replicate determinations were made by each of the above methods on each of the 19 samples analyzed and the data were examined statistically.

RESULTS

Development of Method. The detailed studies made in this portion of the work are not reported nor are data shown, but a number of important observa-

tions should be mentioned, inasmuch as they affect the determination by the picric acid method and since they influenced the selection of a procedure. The color development, on which the method is based, is substantially complete when lactose or invert sugar is heated in the presence of picric acid and sodium carbonate for 20 min. However, it is not absolutely complete and therefore the heating period must be controlled. Blanks or standards preferably should be heated along with unknowns. Color, after development, is relatively stable (constant for 25 min.) but it does fade slowly. Consequently, samples should be limited to a number which can be read in the colorimeter in a 20-min. period. In this study 20 samples were found to be the maximum.

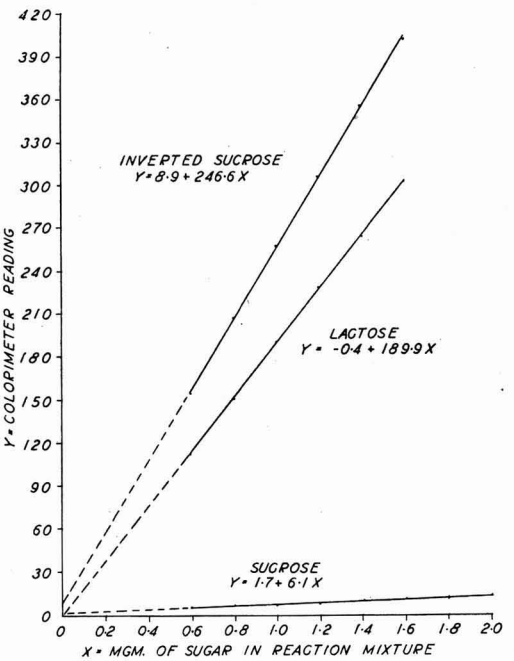

FIG. 1. Regression curves for lactose, sucrose and inverted sucrose.

Lactose. While none of the original methods produced color density in proportion to the concentration of sugar for the full length of the curve, a few of the modifications did. In general, increased heating periods increased the slope of the curve (concentration of sugar = X and color density = Y) and also shifted the point of origin in a positive direction. A modification of the method of Willaman and Davison finally was selected as the most suitable, of those giving results conforming to Beer's law, for use in analyzing milk. A calibration curve and regression equation for lactose (fig. 1) was established from the analysis of

seven series of samples each containing six concentrations of pure lactose varying from 0.6 to 1.6 mg. in the reaction mixture. This equation is as follows: $Y = -0.4 + 189.9\ X$, where Y is the colorimeter reading, -0.4 the origin of the curve, and 189.9, the increase of reading for each milligram of lactose (slope).

Lactose and sucrose. The literature (16, 19) states that sucrose is easily and quickly inverted by heating in picric acid and, further, that for reasonable periods at room temperature picric acid does not invert sucrose even in saturated solution (3, 16, 17). These facts were verified. Sucrose was found to be completely inverted in sugar tubes heated in the boiling water bath for 4 min. and saturated picric acid caused no measurable hydrolysis of sucrose at room temperatures over a period of 30 min. These observations are important because in the determination of lactose and sucrose in a medium where both are present colorimeter readings are made twice, once without inversion of sucrose and once after sucrose inversion.

Under these conditions it is necessary to know whether uninverted sucrose exhibits any reducing properties when heated in alkaline picrate solution. The literature suggests that it does not but repeated, careful trials in this work demonstrated that it does have a slight but significant effect. For accurate work, therefore, lactose determinations on products containing sucrose must be corrected. Since the reducing power of uninverted sucrose was found to increase with the alkalinity and to be proportional to the amount of sucrose present, this phenomenon apparently is the result of a slight degradation of the sucrose brought about by heating in alkaline solution, giving rise to fragments with reducing power. White (18), in his study of the Munson-Walker method for sweetened condensed milk, found the same error in that method and his modification corrects for it.

Previous workers found that the heat treament in picric acid, used for inverting sucrose, does not affect the reducing power of lactose and other reducing sugars if also present. This fact was confirmed.

A considerable amount of time and effort was expended in attempting to find conditions for the reduction of picrate by inverted sucrose which would result in a color regression curve originating at zero and still not complicate the procedure or change it too radically from the simple procedure found satisfactory with lactose. This effort was not successful and it was finally decided to use the lactose procedure and adjust the concentration of sucrose in the sample to the portion of the color curve away from the lower readings.

A calibration curve and regression equation was established from data obtained in a similar manner as with lactose alone, but for both uninverted sucrose (correction on lactose) and inverted sucrose. These curves also are plotted in figure 1. For uninverted sucrose, $Y = 1.7 + 6.1\ X$. For inverted sucrose, $Y = 8.9 + 246.6\ X$.

METHOD

Reagents. Saturated picric acid is prepared by heating 16 g. of the wet, C.P., reagent (special for blood test) per liter of distilled water until dissolved, then

cooling it slowly at room temperature for several days until the excess solute has crystallized in the form of large, blade-like crystals. Quick cooling and agitation are conducive to fine, powdery crystals difficult to keep out of the supernatant liquid which is the reagent.

Twenty-five g. of C.P., anhydrous Na_2CO_3 are dissolved and made up to 100 ml. with distilled water. This solution should not be allowed to cool much under 65° F. or some of the solute will crystallize.

Where lactose is the only sugar. Approximately 1 g. of milk, cream, skim-milk or a proportionate amount of other product, is weighed accurately into a 100-ml. volumetric flask and diluted to volume with saturated picric acid. The flask contents are shaken and filtered through a fluted filter. Two ml. of the filtrate are transferred to a Myers and Bailey sugar tube containing 1 ml. of the Na_2CO_3 reagent, stoppered lightly, shaken and placed in a bath of boiling water for 20 min. The tube then is cooled to room temperature (approx. 20° C.), diluted to 20 ml. with distilled water and mixed by inverting. A portion is transferred to a colorimeter tube and a reading obtained within 20 min, of removal from bath. A blank consisting of 2 ml. of picric acid and 1 ml. of Na_2CO_3 is heated, cooled and diluted along with the unknown for adjustment of the zero point of the colorimeter scale.

The calculation is simple where lactose is the only sugar present. The value of X is first determined from the regression equation for lactose, $X = \frac{Y + 0.4}{189.9}$, where X = mg. of lactose in 2 ml. of filtrate and Y = photoelectric colorimeter reading. From this, the amount of lactose in the unknown is calculated as follows: $\%\ \text{lactose} = \frac{X \cdot 100 \cdot 100}{1000 \cdot 2 \cdot \text{wt. of sample}} = \frac{5X}{\text{wt. of sample}}$

Where lactose and sucrose are both present. Approximately 5 g. of sweetened condensed milk, 13 g. of ice cream or an amount of other product giving a comparable amount of sucrose are weighed into a 100-ml. volumetric flask and diluted to volume with distilled water. The contents are well mixed and a 5-ml. portion transferred to another 100-ml. flask and made to volume with saturated picric acid, mixed and filtered. Then 2 ml. of the filtrate are introduced into a "sugar tube" containing 1 ml. of Na_2CO_3 reagent, mixed and lightly stoppered.

Another 1-ml. portion of the same filtrate is transferred to a sugar tube containing 1 ml. of saturated picric acid, mixed well and placed in the boiling water bath for 5 min., after which it is cooled to room temperature. This second tube now contains inverted sucrose. One ml. of Na_2CO_3 is added to it and both tubes are placed in the boiling water bath for 20 min., along with a blank for each of them consisting of 2 ml. of saturated picric acid plus 1 ml. of carbonate for the first and 1 ml. of each reagent for the second. All the tubes then are cooled to room temperature, diluted to 20 ml. with distilled water and transferred to colorimeter tubes for reading. The instrument scale is set at zero using the proper blank before the respective readings are made.

The calculations required when both sugars are present are considerably more involved, even when results for only one are desired, inasmuch as a correction

must be made for the effect of uninverted sucrose on the lactose reading. The following symbols are used in explaining these calculations: X_1 = mg. lactose in 2 ml. of filtrate, X_2 = mg. sucrose in 1 ml. of filtrate, Y_1 = colorimeter reading before inversion of sucrose, Y_2 = colorimeter reading after inversion of sucrose and Y_3 = portion of Y_1 reading due to action of uninverted sucrose. Using the regression equation for inverted sucrose, $Y = 8.9 + 246.6\,X$ or $X = \frac{Y - 8.9}{246.6}$, an estimated value for X_2, sufficiently accurate for calculating the value Y_3, is obtained, thus:

$$X_2 \text{ (est.)} = \frac{Y_2 - \frac{Y_1}{2} - 8.9}{246.6}$$

The amount of sucrose present in the reaction mixture when the color due to lactose is being developed is twice this amount or $2X_2$ (est.). The regression equation for uninverted sucrose, $Y = 1.7 + 6.1\,X$, then becomes $Y_3 = 1.7 + 6.1\,[2X_2 \text{ (est.)}]$. Substituting the value of X_2 (est.), one obtains $Y_3 = 1.7 + 6.1\left[2\left(\frac{Y_2 - \frac{Y_1}{2} - 8.9}{246.6}\right)\right]$, which may be simplified to $Y_3 = \frac{Y_2 - \frac{Y_1}{2} + 25.4}{20.2}$

The regression equation for lactose, $Y = -0.4 + 189.9\,X$ or $X = \frac{Y + 0.4}{189.9}$, now is employed and $X_1 = \frac{Y_1 - Y_3 + 0.4}{189.9}$. Consequently, the lactose in the sample can be calculated as follows:

$$\%\ \text{lactose} = \frac{X_1 \cdot 100 \cdot 100 \cdot 100}{1000 \cdot 2 \cdot 5 \cdot \text{wt. of sample}} = \frac{100\ X_1}{\text{wt. of sample}}$$

The regression equation for inverted sucrose again is used for calculating accurately the value of X_2, and hence the amount of sucrose in the sample:

$X_2 = Y_2 - \frac{Y_1 - Y_3}{2} - 8.9$ / 246.6; and $\%\ \text{sucrose} = \frac{X_2 \cdot 100 \cdot 100 \cdot 100}{1000 \cdot 1 \cdot 5 \cdot \text{wt. of sample}} = \frac{200\ X_2}{\text{wt. of sample}}$

The regression curves and methods of calculation used in the described method should be applicable to any colorimeter using a scale similar to the Klett-Summerson (logarithmic). For other colorimeters, calibration curves obtained with pure sugar solutions can be employed. Such curves (fig. 1) also may be used, if desired, with logarithmic scales.

ACCURACY OF METHOD

Lactose. The picric acid method, as described, was employed in analyzing nine samples of milk and lactose-adjusted milk for lactose alone and the results compared with those obtained by means of the official Munson-Walker method and the official polarimetric method. Ten replicate determinations were made by each method on each sample. The results are summarized in table 1. These show excellent agreement of the average results by all three methods. The picric

acid method gives results intermediate between the two official methods but the results are slightly more variable than for either of them.

Analysis of variance of the original data indicates that differences between replicates are not significant. Variations among methods, using the interaction between methods and replications, are significant. The difference between the average per cent of lactose by the picric acid and the polarimetric methods is not

TABLE 1

Accuracy and variability of the picric acid method as compared with the Munson-Walker and polarimetric methods on milk where lactose only is being determined

Method	Lactose[a]	Standard deviation	Coefficient of variation
	(%)		(%)
Picric acid	5.929	0.055	0.93
Munson-Walker	5.904	0.044	0.74
Polarimetric	5.932	0.044	0.74

[a] Av. of 90 determinations by each method.

significant; that between the picric acid and the Munson-Walker methods is significant; that between the polarimetric and the Munson-Walker methods is highly significant. For ordinary analytical purposes these differences are believed to be inconsequential.

Four of the samples analyzed in this comparison were obtained by adding lactose to two normal samples of milk. The recoveries of these added quantities of this sugar by all three methods used are indicated in table 2. These are exceptionally close to the expected values.

TABLE 2

Recovery of added lactose in four samples of milk by the three methods of analysis

Method	Sample					
	Normal	Added lactose		Normal	Added lactose	
Picric acid method						
% lactose found	4.83	6.23	7.62	4.74	6.04	7.33
% lactose expected		6.24	7.60		6.05	7.32
% of expected		99.8	100.3		99.8	100.1
Munson-Walker method						
% lactose found	4.78	6.17	7.54	4.68	6.03	7.29
% lactose expected		6.19	7.55		5.99	7.26
% recovery		99.7	99.9		100.7	100.4
Polarimetric method						
% lactose found	4.81	6.21	7.62	4.78	6.07	7.37
% lactose expected		6.22	7.58		6.09	7.36
% of expected		99.8	100.5		99.7	100.1

Lactose and sucrose. White's copper reduction method for lactose and sucrose was the method used for comparative purposes with the picric acid method where both sugars were determined. Ten replicate determinations were made on each of ten different samples of ice cream mix, simulated sweetened condensed milk and sweetened condensed milk. The ratios of sucrose to lactose in the ice

cream mix samples and the simulated sweetened condensed milk were of such a range as to cover all possibilities likely to be encountered in commercial products. The results obtained for lactose in these products are summarized in table 3.

The data indicate excellent agreement between the two methods but, as in the previous comparison, the picric acid method exhibits results which are slightly more variable than the method used for comparison. Analysis of variance reveals no significant difference between the mean values obtained by the two methods.

TABLE 3

Accuracy and variability of the picric acid method as compared with White's modification of the Munson-Walker method for lactose in dairy products containing sucrose

Method	Lactose[a]	Standard deviation	Coefficient of variation
	(%)		(%)
Picric acid	5.409	0.062	1.15
White's	5.396	0.053	0.98

[a] Average of 100 determinations by each method.

The results obtained for sucrose on these same samples are presented in summarized form in table 4. Analysis of variance of these data does indicate a significant difference between the mean values obtained by the two methods. Most analysts probably would consider even the widest variations obtained in the study (0.33 per cent for a sample of commercial, sweetened condensed milk) a reasonably small error for sucrose determination. As the data show, the picric acid method gives somewhat more variable results than the method of White.

TABLE 4

Accuracy and variability of the picric acid method as compared with White's modification of the Munson-Walker method for sucrose in dairy products

Method	Sucrose[a]	Standard deviation	Coefficient of variation
	(%)		(%)
Picric acid	16.609	0.114	0.69
White's	16.694	0.096	0.58

[a] Average of 100 determinations by each method.

Six of the ten samples analyzed for both lactose and sucrose were samples of ice cream mix and simulated sweetened condensed milk, where the lactose content of the milk and condensed milk used in their preparation was known and the amount of sucrose added was weighed carefully. Consequently it was possible to compare the values obtained by the picric acid method and White's method with expected values for sucrose. These comparisons are presented in table 5. The results show excellent agreement except for one value by White's method.

TABLE 5

Recovery of added sucrose in six samples of ice cream mix and simulated sweetened condensed milk by two methods of analysis

Ratio of sucrose to lactose	Sucrose expected	Picric acid method		White's method	
		Sucrose found	Per cent of expected	Sucrose found	Per cent of expected
	(%)	(%)		(%)	
2.40–1.0	10.43	10.49	100.6	10.57	101.3
2.65–1.0	11.39	11.43	100.4	11.35	99.6
2.90–1.0	12.33	12.31	99.8	12.28	99.6
3.30–1.0	12.93	12.88	99.6	12.99	100.5
3.65–1.0	14.11	14.08	99.8	14.15	100.3
4.00–1.0	15.25	15.19	99.6	15.27	100.1

CONCLUSIONS

As a result of detailed studies of the procedures recommended in the literature for the colorimetric determination of sugars by the reduction of picric acid or sodium picramate, a method employing this technique but utilizing a photoelectric colorimeter was evolved for the simultaneous determination of lactose and sucrose in dairy products. The method also is applicable to the determination of either sugar alone.

The picric acid method is empirical and time factors must be controlled carefully. The technique is relatively simple as only two easily prepared reagents are required and, compared with commonly used methods, it is less tedious and less time consuming. The calculations, where both sugars are present, are somewhat involved but not difficult to apply.

Comparative studies indicate that the picric acid method probably is as accurate as the Munson-Walker, the polarimetric or White's modification of the Munson-Walker, although analysis shows that the variation of replicates is slightly wider.

It is felt that the method offers distinct advantages over currently used procedures for sugar determinations in a number of dairy products. It also appears simpler, especially insofar as reagents are concerned, than the modified ferricyanide procedure of Hites and Ackerson (8) and at least as convenient as the saccharimetric-refractometric method of Browne (4).

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THE EFFECTS OF MILD INBREEDING ON A HERD OF HOLSTEIN-FRIESIAN CATTLE[1]

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Inbreeding, in some instances, has been an effective system of breeding for livestock improvement but never has come into very common use in purebred herds and flocks, presumably because the incidence of abnormalities and other undesired traits is higher among inbred individuals. In recent years and at the present time, inbreeding projects have been and are being initiated by many experiment stations to obtain a more conclusive answer on how to derive greater benefit from this system of mating. With few exceptions, these experiments with large animals, as well as those with laboratory animals, have resulted in reduced vigor as exhibited by slower growth, smaller size, greater mortality and lower production and fertility. The present paper reports the effects of mild inbreeding on several characteristics in a herd of Holstein-Friesian cattle.

DATA AND METHOD USED

A project with registered Holstein cattle was inaugurated by the Iowa Agricultural Experiment Station in 1930 to determine the consequences of mild inbreeding accompanied by selection for high production. This study is an analysis of the records accumulated in this project between 1930 and 1942.

The herd was closed to outside blood in 1930 except for three proven sires used briefly in 1932 to 1935. Usually about 35 to 50 females of breeding age were maintained in the herd, the number being larger in the later years. The breeding system followed was to use sons of the best producing cows and to keep them in service until sufficient cows (30 or more) were bred to each one to be fairly certain he would have at least eight tested daughters. This resulted in most of the bulls being used for slightly over 1 yr. each. This breeding system would be expected to raise the inbreeding something like 3 per cent per generation or a little under 1 per cent per year (14). An analysis of the pedigrees indicates this is approximately the amount of inbreeding that did occur. Inbreeding was measured by Wright's (13) formula and was computed from pedigrees traced in all lines to animals born in 1910 or earlier. Inbreeding coefficients ranged from 0 to 28 per cent, with the majority of the animals falling in the lower third of the range.

In addition to birth weights of both bull and heifer calves, the following measurements were taken on females at 6 mo. and 1, 2, 3, 4, 5 and 7 yr. of age:

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wither height, chest depth, body length, heart girth, paunch girth and weight. Weight was recorded in pounds and all other measurements in centimeters. Production records were kept on all cows. These records were converted to a 305-day mature equivalent basis. During much of the period covered by this study, the herd was on 3 times milking; hence the records made on 2 times or 4 times milking were converted to the 3 times basis. All animals over 6 mo. of age were classified for type each year, using judges who did not know this herd but were experienced. In most cases these judges were official classifiers for the breed association, although these classifications were not made official. These type ratings were used to study the effect of inbreeding on type. Correlation coefficients and the regressions of the various characters on inbreeding were used to measure the effect of inbreeding. Coefficients referred to as being statistically significant are those expected to occur by chance less than 5 per cent of the time.

The animals included in the study were sired by 26 different bulls. An analysis of variance of each of the measurements indicated that in most cases the

TABLE 1

Effect of inbreeding on weight at various ages

Age	No. animals	Av. inbreeding	Av. weight	No. sires	Intra-sire	
					Correlation	Regression
		(%)	(*lb.*)			
Birth (males)	179	6	92	17	− 0.03	− 0.09
Birth (females)	191	5	86	25	− 0.08	− 0.16
6 mo.	176	5	354	19	− 0.08	− 0.72
1 yr.	168	5	638	23	− 0.22[b]	− 2.74[b]
2 yr.	153	5	1085	24	− 0.24[b]	− 4.75[b]
3 yr.	127	4	1192	26	− 0.14	− 4.00
4 yr.	90	3	1276	21	− 0.26[a]	− 2.89[a]
5 yr.	65	3	1329	20	+ 0.19	+ 5.46

[a] $0.01 < P < 0.05$.
[b] $P < 0.01$.

differences between sires caused a significant portion of the variation in measurements. To eliminate these sire differences and to keep all coefficients comparable, all of the correlations and regressions were calculated on an intrasire basis. Since all of a sire's progeny tended to be born within a period of slightly over 1 yr. with the breeding system followed in this herd, calculation on an intrasire basis tended to eliminate any time trends resulting from changes in management.

RESULTS AND DISCUSSION

No definite lethals were found. The very few distinct abnormalities observed were slightly (but insignificantly) more abundant among the non-inbred calves, but the inbreeding was scarcely extreme enough to reveal rare recessive single-gene defects on a detectable scale anyway.

Birth weight. The birth weights were analyzed to determine the effect of factors other than inbreeding. Age of dam had a significant effect on weight at birth. Calves from 2-yr.-old heifers averaged 8 lb. less at birth than calves from

older cows. This amount was added to the birth weights of the calves from 2-yr.-olds to make those suitable for inclusion in the analysis of the effect of inbreeding.

The average inbreeding, birth weights and the intra-sire correlations and regressions of birth weight on inbreeding are included in table 1 for the 191 heifer and 179 bull calves. The weighted average of the bull and heifer regressions shows a decrease of about one-eighth of a pound in birth weight for each increase of 1 per cent in inbreeding. This value is just below the level of statistical significance. On the basis of this regression, a first generation of parent-offspring or full-sib matings would be expected to lower average birth weight by about 3 lb.

The effect of the inbreeding of the dam on the birth weight of the calf also was studied. Using the same birth weights as above, the regression of birth weight on inbreeding of the dam was – 0.05 for heifer calves and – 0.14 for bull calves. The weighted mean of the two gives a decrease of approximately one-eleventh of a pound for each increase of 1 per cent in inbreeding. This also is below the level of significance but is quite similar to the coefficient obtained for the effect of the inbreeding of the individual itself on its birth weight.

Though no definite conclusions can be drawn from these results, they are similar to those found by Woodward and Graves (12), Dickerson (5) and Tyler *et al.* (10), all of whom reported a decline in birth weight with increased inbreeding. Bartlett *et al.* (2, 3, 4, 9) reported that inbreeding had no apparent effect on birth weight in the Holstein herd they studied.

Weights at 6 months and over. The effect of inbreeding on weight at the various ages is shown by the regression coefficients of table 1. These show that, in general, increased inbreeding resulted in lighter weights at all ages except 5 yr. The regression coefficient increased up to 2 yr. Then, although the mean weight continued to increase, the regression coefficients decreased with advancing age up to 5 yr. This indicates that inbreeding not only resulted in lighter calves at birth, but in slower gains during the first 2 yr. of life. After 2 yr., the inbreds apparently gained faster than the non-inbreds and by 5 yr. of age approached or exceeded the non-inbreds in weight. Inbreeding evidently slowed the gains at younger ages but did not influence mature weight. The non-inbred individuals merely approached their mature weights at a younger age. The regression coefficient at 5 yr. indicates that mature body weight increased as inbreeding increased but the volume of data was not sufficient to make this trend significant.

As compared with earlier Holsteins from the same herd, (table IV in Espe *et al.*, 6) the ones in the present study were about 4 per cent lighter at 1 yr. and about 3 per cent heavier at 3 yr. and at 4 yr. At other ages the averages differed by only about 1 per cent.

Several have reported on the effect of inbreeding on growth rate. Bartlett *et al.* (2, 3, 4, 9) observed that growth rates of inbreds with a coefficient of inbreeding of less than 20 per cent were not significantly different from outbreds, although the outbreds showed a slight advantage at 2 yr. and the inbreds at 5 yr. They also found that animals with more than 20 per cent inbreeding were

smaller at maturity than outbreds. Dickerson (5) stated that the size difference in favor of outbreds appeared to become proportionately smaller with growth up to 6 mo. of age. In an inbreeding project with Guernseys and Holsteins, Woodward and Graves (12) observed that inbreeding tended to reduce mature weight. Baker *et al.* (1) analyzed the growth records on 63 daughters of one Holstein bull and found that weight decreased with increased inbreeding at all ages.

TABLE 2

Average measurements at various ages

Age	No. animals	Av. inbreeding	Wither height	Body length	Chest depth	Heart girth	Paunch girth
(*yr.*)		(%)	(*cm.*)	(*cm.*)	(*cm.*)	(*cm.*)	(*cm.*)
0.5	176	5	100	107	47	121	149
1	168	5	116	131	58	151	181
2	153	5	130	152	69	183	223
3	127	4	134	159	72	188	231
4	90	3	135	163	74	192	237
5	65	3	136	165	75	195	240

Body measurements. The results for the five body measurements were all quite similar and therefore will be presented as a group. The number of animals available for study, their average inbreeding and the average of each of the five measurements at the various ages are given in table 2. These figures show that average size continued to increase to at least 5 yr. of age. The averages for wither height and for chest depth are almost the same as those for earlier Holsteins in the same herd (table V in Espe *et al.*, 6). Wither height is a

TABLE 3

Intra-sire correlation coefficients between body measurements and inbreeding at various ages

Age	No. sire groups	Wither height	Body length	Chest depth	Heart girth	Paunch girth
(*yr.*)						
0.5	19	−0.07	−0.14	−0.17[a]	−0.15	−0.12
1	23	−0.16	−0.19[a]	−0.23[a]	−0.20[a]	−0.17[a]
2	24	−0.05	−0.18[a]	−0.21[a]	−0.22[a]	−0.22[a]
3	26	+0.14	−0.08	+0.08	0.00	−0.13
4	21	+0.31[b]	−0.08	+0.19	+0.05	−0.10
5	20	+0.38[b]	+0.06	+0.32[a]	+0.19	+0.26

[a] $0.01 < P < 0.05$.
[b] $P < 0.01$.

little lower in these cows, but the difference reaches 1 per cent only at 5 yr. Only at 5 yr. is average chest depth as much as 0.5 cm. less in the cows in the present study.

Tables 3 and 4 give the intra-sire correlations and regressions of body measurements on inbreeding at the various ages. From these figures it is clear that inbreeding resulted in smaller size at all ages up to 2 yr. Although not all of the coefficients are statistically significant up to that age, the majority of them

are, and all are of negative sign and of similar magnitude. After about 2 yr., the inbreds grew the faster. At 5 yr. they were larger than non-inbreds, although not significantly so except in wither height and chest depth. The outbreds approached their mature size earlier. In the case of wither height, these cattle had reached 85 per cent of their 5-yr.-old height at 1 yr. Since wither height approached its mature size at the earliest age, it would be expected that any general effect of inbreeding in retarding early growth and prolonging later growth would show this reversal of sign at an earlier age for wither height than for the other measurements. The correlation coefficients reached their maximum negative values earliest with wither height and latest with heart girth and paunch girth. For all measurements except wither height, inbreeding resulted in significantly smaller size at 1 and 2 yr. In general, it appears that inbreeding slowed early growth rate but accelerated or prolonged it at later ages, so that mature size was unchanged or actually increased.

Tyler *et al.* (11), in three herds of Holsteins where inbreeding varied from 0 to 37 per cent, did not find that inbreeding had any significant effect on

TABLE 4

Intra-sire regression coefficients of body measurements on inbreeding at various ages

Age	No. sire groups	Wither height	Body length	Chest depth	Heart girth	Paunch girth
(*yr.*)						
0.5	19	−0.05	−0.12	−0.06[a]	−0.14	−0.18
1	23	−0.10	−0.16[a]	−0.09[a]	−0.23[a]	−0.29[a]
2	24	−0.03	−0.15[a]	−0.09[a]	−0.29[a]	−0.47[a]
3	26	+0.11	−0.08	+0.05	0.00	−0.34
4	21	+0.24[b]	−0.07	+0.09	+0.07	−0.27
5	20	+0.33[b]	+0.06	+0.21[a]	+0.32	+0.71

[a] $0.01 < P < 0.05$.
[b] $P < 0.01$.

height at withers, circumference of shin bone or width at hips, either at 18 mo. or at maturity. They did find a significant decrease in heart girth at 18 mo. with increased inbreeding.

Bartlett *et al.* (2, 3, 9) found no difference between inbreds and outbreds for wither height but did find a slight advantage for outbreds in heart girth, both at 2 and 5 yr.

Baker *et al.* (1) found decreased wither height and heart girth with increased inbreeding.

Type. All animals were classified for type each year, resulting in most animals being classified several times. The official terms of excellent, very good, good plus, good, fair and poor were used, and it was intended that the classes would correspond to the official ones, except that each class was divided into three subclasses, low, medium and high, thus resulting in a total of 18 possible type classifications. Also, heifers were classified even before calving, which is not done in the official plan. Each subclass was given a numerical value starting with 0 for low poor and going to 18 for high excellent. The measure of type used for each cow was the average of all her ratings. To give more weight

to animals classified most often, this average was regressed towards the herd average according to the number of ratings included and using a repeatability of 0.4 for single type ratings (8). This makes the regressions a bit smaller numerically than if permanent type could have been classified without error. The average score for the herd was 7, which is equivalent to a classification of middle good. Data were available on the classification of 215 individuals whose average inbreeding was 4.6 per cent. They were sired by 37 different bulls and the differences in type between groups of daughters from different bulls were not statistically significant. The intra-sire correlation between inbreeding and type was -0.12 and the regression of type on inbreeding was -0.04. For coefficients of this size to be statistically significant would require 300 observations, or 85 more than were available. However, if accepted at face value, they do indicate a tendency for poorer type as inbreeding increased. Using the regression coefficient obtained here, it would require an increase in inbreeding of 25–30 per cent to lower the average type classification one-third of a class; for example, from middle good to low good.

Bartlett *et al.* (2, 3), on 112 animals, found no significant effect of inbreeding on type.

Production. To determine the effect of inbreeding on production, butterfat records for 305-day lactations on a 3 times mature equivalent basis were used. The measure used for each cow was her lifetime average. The average of all of a cow's record is a more accurate indicator of her ability than is any single record, since random environmental errors will tend to cancel each other out of the averages. The average production of the 156 cows available for this phase of the study was 477 lb. Correlation coefficients and regressions of production on inbreeding were calculated on an intra-sire basis to help eliminate environmental changes, differences between sires, and effects of selection.

The average inbreeding coefficient was 4 per cent. The regression of production on inbreeding was -4.5 lb. and the correlation coefficient was -0.23. The coefficients are statistically significant based on this volume of data. This regression coefficient indicates that in this herd an increase of 1 per cent in inbreeding was accompanied by an average decrease of 4.5 lb. of butterfat in a 10-mo. lactation.

Since selection was practiced for high production, the data were studied to determine if it were possible for selection to be strong enough to overbalance the decline expected as a result of inbreeding. From 1932 to 1942, the average inbreeding coefficient had increased from 1.6 per cent to 3.9 per cent, or an increase of 2.3 per cent. Providing there were no environmental changes or no selection for production, this increase in inbreeding would have been expected to lower average production by 10 lb. The yearly herd averages were adjusted for yearly changes in uncontrolled factors by a least squares procedure. The adjusted averages indicated that the average genetic merit of the herd for butterfat production had increased approximately 40 lb. Presumably, this is the increase left after deducting the decline caused by inbreeding. If there had been no inbreeding, this 40-lb. increase resulting from selection for high produc-

tion would have been expected to be more nearly 50 lb. (40 lb. plus 10 lb. to compensate for the effect of inbreeding). This indicates that selection (mostly of bulls) was intense enough to more than counterbalance the effect of inbreeding. The above discussion is based on the assumption that environmental changes have been eliminated in the adjusted averages. Henderson (7) states that the least squares procedure used here for adjusting yearly herd averages, gives biased estimates when cows culled from the herd are either above or below the herd average. In this herd, during the period these records were made, little selection for production was possible among the cows since the test-and-slaughter policy was followed for controlling brucellosis and, in the early part of the period, reproductive rates were lower than in recent years because heifers were bred to calve at older ages and cows were not rebred as soon after calving as is now practiced. The average production of the cows leaving the herd usually was close to the herd average. Therefore, these estimates based on the least squares procedure should not have much bias from this cause.

These results of the effects of inbreeding are not in agreement with those reported by Woodward and Graves (12), in which they found no apparent effect on production. Tyler *et al.* (11) reported an average decrease of 74 lb. of milk and 2.3 lb. butterfat for each 1 per cent increase in inbreeding. Bartlett *et al.* (2, 4, 9) found that inbreds produced less milk and less total pounds butterfat than outbreds.

SUMMARY

The effect of mild inbreeding on size, type and production in a herd of Holstein-Friesian cattle was analyzed. The measures used were intra-sire correlations and regressions of the various traits on inbreeding.

The inbreeding of the individual itself resulted in an average decrease of about one-eighth of a pound in birth weight for each increase of 1 per cent in intensity of inbreeding. The inbreeding of the dam had a slightly smaller effect than this on the birth weight of the calf. Both values border on statistical significance.

For the five body measurements and weight at 6 mo. and over, an increase of 1 per cent in inbreeding never resulted in a decrease of more than 0.5 per cent and usually only about 0.1 per cent of the average of the respective measurement. The results indicate that the shape of the growth curve changes as the intensity of inbreeding changes. It appears that inbreeding slows the rate of growth at early ages but permits rapid growth to continue longer, so that mature size is not decreased and may even be increased. Although not all of the coefficients are significant, it is concluded that, in general, increased inbreeding resulted in a smaller size at least to 2 yr. and, for some of the later-maturing measurements, perhaps up to 4 yr. of age. A tendency for larger size with increased inbreeding was indicated at 5 yr.

Inbreeding had no certain effect on type ratings. A non-significant negative regression coefficient of type rating on inbreeding suggests a slight tendency for inbreeding to be detrimental to desired type.

Production decreased as inbreeding increased. The regression of butterfat production on inbreeding was −4.5 lb. per 1 per cent inbreeding. This coefficient is significant at the 1 per cent level.

It was possible to practice enough selection for production, by using bulls from the best producing cows, to counterbalance the effect of inbreeding and to raise the genetic ability for butterfat production approximately 40 lb. during the 12 yr. studied. It appears that if a breeding plan is followed in which the increase in intensity of inbreeding is less than 2 per cent per generation, it should be possible to practice enough selection to counterbalance the decline in production expected to result from inbreeding.

Inbreeding did not result in the birth of any physically abnormal calves.

The numbers were too small and the intensity of inbreeding too low for any prediction of the effect of really intense inbreeding.

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HORMONAL DEVELOPMENT OF THE MAMMARY GLAND OF DAIRY HEIFERS

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The important activities of the secretions from the endocrine glands in the development of the mammary glands of several species have been indicated by a large body of experimental data. Recent reviews by Petersen (17), Turner (21) and Folley (2, 3) have summarized and integrated most of these studies. The predominant role of the ovarian hormones—the estrogens and progesterone—and of certain pituitary hormones has been emphasized.

In most species both estrogen and progesterone are necessary for duct and lobule-alveolar growth in intact animals. The guinea pig and possibly the monkey are exceptions in that complete mammary development can be induced by estrogen alone. In hypophysectomized animals, pituitary hormones (notably prolactin) are necessary, in addition to estrogen and progesterone, for mammary growth comparable to that developed during pregnancy.

Very few detailed studies have been conducted with the larger domestic animals. In 1941, Walker and Stanley (22) induced udder development and copious lactation in a castrate heifer by injecting steroid hormones. Subsequently, Folley and Malpress (5), Hammond, and Day (9) and Spriggs (19) on an extensive scale showed that marked udder development and copious lactation could be induced in unbred heifers by subcutaneous implantation of synthetic estrogen tablets. The copious lactation induced in many of these animals led to the obvious inference that complete mammary development had been induced by estrogen and that progesterone was not necessary for udder development in the bovine. No detailed histological examination of the udder tissues of these animals was made. Milk yield was the main criterion upon which estimates of the normality of mammary development were based.

The above studies were characterized by great variability in the gross appearance of the udder and in the lactation responses obtained, indicating that estrogen alone will not invariably induce udder development and lactation in the bovine. The lactation responses also usually were quantitatively smaller than might normally be expected. Therefore, on this basis also, it might be questioned whether completely normal udder development had taken place. The generally poor responses of freemartins (5, 9) to estrogen implants likewise would cast some doubt on the assumption that progesterone is unnecessary for complete mammary development in the bovine.

Results similar to the above have been obtained with the goat (6, 10, 14, 16). More detailed histological examination of the udder tissue was made in these

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studies. Lewis and Turner (10) noted that fairly complete lobule-alveolar development occurred in five goats after long continued treatment with diethylstilbestrol, and in three additional animals the lobules consisted of solid masses of cells. Mixner and Turner (16) noted that the alveoli that were developed by using estrogen alone were excessively large and exhibited a tendency to papillomatous folding, whereas the alveoli that were developed by using both estrogen and progesterone appeared more normal in structure. Folley (4) reported preliminary observations similar to those of Mixner and Turner (16), although Malpress (12), apparently referring to the same study (4), indicated there was no significant quantitative superiority of the alveolar tissue of animals treated with progesterone and estrogen over that of animals treated with estrogen only.

In all the studies noted above, fairly mature animals were used. In these studies, the effects of estrogen on mammary growth certainly were complicated to a variable and unknown extent by the experimental animals' own secretions. Even in the castrate studied by Walker and Stanley (22), the effects of the progesterone-like activity of adrenal-gland steroids cannot be ruled out. Such activity also may have been a factor in the mammary development noted by others in heifers (5, 9, 19), even though the ovaries in these heifers appeared to be inactive and, therefore, not producing appreciable quantities of progesterone. The extent to which the pituitary secretions of these animals participated in the response to estrogens also is unknown. Gardner and White (7) have suggested that prolactin sensitizes the mammary gland to estrogens. The secretions of the pituitary gland, either before or during treatment, therefore may have modified greatly the estrogenic effects noted in both the bovine and the goat.

Experimental work bearing on the problem of mammary developmnt in the bovine does not permit definite conclusions concerning the hormonal mechanisms which may be involved. Little or no direct experimentation with various hormone combinations, including detailed examination of the tissues involved, has been conducted with the bovine species. The present study was initiated to investigate some of these factors in dairy cattle.

PROCEDURE

Eleven Holstein heifers were used in this study. They were given injections of stilbestrol or stilbestrol plus progesterone alone and in combination with a pituitary extract, as indicated in table 1. The pituitary extract used was prepared from fresh beef anterior lobe of the pituitary gland by the method de-

TABLE 1

Treatment of experimental heifers

Group	No. of animals	Treatment
1	2	Stilbestrol
2	3	Stilbestrol plus progesterone
3	2	Stilbestrol plus pituitary extract
4	2	Stilbestrol plus progesterone plus pituitary extract
5	2	No treatment (controls)

scribed by Bergman and Turner (1) for their "initial extract." Several batches of this extract were prepared, dried, mixed and stored in the cold so that an homogeneous preparation could be used throughout the experimental period. Thirty mg. of the dried extract were injected into the animals of groups 3 and 4, three times weekly. The dried powder was dissolved in water and adjusted to pH 7.0 to 7.5 for injection purposes at weekly intervals.

Stilbestrol and progesterone were dissolved in olive oil and injected in this form. One mg. of stilbestrol was injected three times weekly in all the experimental animals until they reached 4 mo. of age. The dose of stilbestrol then was doubled and maintained at this level throughout the remainder of the experimental period. Progesterone was injected at the rate of 20 mg. three times weekly until 4 mo. of age and thereafter at the rate of 40 mg. three times weekly. The ratio of progesterone to stilbestrol injected was 20 : 1 throughout.

Injections were started when the calves were 1 mo. of age. In all instances, stilbestrol only was given for the first month and, in groups 2 to 4, inclusive, the additional hormones indicated in table 1 then were added to stilbestrol. This technique was employed in the hope that inhibition of pituitary and ovarian secretions would be produced by stilbestrol during the first month of injections and subsequently so that the observed effects on mammary growth at succeeding intervals could be related more directly to the activity of the injected hormones. When injections are started at this early age, the effects of the animals' ovarian secretions and the possible sensitizing or stimulating effects of pituitary secretions should be at a minimum, even when possible inhibition by stilbestrol is not considered.

Throughout the experiment the size of the udder was determined by palpation.[1] When the animals attained 5 mo. of age, half of the udder was removed for histological examination.[2] Injections were continued for an additional 4 mo., at which time the remaining half of the udder was removed at autopsy. Udder tissue was fixed in Bouin's fixative. Several blocks of tissues were obtained from various parts of the udder, and microtome sections were prepared from these for study after staining with hematoxylin and eosin. From these same areas larger and thicker sections were obtained and stained with Mayer's hemalum so that a somewhat detailed gross examination of gland architecture could be made.

In addition to udder tissue, the ovaries and the adrenal, thyroid and pituitary glands were obtained at autopsy and weighed. Bioassays for prolactin and gonadotrophic activity of the anterior lobe of the pituitary glands were made. Prolactin activity was determined by injecting pituitary tissue extracts intramuscularly into groups of 20 6-wk. old White Carnean squabs for 4 days. The crop glands of the pigeons were removed and weighed 96 hr. after the first injection. Results are expressed in units based on the table for conversion of crop sac weights to units as determined by Hall (8). These values may or may not be referable to international units but for comparative purposes this method of

[1] For these determinations the authors are indebted to W. W. Swett and his coworkers, C. A. Matthews and J. H. Book.

[2] The assistance of P. C. Underwood in these surgical procedures is gratefully acknowledged.

expression is adequate. Gonadotrophic activity was determined by injecting the pituitary extracts subcutaneously twice daily for 3 days into mice 21 to 28 days old. Groups of 10 mice were used for each dosage level. Uterine weights were determined 96 hr. after the first injection.

RESULTS AND DISCUSSION

Udder development, as determined by palpation, was not increased by any of the hormone treatments over that observed in the control heifers. The grades assigned to udder development of the various animals are shown in table 2. The udders of the treated heifers (groups 1–4) in general appear to be slightly underdeveloped terminally as compared to the udders of the control heifers (group 5). This difference was not evident until the heifers were 4 to 5 mo. of age, and there was sufficient variation that it may not be significant. No significant differences between the groups of the treated heifers could be detected. Udder development as determined by palpation under these experimental conditions, however, is not a good measure of the type or amount of actual mammary-gland tissue which may

TABLE 2

Palpation grades[a] of udders of treated and control heifers

Group	1		2			3		4		5	
Heifer	1	2	1	2	3	1	2	1	2	1	2
Age (*mo.*)											
1	5	4	5	5	–	6	–	5	5+	5	6
2	6+	6	7–	7–	6+	6+	7–	7	6+	7–	7–
3	7–	–	5	6+	7	5+	5	8	5+	6	4+
4	3+	6–	–	5	6+	4+	4+	–	6–	5+	4
5	3+	6	4	5–	6–	4	5	5+	6–	7–	5
6	–	–	–	–	–	3+	5+	5–	5	6	5
7	3+	–	5+	6+	–	–	–	–	–	–	–
8	4+	5–	–	–	4+	–	–	–	–	–	–
9	–	4+	4	5–	5–	4+	4	5–	6+	6+	6+

[a] The values refer to the numerical grades assigned in Swett's system of grading (20). (A grade of 5 is about average for the Beltsville herd.)

be present. The histological examinations indicated that the proportion of mammary tissue to fat was almost always greater in the treated than in the control heifers. The proportion of mammary tissue to fat also appeared to be greater at 5 mo. of age in the control heifers than it was at 9 mo.

No marked swelling of the udders with secretion occurred at any time in these heifers. Small amounts of secretion were present in the udders of all the treated heifers. The amount was small, never exceeding 100 ml., and, while it was milky in appearance, it did not appear to be milk of normal composition. Sufficient quantities for analysis were not obtained. No secretion was obtained from the control heifers.

Histological examination of the udder tissue showed that marked changes in mammary gland structure had occurred in all the treated heifers. The mammary glands of the control heifers consisted of ducts only, at both 5 and 9 mo. No alveoli were present at any stage. The treated animals, in addition to prolifera-

tion of ducts, showed considerable lobule-alveolar development. The relative amounts of duct and alveolar tissue varied, depending on the treatment and age of the animals.

Examination of the udder tissue obtained when the heifers were 5 mo. of age revealed marked differences in structure of the udders of the heifers which received steroid hormones only (stilbestrol or stilbestrol plus progesterone) as compared to those which received pituitary extract in addition to the steroid hormones. Definite alveolar development had occurred in the "steroid" heifers (groups 1 and 2) in all instances except one. With one exception, the udder tissue of the "pituitary" heifers (groups 3 and 4) consisted solely of duct tissue, although this was more extensive, as noted above, than in the control heifers. Fig. 1 illustrates typical differences observed in these two lots of animals.

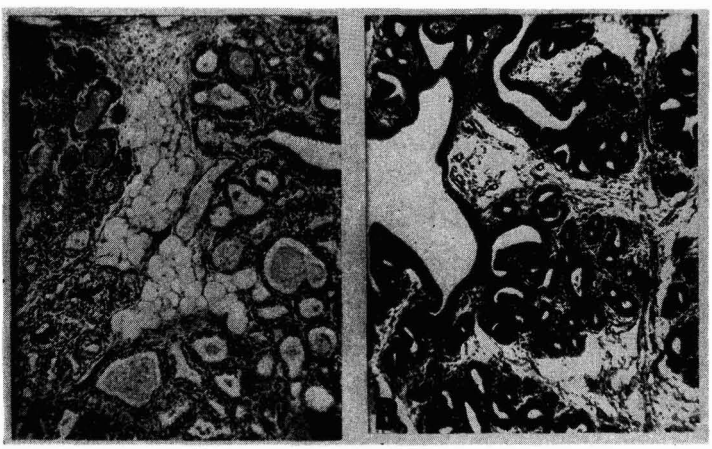

FIG. 1. Typical mammary gland structure at 5 mo. of age.

A. From heifers injected with stilbestrol or stilbestrol plus progesterone. (X375)

B. From heifers injected with stilbestrol plus pituitary extract or stilbestrol plus progesterone plus pituitary extract. (X375)

Examination of the remaining udder tissue of these same heifers at 9 mo. showed that marked changes in development had occurred between the groups as contrasted to the development seen at 5 mo. The udders of the pituitary heifers (groups 3 and 4) consisted largely of well-developed lobules with mature-appearing alveoli. Some lobules contained excessively distended alveoli. Alveoli with thickened walls and with papillae projecting into the lumina were seen in some areas. The papillae were apparently similar to those noted by Mixner and Turner (16) in goats (fig. 2). The alveolar wall appeared to consist of a single layer of elongated cells and the papillae to be a result of folding of a portion of the alveolar wall. The structure of the udders of these heifers was in distinct contrast to that seen in the same heifers at 5 mo., when duct development only was an outstanding characteristic. In the succeeding 4 mo. very rapid lobule-

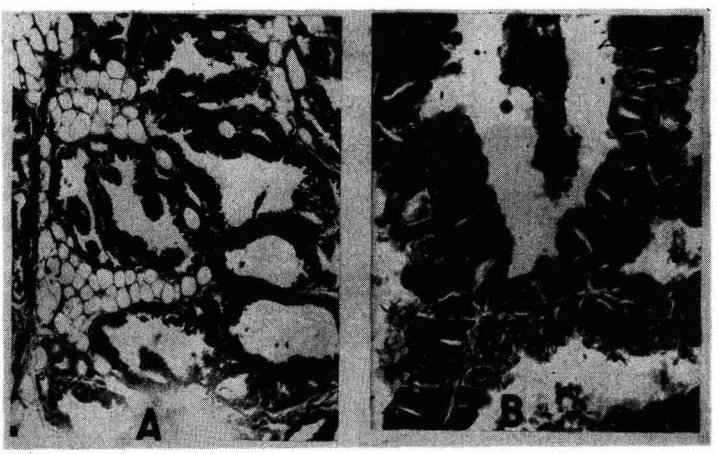

FIG. 2. Abnormal alveolar structure noted in certain areas.
A. Low power (X375) view showing thickened walls and papillomatous folding.
B. High power (X1770) showing enlongated (columnar) cells of alveolar wall.

alveolar development had taken place and, in general, it exceeded that noted in the steroid heifers (groups 1 and 2) in spite of the fact that alveolar development was evident in these at 5 mo.

At 9 mo. further alveolar development had taken place in the steroid heifers over that seen at 5 mo. One udder was developed to a point comparable to that seen in any of the pituitary heifers, and in three others mature-appearing dis-

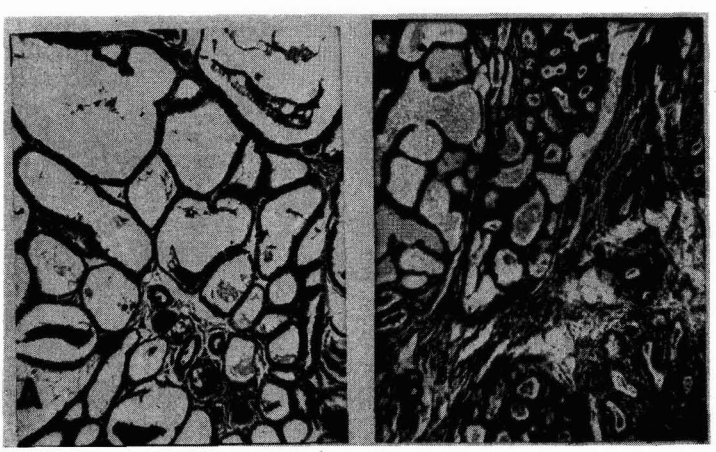

FIG. 3. Mammary gland structure at 9 mo. of age.
A. From heifers injected with stilbestrol plus pituitary extract or stilbestrol plus progesterone plus pituitary extract. (X375)
B. From heifers injected with stilbestrol or stilbestrol plus progesterone. (X375)

tended alveoli were more numerous than at 5 mo. of age, although many alveoli appeared to have advanced little beyond the terminal duct stage. The udder of one heifer in these groups at this time appeared definitely abnormal. It consisted almost entirely of solid cords of columnar cells, and the lobule formation was irregular and indistinct. Alveoli with thickened walls and papillae also were seen in the udders of these heifers but not as frequently as in the pituitary heifers. Fig. 3 illustrates the characteristic differences between the mammary structure of the steroid (groups 1 and 2) and the pituitary (groups 3 and 4) heifers as seen at 9 mo. of age.

The differences observed in structure of the glands of the steroid and pituitary heifers at the different ages are rather difficult to explain. The results obtained indicate that the pituitary extract increased the effects of the steroid hormones. The mammary glands of heifers receiving both steroid and pituitary hormones on the average appeared more nearly mature terminally, even though they were less mature earlier in development, than did the glands of heifers receiving only steroid hormones. The manner in which these effects occurred is more obscure, particularly when the differences noted at 5 and 9 mo. are considered.

It appears somewhat evident from this study that estrogen or estrogen plus progesterone will produce alveolar development at any stage, but a period of sensitization by pituitary hormones is necessary before their full effects may be realized. The occurrence of duct tissue only at 5 mo. of age in most of the heifers which received both steroids and pituitary extract would suggest that, when adequate hormonal stimuli (steroids plus pituitary hormones) are acting, the emphasis on udder development during the earlier stages is on extension and maturation of the more rudimentary duct tissue. At a later stage in development, providing that the requirements for maturation have been met, the emphasis would appear to shift to alveolar development. This is indicated by the rapid development of alveolar tissue in these heifers from 5 to 9 mo. of age. The failure of steroid hormones to produce alveolar development comparable to that produced by the combined action of steroids and pituitary extract could have been a result of inadequate sensitization or maturation of the rudimentary mammary tissues by pituitary hormones, in those cases where pituitary hormones were not injected.

A situation somewhat analogous to this can be visualized as occurring during normal development of the mammary gland of cattle. Up until the third or fourth month of pregnancy the udders of heifers consist solely of an extensive system of ducts. This rather prolonged period may be a period of extension and maturation of rudimentary tissues primarily under the influence of pituitary hormones, since the amounts of steroid hormones secreted during this interval are almost certainly very low. The rapid development of alveoli during the latter two-thirds of pregnancy could be a result of the previous maturation combined with the increased secretion of steroid hormones which occurs during pregnancy.

In the examination of udder tissue at both 5 and 9 mo. the authors have been unable to detect any effect of progesterone, either inhibitory or stimulatory, on the type or extent of development of the udder. These results are somewhat at variance with results reported by others in the goat (4, 12, 16). These results

may be due to the different estrogen-progesterone ratio used. Mixner and Turner (16) used 5 μg. of stilbestrol to 1 mg. of progesterone whereas 50 μg. of stilbestrol to 1 mg. of progesterone were used in this experiment. Mixner and Turner (15) have shown that a ratio of 25 μg. of stilbestrol to 1 mg. of progesterone is adequate for mammary development in mice. These authors also note a rather wide range of estrogen-progesterone ratios which appear optimal for mammary growth. However, the ratio used here may not be optimal for the young bovine.

The data on weights of the endocrine glands which were obtained at autopsy

TABLE 3

Endocrine gland—body weight ratios × 100,000 of experimental and control heifers

Gland	Groups				
	1	2	3	4	5 (control)
Pituitary (whole)	0.56	0.64	0.85	0.85	0.90
Ovaries	1.22	0.96	1.64	3.29	5.99
Thyroid	5.40	7.04	8.37	8.86	8.36
Adrenals	5.00	4.97	5.77	6.19	4.61

indicate that, in certain instances at least, the injected hormones produced some inhibition of secretion in both the pituitary gland and the ovaries. These data are shown in table 3. Average values for each group are presented. The pituitary and thyroid glands and the ovaries were distinctly subnormal in the heifers (groups 1 and 2) that received steroid hormones only. The adrenals were slightly but not significantly larger than those of the control heifers. The reduced size of the ovaries and the thyroid gland apparently indicates that inhibition of both

TABLE 4

Hormone content of anterior pituitary tissue of experimental and control heifers

Group	Prolactin content (Units)[a]	Gonadotrophic activity (Mouse uterine weight)[b]
1	0	.....
2	1.0	.....
3	2.0	19.6
4	2.0	24.7
5	8.0	30.1

[a] Comparative values only—25.0 mg. (wet weight) of anterior pituitary tissue injected/bird.

[b] 16.0 mg. (wet weight) of anterior lobe tissue injected/mouse. (Control uterine weight = 24.7 mg.)

gonadotrophic and thyrotrophic hormone secretion by the pituitary gland had been produced in the heifers in these two groups. A similar inhibition of pituitary secretion probably was produced in the heifers of groups 3 and 4, as indicated by the subnormal ovarian size. The increased size of the adrenals over control values, the increase in the thyroid gland to normal values and the tendency for the ovaries to be somewhat larger than in groups 1 and 2 can be accounted for by the direct stimulating effect of the trophic hormones contained in the pituitary extract given to these heifers. The reduced size of the pituitary gland in

groups 1 and 2 also might suggest inhibition of activity of this gland. The essentially normal pituitary size observed in groups 3 and 4 is somewhat anomalous, however, since it might be expected that the injection of pituitary hormones would, in itself, cause a reduction in pituitary size.

The bioassay data also indicated that inhibition of pituitary-gland secretion occurred, if it is assumed that reduced hormone content of the gland represents reduced secretion and not merely exhaustion of the gland. These data are shown in table 4.

The data on gonadotrophic activity are quite unsatisfactory. No activity was detected in the pituitary tissue of any of the injected heifers when 16.0 mg. of this tissue were injected into immature mice. Only very slight activity was seen in the tissue from the control heifers. Sufficient tissue was not available to test the activity at higher dosage levels, and in groups 1 and 2 tissue was not available for testing at the 16.0-mg. level.

However, the pituitary tissue from the injected heifers definitely contained much less prolactin than did similar tissue from the control heifers. The very low prolactin content of these injected heifers differs markedly from the effects produced in other species by estrogen injections. Turner and his coworkers (11, 13, 18) have accumulated evidence which shows that the injection of estrogen increases the prolactin content of the pituitary glands of several species. The difference in the response of cattle to estrogen, as noted in the present study, may be a result of the prolonged period of injections and possible exhaustion of the pituitary gland or it may be a true species difference.

In general, the bioassay data and the data on endocrine gland size indicated that the effects on udder development were produced under conditions of reduced secretion of endogenous hormones. This was shown most definitely for the ovarian secretions, the data for pituitary secretions being suggestive. In any case, the rudimentary mammary tissue of these very young animals had been exposed to relatively little stimulation by hormones of endogenous origin before injections were started. These observations suggest that very young heifers may prove to be more suitable experimental subjects for determining hormonal effects on udder development than the more mature animals which have been used previously.

SUMMARY AND CONCLUSIONS

Accelerated mammary-gland development has been produced in very young dairy heifers by hormone injections.

The type of development and the sequence of developmental stages produced by stilbestrol or stilbestrol and progesterone were distinctly modified by the injection of a crude extract from the pituitary gland. Pituitary hormones accentuated the effects of these steroids on udder development. The udders developed as a result of injections of both steroids and pituitary extract appeared more mature structurally than the udders of heifers injected with steroids only.

In the dosages employed in this study, progesterone had no detectable effect on udder development.

Evidence is presented to indicate that the injections of the various hormones produced an inhibition of endogenous hormone production.

It is suggested that very young dairy heifers may be particularly suitable experimental subjects for determining the effects of the several hormonal factors which appear to participate in udder development of the bovine.

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ABSTRACTS OF LITERATURE

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BOOK REVIEWS

130. Cheese. L. L. VAN SLYKE AND W. V. PRICE. Orange-Judd Publishing Co., Inc., New York, N. Y. 522 pp. $4.50. 1949.

The many persons who have used and appreciated the first edition of *Cheese* by the same authors especially will be grateful for this thoroughly revised and enlarged volume. Dr. Price has provided an excellent textbook in a field where such has been sorely needed. Although written at the college level, the style is simple and direct. It should be interesting and understandable reading for the practical cheesemaker. Cheddar cheese in its many aspects forms the body of the text but process, cottage and cream cheeses also are well covered. No attempt is made to deal with the so-called "foreign types" of cheese. Especially effective use is made of graphs, charts and line drawings. Extensive references to original literature invite the student to pursue further those aspects of the subject which particularly interest him. Excellent practical discussions on natural cheese in consumer packages and bacteriophage in cheese starters indicate the author's up to date approach. The index covers 12 double-column pages and gives evidence of careful preparation. This volume compares favorably in organization, style and selection of subject matter with our best current college text books. E. F. Goss

131. Laboratory Manual for Dairy Bacteriology. E. M. FOSTER AND W. C. FRAZIER. Burgess Publishing Co., Minneapolis, Minn. 59 pp. Mimeoprint. $1.75. 1950.

This laboratory manual is intended for use in classes that meet 30–32 laboratory periods for 2 hr. each, with intervals of 2 and 5 days. It is divided into 3 parts, the first of which deals with common microorganisms found in milk. In this part the exercises include the various groups of microorganisms with a study of representative species. The second part takes up the methods used in the control of milk quality. This includes exercises on the agar plate method and the direct microscopic count for bacteria, methylene blue, resazurin and fermentation tests and the detection of coliforms, along with tests for abnormal milk. The third part is devoted to the microbiology of dairy products, with exercises on starters, evaporated and sweetened condensed milk, butter, cheese, dried milk and ice cream.

Each exercise is followed by a series of related questions. Detail in explanation is kept to a minimum. Explanation of methods and interpretation of results are grouped together in an appendix for easy reference. W. W. Overcast

ANIMAL DISEASES

W. D. POUNDEN, SECTION EDITOR

132. Bovine mastitis. Treatment with penicillin and herd practices which aid in its control. D. F. BREAZEALE, P. L. KELLY, E. BARTLE, A. B. HOERLEIN AND G. S. HARSHFIELD. S. Dakota Agr. Expt. Sta. Bull. 392. 1949.

Treatment of bovine mastitis by penicillin infusion of infected quarters was carried out over a 2-yr. period in the dairy herd of the S. D. Agr. Expt. Station. At the beginning, 55.0% of the herd had infections in 1 or more quarters. At the end of 2 yr., infection had been reduced to 14.6% by herd management practices, treatment and culling.

Penicillin was more effective against streptococci than against staphylococci. Penicillin treatment freed the quarters of *S. agalactiae* in 70.3% of the cases. Treatment was more effective for mild cases of short duration than for well-advanced cases. Penicillin infusions were somewhat less effective for reinfections of *S. agalactiae* than were first treatments. Clinical mastitis occurred more frequently among cows kept in stanchions than among those kept in pen-barns.

J. W. Stull

133. Characteristics of some strains of streptococci in mastitis. L. A. BURKEY AND CECELIA R. BUCKNER, Bureau of Dairy Industry, Wash-

ington, 25, D. C. Soc. Am. Bact., Abs. of Papers, p. 51. May, 1949.

At least 5 species of streptococci were found in the Bureau's herds at Beltsville, Md. The percentage of quarters infected with strains of *S. agalactiae* was 10; with *S. dysgalactiae,* 5; *S. uberis,* 26; the viridans group, 8; the enterococcus group, 4; hemolytic staphylococci, 29; pseudomonads, 8; coliforms, 5; unidentified, 6. Strains of streptococci and enterococci were distinguished by their fermentations. Severity of infection, as indicated by leucocytes and percentage of chlorides in milk, was not correlated with a particular organism. Because of mixed infections involving hemolytic staphylococci and streptococci, it is suggested that there may be a natural association of the salicin-positive strain of *S. agalactiae* with the hemolytic staphylococci. However, mixed infections of these organisms were less severe than those with *S. agalactiae* alone. D. P. Glick

134. The relationship of machine milking to the incidence and severity of mastitis. E. B. Meigs, L. A. Burkey, G. P. Sanders, M. Rogosa and H. T. Converse, U. S. Dept. Agr. Tech. Bull. 992. 51 pp. Aug., 1949.

Twenty-five cows were studied using severe, routine and mild machine milking and hand milking for extended periods in 1 or 2 lactations. Presence and severity of mastitis were defined by leucocyte and *Streptococcus agalactiae* counts, and by chloride determinations on milk samples from separate quarters. Incidence of mastitis was reduced by shortening the time from approximately an average of 14–5 min./cow/milking and reducing the vacuum applied in machine milking from 16–12 in. of Hg. Even less mastitis occurred upon changing from machine to hand milking. High chloride contents were encountered in some milk of normal cows on routine or severe machine milking, even without mastitis occurring. Some mastitis cases were observed in which *S. agalactiae* was absent or in small numbers. Also, milk from some normal cows contained several thousand of this organism/ml.[3] without other evidence of udder injury. Udder injuries caused by severe milking methods decreased milk yields or caused complete loss of secretory function in individual quarters of the udder. R. B. Becker

135. Field experience with Brucella M vaccine. B. J. Killham, G. W. Reed and C. F. Clark. Mich. Agr. Expt. Sta. Quart. Bull., **32,** 2: 240–244. Nov., 1949.

Agglutination tests were made on cattle in 81 herds (77 infected with brucellosis) in 2 counties under area test and 36 herds (30 infected) in another county. Some 2,402 animals were vaccinated with *Brucella M* vaccine and subsequently re-tested. Records on 2,927 unvaccinated cattle were obtained for comparison, based on both initial and 2 retests. Though most herds were found by the initial test to be infected before vaccination, reactors and suspects were reduced about one-half on the subsequent retests, attributable to vaccination. R. B. Becker

136. Further observations on brucella infections and the role of a selective host-factor affecting variation. W. Braun and Dorothy Mead, Camp Detrick, Frederick, Md. Soc. Am. Bact., Abs. of Papers, p. 86. May, 1949.

Embryonated eggs, which are susceptible to *Brucella,* were inoculated with known mixtures of *B. abortus S* and *R* cells, or *S* and *M* cells. When the cultures were recovered from the eggs, it was observed that the establishment of non-smooth types had been suppressed. On the other hand, studies with chicken sera had indicated that the selective effect is lacking in adult chickens, which are relatively insusceptible to *Brucella* infections. Earlier *in vitro* tests showed that the selective serum factor disappears after infection. This was supported by experiments with guinea pigs which were inoculated with *B. suis* containing a small percentage of a non-smooth type. When animals were sacrificed at different periods after infection, a progressive establishment of the non-smooth type was observed in cultures from spleen and lymph nodes. D. P. Glick

137. Some considerations on the eradication of bovine tuberculosis. G. Fluckiger, Berne, Switzerland. British Vet. J., **105,** 11: 401–414. Nov., 1949.

The first steps for a systematic program for combating this disease in Switzerland was started in 1934. By 1948, 1/5th of all the national herd was under official control. Extensive areas are now practically free from bovine tuberculosis. Some of the problems encountered were economic rather than scientific. The various methods of combating the disease in Switzerland are discussed. It was pointed out that the eradication of the disease is easy where the incidence is low and very difficult where it is high. At the present time approximately 20% of the cattle in Switzerland show tuberculosis lesions.

B. B. Morgan

Also see abs. no. 162, 163, 211.

BUTTER

O. F. HUNZIKER, SECTION EDITOR

138. Character of Ontario butter. F. W. Hamilton, A. G. Leggatt and W. H. Sproule. Can. Dairy Ice Cream J., **28,** 12: 44–57. Dec., 1949.

A study was made of the character of Ontario butter based upon analyses of samples submitted over the past 4 yr. to the Dairy Dept. of the Ontario Agricultural College. Of the cream received during the summer season, 74.8% had an acidity ranging from 0.41%–0.6%. After neutralization most of the cream had an acidity of 0.15%–0.20%. The pH of the butter serum recognized for best keeping quality is pH 6.6–7.2; 56.8% of Ontario butter in 1946 fell within this range. By 1949, 61.9% of the total churnings fell within the desired pH range. The results indicate a lack of uniformity in salt control. Moisture content appears to be well controlled. A large proportion of the butter scoring 1st grade into storage dropped to 2nd grade during the storage period of 10 mo. Flavor defects encountered most frequently were stale, unclean neutralizer and metallic. Improvement could be made on yeast and mold content on some of the butter. H. Pyenson

139. Aluminum foil vs. parchment for wrapping print butter. A. H. WHITE. Can. Dairy Ice Cream J., **28,** 9: 27–29, 80. Sept., 1949.

Aluminum foil wraps were compared with parchment for packaging print butter for storage at 10° F. and 28°–30° F. for periods ranging from 15–37 wk. Butter put up in foil wraps prevented flavor deterioration at the surface of the prints and the butter maintained first grade quality. The surfaces of the butter wrapped in parchment deteriorated enough in flavor to put the butter in second grade. At 10° F., loss of weight was slightly less and more uniform color was maintained with foil wrap than with parchment. At 28–30° F. with high humidity, butter in both wraps maintained good color, and the loss in weight was less for the parchment-wrapped prints than for prints in foil. The results indicate the possibility of storing high quality print butter in aluminum foil at cold storage temperatures for periods up to 37 wk. without loss of grade. H. Pyenson

140. Use of milk fat fractions in baked products. LURA M. MORSE AND E. L. JACK, Univ. of Cal., Davis. Food Research, **14,** 4: 320–324. July-Aug., 1949.

Studies were made, of the use in baked products, of 2 fractions of milk fat, 1 precipitated from solvent at −20° C., the other at −53° C. The higher solidifying fraction was more suitable as a shortening in cake than the lower solidifying fraction. In pastries the 2 fractions reversed their roles and the −20° fraction was not suitable for the ice water method, whereas the −53° fraction could be used successfully if chilled to 7.8° C. F. J. Doan

CHEESE

A. C. DAHLBERG, SECTION EDITOR

141. Milk pasteurization for cheese making. N. S. GOLDING AND I. ERICKSEN. Can. Dairy Ice Cream J., **28,** 9: 68–74. Sept., 1949.

Four organisms which had been found to survive pasteurization and grow in milk were added to the cheesemilk before pasteurization. With the exception of 1 culture, these organisms greatly increased the count of the pasteurized milk. During the cheese making procedure, all of the organisms except one showed a rapid multiplication in the cheesemilk. The addition of the cultures to the cheesemilk did not change significantly the gas production in the cheese. Two of the cultures slightly decreased the quality of the cheese below that of the control cheese at low ripening temperatures. It is questionable whether the slight differences in quality of the cheese could be attributed to the cultures used. H. Pyenson

142. Effect of added micrococci on flavor development in Cheddar cheese from pasteurized milk. J. A. ALFORD AND W. C. FRAZIER, Univ. of Wisconsin, Madison. Soc. Am. Bact., Abs. of Papers, p. 53. May, 1949.

Selected strains of micrococci were isolated from young, raw milk cheese. A 1–3% inoculum of *Micrococcus* sp. was added with lactic starter to pasteurized milk cheeses. The cheeses were ground after 2–4 wk. to hasten development of flavor. Two strains of *Micrococcus* produced an enhanced flavor development, compared with control lots. Both strains developed rapidly during manufacture and pressing and reached maximum count by the 2nd d. One strain decreased rapidly after the 3rd-4th d. and disappeared almost completely in 2–4 wk. The other strain died very slowly. Continued viability may not be essential to flavor development. There was no relation to increases in water soluble nitrogen and total volatile acidity. D. P. Glick

143. The use of a semi-automatic moisture tester for cheese and cheese products. F. V. KOSIKOWSKY, A. C. DAHLBERG AND B. L. HERRINGTON, Cornell Univ., Ithaca, N. Y. Food Tech., **3,** 9: 320–322. 1949.

The operation of the Brabender semi-automatic moisture tester is described. Only 1 outside weighing is required with this moisture tester, the final weighing being conducted while the pans

are in the oven. The temperature of the oven is controlled by an electrical contact thermoregulator adjustable from 45°–160° C.

Rates of drying curves obtained on American cheddar cheese, mild process cheese food and sharp process cheddar cheese are shown. For American cheddar cheese, a temperature of 135° C. for 45 min. gave the most accurate results. Age and moisture level of the cheese had some effect upon the final moisture percentage, but the variations were not very significant. For mild process cheese food and aged process cheddar, a temperature of 140° C. for 1 hr. was required. A full oven of 10 pans did not give the same results on the same cheese as an oven that contained only 2 pans. E. R. Garrison

144. Microbiological determination of free amino acids in cheese during the curing period. D. G. REIHARD AND J. C. GAREY, Pennsylvania State College, State College. Soc. Am. Bact., Abs. of Papers, p. 52. May, 1949.

To obtain complete extraction of free amino acids, cheese was dried *in vacuo,* fat removed by ether extraction in the Soxhlet apparatus and the lipid-free cheese then was subjected to 4 successive extractions with boiling water. Each water extraction was followed by centrifugation. The 4 samples of supernatant fluid were combined for assay. The free amino acid content of American cheese did not change during manufacture but significant increases developed thereafter. Cheese after pressing was used as reference. After 2 wk., leucine and isoleucine increased 2-fold and glutamic acid increased 5-fold. At 12 wk. there was a 2-fold increase in threonine, methionine and lysine; 4-fold increase in leucine and isoleucine; 3-fold increase of valine and 7-fold increase of glutamic acid. Free tyrosine, tryptophane and histidine were found but without significant increases in content. Free amino acids of cheese made from raw milk increased more rapidly than in cheese made from pasteurized milk. Similar data on Trappist cheese were found.

D. P. Glick

145. Enriched cottage cheese. Anonymous. Milk Dealer, **38,** 11: 45, 106. Aug., 1949.

A number of milk dealers are now marketing an enriched cottage cheese which contains not only vitamin D, to make a rich source of Ca and P available to the consumer, but also vitamin A to increase its nutritional value. Fortification now opens new sales possibilities for this product.

C. J. Babcock

Also see abs. no. 130, 151, 152, 153, 154, 156, 157.

CONDENSED AND DRIED MILKS; BY-PRODUCTS

F. J. DOAN, SECTION EDITOR

146. The body of cultured cream. E. S. GUTHRIE. Can. Dairy Ice Cream J., **28,** 9: 34–35. Sept., 1949.

The firmness and the viscosity of cultured cream can be controlled largely by proper homogenization and pasteurization of the original cream. A temperature of 165° F. for 30 min. and homogenization at 3000 lb./in.^{2} pressure or rehomogenization at the same pressure and temperature gives a firm dry desirable body. Firmness of the cultured cream is evaluated with a plummet described by Hilker (J. Dairy Sci., Mar., 1947).

H. Pyenson

147. Consumer reaction to bottled fresh concentrated milk. G. M. TROUT AND G. G. QUACKENBUSH, Mich. Agr. Expt. Sta. Sou. Dairy Prod. J., **46,** 5: 68–69, 74–75. Nov., 1949.

Consumer reaction on bottled fresh concentrated milk in the ration of 2: 1 and 3: 1, homogenized and pasteurized was obtained.

In spite of low forewarming temperatures, cooked flavor predominated in the reconstituted product. Homogenization pressures of 2,000–2,500 lb. were adequate to maintain satisfactory homogeneity. The type of water used affected the flavor of the reconstituted milk, but this was not believed to be a serious factor. The noticeable cooked flavor was not objectionable to the majority of the consumers. Most of the consumers were interested in saving refrigerator space by using the concentrated product, but not interested in buying it unless they could save 2 or 3¢/qt. of milk equivalent. The majority of customers believed that the product had commercial possibilities. F. W. Bennett

Also see abs. no. 140, 150, 215, 218.

DAIRY BACTERIOLOGY

P. R. ELLIKER, SECTION EDITOR

148. An analysis of several stains used and proposed for the direct microscopic enumeration of the bacteria in milk. M. BRANDSTEIN AND J. O. MUNDT, Univ., of Tenn., Knoxville. Food Tech., **3,** 10: 324–326. 1949.

Direct microscopic bacterial counts were made on the dried smears prepared from 61 producer milk samples and stained by 6 staining procedures. The counts obtained by each staining method were compared statistically to determine maximum numbers and deviations. Twelve characteristics desired in a good stain were listed and the 6

stains were evaluated thereby. According to this method of evaluation North's stain received a total of 65 out of a possible 72 points in scoring. The points scored by the other stains used in this study were as follows: Breed 45, Broadhurst-Paley 42, Mandel 40, Watrous-Doan 37 and Gray 22.
E. R. Garrison

149. An improved microscopic method of examining fatty foods. T. H. LORD AND MARGARET M. SMALL, Kansas State College, Manhattan. Food Research, **14,** 3: 241–242. May-June, 1949.

The use of a surface active agent (Tide) in the preparation of a fatty food (oleomargarine) for microscopic examination to observe number and type of microorganisms was found to give greatly superior results to those obtained with Fay's method originally proposed for butter. The suggested technique results in vastly greater homogeneity in the appearance of the slide and in the prevention of clumping of bacterial cells.
F. J. Doan

150. Comparison of methods of reconstituting milk powder for the plate count with an anlaysis of variance. F. J. CONE, AND U. S. ASHWORTH, State College of Washington, Pullman. Food Research, **14,** 2: 165–176. Mar.-Apr., 1949.

In this study, wherein spray powders only were used and the results subjected to statistical analysis, reconstitution with water at 45, 50 or 55° C. gave much higher bacteria counts (plate) than when water at room temperature was employed. The use of mechanical shaking, with and without beads, for periods of 2, 5 and 15 min., when the powders were reconstituted with water at room temperature, resulted in no significant increase in count.

Alkaline water had no measurable effect in increasing the dispersion of bacterial cells as far as could be judged from the counts, but LiOH (N/10) actually lowered the number of colonies developing on the plates.

Water at 50° C. and quarter-strength Ringer's solution (50° C.) as the reconstituting medium gave closely agreeing results, while solutions of dilute Na citrate and Na_2HPO_4 appeared to interfere with the so-called "heat activation" of the cells.
F. J. Doan

151. Inhibition of lactic organisms by cheese starter cultures. L. E. BARIBO AND E. M. FOSTER, Univ. of Wisconsin, Madison. Soc. Am. Bact., Abs. of Papers, p. 52. May, 1949.

Lactobacillus casei was inhibited when grown in milk with *Streptococcus lactis.* Inhibition was not due to acid production nor to competition for food. Growth of *L. casei* was inhibited when heat-killed cultures of lactic streptococci were added. After 4–5 d. the effect was overcome. Three commerical cheese starters inhibited *L. casei.* Inhibition was demonstrated in whey samples from a Cheddar cheese vat and in curd after removal from the press. The inhibitory factor was heat-stable at acid reaction but was labile in the presence of alkali.
D. P. Glick

152. Penicillin in milk. A hazard to starters, buttermilk and cottage cheese manufacture. W. A. KRIENKE, Florida Agr. Expt. Sta., Gainesville. Milk Dealer, **39,** 2: 126–129. Nov., 1949; also Southern Dairy Prod. J., **46,** 6: 32, 38. Dec., 1949.

Milk containing as little as 0.10 I.U. of penicillin/ml. of milk developed 0.46% titratable acidity, as compared with the non-penicillin control of 0.75% titratable acidity, when incubated at 68–70° F. for 16 hr.; after 24 hr. the values were 0.59 and 0.80%, respectively. When 1.0, 0.50 and 0.25 I.U.'s of penicillin were present in the cultured milk, the acidity developed to 0.26, 0.25 and 0.27%, respectively, during a 16-hr. incubation period.

Regardless of the heat treatment given the milk containing 1 I.U. of penicillin/ml. of milk, 143° F. for 30 min., 190° F. for 60 min., 10 lb. steam pressure in an autoclave for 15 min., or 15 lb. steam pressure for 15 min. followed by temperature adjustment to 70° F. and subsequent inoculation with 1% of culture, the titratable acidity did not exceed 0.24% within 18 hr. when incubated at 68–70° F.

Penicillin in milk from cows treated for mastitis is a hazard to starters, buttermilk and cottage cheese.
C. J. Babcock

153. Penicillin and cheese making. E. G. HOOD AND H. KATZNELSON. Can. Dairy Ice Cream J., **28,** 10: 27. Oct., 1949.

Penicillin in cheese factory milk and milk used for starter making may present a major problem as the use of penicillin in the treatment of mastitis becomes more extensive. Penicillin in starter milk is not completely inactivated at temperatures as high as 185°–190° F. Therefore, care should be exercised in milk selection and only milk from healthy animals should be used.
H. Pyenson

154. Penicillin in relation to lactic acid streptococci in starter cultures used in Cheddar cheesemaking. H. KATZNELSON AND E. G. HOOD, Dept. of Agr., Science Service, Ottawa, Canada. Soc. Am. Bact., Abs. of Papers, p. 53. May, 1949.

Penicillin, 50–100 units/100 ml. or pasteurized milk, completely inhibited acid production by a mixed or a single strain starter culture. Partial

inhibition was obtained with 0.5–5.0 units. Neither pasteurization nor cysteine inactivated penicillin. Penicillinase, 0.02 mg./100 ml. milk, overcame the effect of 5–10 units of penicillin and permitted acid production in the presence of 100 units. Of 44 strains of streptococci tested in whey broth and in skim milk, all were more sensitive in whey broth, most being inhibited completely at a dilution of 1: 16–1: 32 million. Some were inhibited at 1: 128 and 1:256 million. In skim milk, all strains were inhibited by dilutions ranging from 1: 4–1: 16 million and most by 1: 8 million. Using graded amounts of penicillin in milk, increased resistance of starter cultures could be developed. Four out of 6 commercial starters gave normal coagulation of 100 ml. milk in 24 hr. at 18° C. in the presence of 13 units of penicillin. D. P. Glick

155. The effect of quaternary ammonium compounds on lactic starter cultures. F. W. Barber, H. P. Hodes and Anna M. Dunne, National Dairy Research Labs., Inc., Oakdale, N. Y. Soc. Am. Bact., Abs. of Papers, p. 56. May, 1949.

Milks containing various concentrations of quaternary ammonium compounds and cleaner-sanitizer compounds were inoculated with a 3% inoculum of an 18-hr. culture of *Streptococcus lactis*. In concentrations up to 10 p.p.m. of active ingredient, development was normal after 18 hr. incubation. Acid production decreased and chaining of cells increased at concentrations of 25–50 p.p.m. Concentrations of 100 p.p.m. inhibited growth and acid production. D. P. Glick

156. Factors affecting the quantitative measurement of Streptococcus lactis bacteriophage. W. B. Cherry and D. W. Watson, Univ. of Wisconsin, Madison. Soc. Am. Bact., Abs. of Papers, p. 22. May, 1949.

Two methods of measuring *Streptococcus lactis* virus, plaque count and lytic activity, have errors not to exceed 13%. Both are subject to variations unless pH, age, activity of cell suspensions and composition of medium are controlled rigidly. Initial pH of medium used is 7.0; if pH drops below 5.0, lysis does not occur. Buffering with phosphates prevents virus adsorption. Best results have been obtained using cells 3–5 hr. old resuspended in normal saline. By such standardization, 1-step growth curves can be used to define virus growth characteristics. D. P. Glick

157. Proliferation of bacteriophage on Streptococcus lactis. F. E. Nelson and C. E. Parmelee, Iowa Agr. Expt. Sta., Ames. Soc. Am. Bact., Abs. of Papers, p. 22. May, 1949.

Changes in bacteriophage and *S. lactis* populations in milk incubated between 21 and 39° C. were followed for such periods of time as to obtain mass lysis of susceptible cells. Bacteriophage particles were counted by plaque procedures in which variations in technique had been adjusted to give maximum counts of the 5 different bacteriophage strains used. Changes in pH were followed. Bacteriophage proliferates at a greater relative rate than that of sensitive *S. lactis* at temperatures favorable to bacteriophage. Optimum temperature for multiplication of both was 32° C. One bacteriophage failed to multiply at 35, another at 37 and a third at 38.5° C., although the homologous bacterium multiplied in each case.

At favorable temperatures, each bacteriophage proliferation curve showed a lag phase, log growth phase and a maximum stationary phase. The maximum level was approximately 10^9 bacteriophage particles/ml. of culture in most cases, irrespective of strain, host organism and some variation in temperature. Acid production of bacteriophage-infected cultures stopped by the time mass lysis occurred, or earlier. Different cultures gave counts from 0–10,000 secondary organisms/ml. at the time of mass lysis, variations depending upon the combination of bacteriophage and bacterium used. D. P. Glick

158. Antigenic interrelationships among certain bacteria of the lactobacillus group. F. J. Orland, Univ. of Chicago. Soc. Am. Bact., Abs. of Papers, p. 76. May, 1949.

Some 200 strains of lactobacilli were collected or isolated and observed for antigenic characteristics by means of agglutination tests and by agglutinin absorption. The antigen *F* was easily detectable in certain strains of *L. casei, L. delbrueckii, L. bulgaricus, L. helveticus* and *L. acidophilus,* and in a few strains from human saliva of individuals with carious teeth. The *F* antigen was associated with the ability to ferment both rhamnose and sorbose. Antigens *G* and *H* were found in a strain of *L. plantarum* and of *L. casei,* respectively, neither of which contained *F antigen* nor fermented rhamnose or sorbose. Agglutinin absorption indicates that the antigenic components are separate entities. D. P. Glick

159. Studies on cellulolytic bacteria in the bovine rumen. R. E. Hungate, Washington State College, Pullman. Soc. Am. Bact., Abs. of Papers, p. 61. May, 1949.

Freshly isolated strains of rods and colorless and yellow cocci were studied. Subculturing in liquid media is conducive to cellulolysis. Rumen fluid is essential to growth of the rods and the colorless cocci and cannot be replaced by any substrates tested. The nutritive value of rumen fluid is due

to associated microorganisms. The rods ferment cellulose, cellobiose, glucose, starch, dextrin, maltose and trehalose. The colorless cocci ferment only cellulose and cellobiose. The rods produce no copper-reducing materials in old cultures containing excess cellulose and the colorless cocci produce only small amounts. The yellow cocci produce cellobiose and small amounts of glucose. Yellow cocci fermentation products are H_2, CO_2 ethyl alcohol, acetic acid and lactic acid, lactic acid being the most important quantitatively. The colorless cocci produce the same substances and formic acid. Only acetic and succinic acids have been identified as fermentation products of the rods. D. P. Glick

160. Salt tolerance of the coliform bacteria. O. FODA AND R. VAUGHN, Univ. of Cal., Berkeley. Soc. Am. Bact., Abs. of Papers, p. 54.. May, 1949.

Salt-tolerant coliforms were isolated by enriching cucumber and olive brines in nutrient glucose broth containing 10% salt. An unusual type of *Aerobacter aerogenes* was identified. The isolates grew in the presence of more than 13% NaCl after adaptation. These will tolerate 10.5 to 11% salt without adaptation and acquired tolerance is lost only after 8 or more transfers in a salt-free environment. Typical coliforms can tolerate about 9.5% salt only after a 6-mo. period of adaptation and this is lost after 1 transfer in a NaCl-free medium. Without adaptation, the tolerance of typical coliforms is 6.5–7.5% salt. D. P. Glick

161. The oxidation of amino acids by brucellae. P. GERHARDT AND J. B. WILSON, Univ. of Wisconsin, Madison, Soc. Am. Bact., Abs. of Papers, p. 40. May, 1949.

Strain 19 was used with Warburg manometric techniques. Of 25 compounds, only L-glutamic acid, L-asparagine and DL-alpha-alanine were oxidized at an appreciable rate; this was accompanied by deamination and decarboxylation. L-glutamic acid was oxidized at a rate greater than glucose or any other compound tested; L-asparagine and DL-alanine were oxidized at lesser rates. The system was specific for L-isomers in the case of glutamic acid and asparagine. Both L- and D-forms of alanine were utilized at approximately the same rate. Oxidative specificity of the organism for glutamic acid, asparagine or alanine may be correlated with utilization of amino acids as the sole nitrogen source in chemically defined media. D. P. Glick

162. Dissociated growth phases of brucella and their properties. I. F. HUDDLESON, Michigan State College, East Lansing. Soc. Am. Bact., Abs. of Papers, p. 11. May, 1949.

A small colony phase (0.1 mm or less) has been obtained from *Brucella abortus* which has the characteristics of the S Phase, but always dissociates into a large colony I phase. Five mucoid phases have been obtained from *Br. suis*; each has a different dissociation pattern. Three different mucoid phases and an SL phase have been obtained from *Br. melitensis*. All mucoid phases but one fail to produce progressive disease in experimental animals. Two suis mucoid phases are highly immunogenic. D. P. Glick

163. Sensitivity changes of Actinomyces bovis to penicillin and streptomycin. A. BOAND AND M. NOVAK, Univ. of Illinois Medical School, Chicago. Soc. Am. Bact., Abs. of Papers, p. 76. May, 1949.

Six strains of *Actinomyces bovis*, 4 from human cases and 2 of bovine origin, were tested to determine whether *A. bovis* would become antibiotic-resistant during prolonged contact *in vitro*. The desired concentration of antibiotic was incorporated in thioglycollate medium. Penicillin sensitivities differed somewhat but all were inhibited by 0.5 unit/ml. Streptomycin inhibited the 6 strains at 30 units/ml.; slight growth occurred at 20 units. Only slight tolerance to penicillin was developed by 4 of the 6 strains during the 1st 16 transfers; this tolerance was not increased after 32 transfers over 3 mo. All strains rapidly developed a high degree of resistance to streptomycin, growing in 5,000 units/ml. on the 10th transfer. Five strains retained full resistance after 54 transfers in streptomycin-free medium; 1 returned to its original sensitivity after 45 transfers. Development of resistance and reversion occurred in a step-wise manner, suggesting the possibility of genetic changes. D. P. Glick

164. Germination of anaerobic spores induced by sublethal heating. H. REYNOLDS AND H. LICHTENSTEIN, Bur. of Human Nutrition and Home Economics, U.S.D.A., Washington, D. C. Soc. Am. Bact., Abs. of Papers, p. 9. May, 1949.

Portions of a suspension of Cameron's putrefactive anaerobe (P.A. 3679), consisting of spores and vegetative cells, were sealed in Pyrex thermal death time tubes, heated at 104° C. and samples removed at intervals for making survivor counts. Instead of a sharp initial drop in numbers, the apparent viable counts increased from 2.5×10^6 to 16.5×10^6/ml. during the first 16 min. of heating. Continued heating resulted in lower counts. In subsequent tests, apparent viable counts were increased from 3–10 fold by heating at 100° C. for 20 min.

It is suggested that heat treatments required for activation may be directly related to natural heat resistance. A strain of *Clostridium botulinun* less than half as resistant as P.A. 3679 at 120° C. was activated when heated for 20 min. at 70, 80 or 90° C. but counts were decreased by heating at 100° C. Modification of the counting medium did not substitute for heat activation.

D. P. Glick

165. The simplification and standardization of microbiological assays in the control laboratory. Beryl F. Capps and N. L. Hobbs, R. P. Scherer Corp., Gelatin Products Div., Detroit, Mich. Soc. Am. Bact., Abs. of Papers, p. 8. May, 1949.

Microbiological vitamin assay methods have been simplified by adopting a basic dilution pattern common to all assays. Working dilution, basal medium and test organism are the only variables. Commercial, dehydrated media are used to prepare basal media. Aluminum caps are used to replace cotton plugs. Sterilization time has been reduced to 3 min. at 121–123° C. This reduces caramelization so that turbidimetric evaluation is more satisfactory. Turbidimetry following 18–20 hr. incubation is preferred to the 72-hr. titrimetric method. D. P. Glick

166. Accuracy and sensitivity of fermentation tests. H. D. Vera, Baltimore Biological Lab., Baltimore, Md. Soc. Am. Bact., Abs. of Papers, p. 6. May, 1949.

Many late and variable fermentation reactions may be attributed to the presence of fermentable carbohydrates in the peptones used in the media. Fifteen cultures were used to test 300 samples of 23 peptones. Gelatin peptones were negative. Casein peptones (2%) were positive, as were all other peptones examined. Incorporation of meat extract into otherwise carbohydrate-free substrate gave 33% positive results. In addition to the use of substrates tested for freedom from fermentable materials, an indicator changing color at about pH 7.0 is recommended. D. P. Glick

167. Methods for determining the ability of yeasts to metabolize nitrate and nitrite. L. J. Wickerham, K. A. Burton and R. J. Gill, Northern Regional Research Lab., Peoria. Soc. Am. Bact., Abs. of Papers, p. 7. May, 1949.

Errors in nitrate reduction and assimilation tests have led to conflicting statements concerning yeast taxonomy. False negatives may be obtained with yeasts which metabolize nitrite as rapidly as it is produced from nitrate. This may be corrected by inoculating 4 tubes of nitrate medium and testing after 2, 4, 8 and 12 d. One or more of the cultures will give a positive nitrite test.

The assimilation test, properly used, gives fewer doubtful reactions. Common errors and means of their elimination are: (1) Impurities which serve as sources of nitrogen for growth. Use liquid medium containing no unwashed agar. (2) Addition of vitamin carriers, such as yeast extract, may add sufficient nitrogen to give a false positive test. The use of pure vitamins eliminates this source of error. (3) Incubation period may be too short. Some yeasts assimilate nitrogen strongly only after a period of adaptation.

Some yeasts assimilate nitrite but are without action on nitrate. Thus *Debaromyces* may have a role in the spoilage of brined or cured meats.

D. P. Glick

168. Bacteria—friend and foe. N. E. Lazarus, Lazarus Laboratories, Inc., Buffalo, N. Y. Milk Dealer, **39,** 3: 53–60. Dec., 1949.

This is a review of the early history of bacteriology followed by a discussion of bacteria and methods of studying their characteristics and actions.

C. J. Babcock

Also see abs. no. 133, 141, 142, 144, 224, 240, 245, 246.

DAIRY CHEMISTRY

H. H. SOMMER, SECTION EDITOR

169. Variations in the compositional quality of milk. G. A. Richardson. Can. Dairy Ice Cream J., **28,** 10: 36–37. Oct., 1949.

The relationship between the fat and non-fat solids of milk are entirely irrational and do not conform to the chemical analyses of thousands of samples of genuine milks. The wide variation in the standards recognizes the great variation in the solids of natural milk. In 1 study in New York involving 200,000 samples of genuine milk, average values for fat and non-fat solids were plotted and the conclusions were drawn that no single simple equation could be established to express the relationship over the entire range of fat values. In a study in Boston, a straight-line relationship between the fat and solids-not-fat was established. The equation representing this relationship is: $S.N.F.\% = 0.4F + 7.07$. Most equations are not accurate for all milks. A table is given showing the composition of milk in relation to fat content that the author feels is fairly accurate. H. Pyenson

170. Method of purifying lactalbumin. W. E. Truce. (Assignor to Swift and Co.) U. S. Patent 2,494,148. 6 claims. Jan. 10, 1950. Official Gaz. U. S. Pat. Office, **630,** 2: 493. 1950.

To facilitate the removal of lactose and minerals from lactalbumin, the usual gel formation found when this material is ppted. from whey, the moist albumin curds separated by heat from whey are heated for about 5 min. at about 100° C. The process is discontinued before the lactalbumin is hydrolyzed. After the destabilizing step, the product is washed, dispersed and dried.
R. Whitaker

171. Hydrolysis of casein. J. A. REYNIERS. (Assignor to Amino Acids, Inc.) U. S. Patent 2,493,777. 2 claims. Jan. 10, 1950. Official Gaz. U. S. Pat. Office, **630,** 2: 398. 1950.

A highly nutritional water soluble hydrolysate is made by ppting. casein from fresh skim milk in a fine flocculent condition by an acid at a temperature of 20° C. or below, then dissolving the casein in an acid and heating the solution to hydrolyze the protein to a point between peptones and amino acids and finally neutralizing, removing the resultant salt and drying to a powder.
R. Whitaker

172. Vitamin A in milk. Microestimation with activated 1,3-dichloro-2-propanol. A. E. SOBEL AND A. A. ROSENBERG, Jewish Hospital of Brooklyn, Brooklyn, N. Y. Anal. Chem., **21,** 12: 1540–1543. Dec., 1949.

Activated 1,3-dichloro-2-propanol was used as a colorimetric reagent in the determination of vitamin A and carotene in samples of human milk as small as 0.25–1.0 ml. Application of this reaction in place of the usual Carr-Price reaction has several advantages. The color was stable for 8 min., the reagent was non-corrosive, the reagent was not affected by extreme humidity and the use of specially purified chloroform and petroleum ether was not required. Results were close to those obtained when vitamin A was determined by antimony trichloride and carotene by light absorption at 440 mu. B. H. Webb

173. Butterfat in ice cream. A. H. WHITE. Can. Dairy Ice Cream J., **28,** 11: 45–49. Nov., 1949.

The perchloric-acetic acid butterfat test for ice cream appeared to be of sufficient merit to warrant further investigation on various types of ice cream. This author has verified some of the results obtained by the original authors of the test. The new test is rapid, gives clear fat columns and readings that are in close agreement with those by the Mojonnier method for most types of ice creams. The straining of fruits, nuts, etc. from ice cream gives more accurate results. Some chocolate ice creams give low inaccurate results due to a formation of a plug of cocoa in the neck of the bottle, causing a mechanical obstruction to the rising of the fat. The test cannot be applied to ice cream or mixes which contain even a few drops of formalin as a preservative. The cost per test by the perchloric acid method is more than for the H_2SO_4 notification but the saving in time compensates somewhat for the increased cost. H. Pyenson

Also see abs. no. 143.

DAIRY ENGINEERING

A. W. FARRALL, SECTION EDITOR

174. Studies on the H.T.S.T. pasteurizer. W. K. JORDAN AND R. F. HOLLAND. Can. Dairy Ice Cream J., **28,** 9: 33. Sept., 1949.

Tests have been conducted to determine the effects of the size of pipe used in the holding tube, the velocity of flow through it, the slope of the tube, the percentage of air in the tube and the suction pressure at the pump inlet. The results indicate that increasing the vacuum at the pump inlet decreases the discharge from the pump and with a given initial vacuum pressure, the discharge diminishes as the amount of air leaking into the pump inlet increases. The actual velocity of the liquid is greater when both air and liquid are flowing through the holding tube than when the same quantity of liquid is flowing through the tube with no air present. The flow in the tube is not affected by changes in the slope when the tube is filled completely with liquid. When air is present, the velocity at which the air bubbles move through the tube increases with the slope. In the region of turbulent flow, the holding tube efficiency increases slightly as the average velocity of the flow increases. The presence of air in the holding tube results in a decrease in the efficiency. The efficiency is reduced by about 3–5% with 5% of air in the tube.
H. Pyenson

175. Milk cooler having automatic control means. C. H. KAFER AND H. D. WHITE. (Assignors to Revco, Inc.) U. S. Patent 2,494,512. 12 claims. Jan. 10, 1950. Official Gaz. U. S. Pat. Office, **630,** 2: 588. 1950.

A cabinet contains water maintained at a definite level by means of a standpipe and refrigerated by means of a coil in which a cooled compressed gas is allowed to expand. A pump circulates the water around the coils. R. Whitaker

176. Food and cream freezer. D. L. CALMES. U. S. Patent 2,491,952. 1 claim. Dec., 20, 1949. Official Gaz. U. S. Pat. Office, **629,** 3: 783. 1949.

A vertical cylindrical ice cream and other food

freezer has a central shaft which rotates a series of short blades against the outer wall. Between the shaft and each blade, a flat inclined plate causes agitation. The vessel is enclosed in a larger chamber in which a refrigerant is placed.
R. Whitaker

177. Air vent. F. DURAN. U. S. Patent 2,493,-861. 3 claims. Jan. 10, 1950. Official Gaz. U. S. Pat. Office, **630,** 2: 419. 1950.

To relieve any pressure which may develop in a covered milk can, the cover is provided with a protected vent which is located entirely within the cover. R. Whitaker

178. Glass sanitary piping in dairy plants. E. THOM. Milk Dealer, **39,** 1: 42–43, 134–138. Oct., 1949.

Commercial use of pyrex heat resilient glass piping is expanding rapidly and proving a time and labor saver in the dairy plant. Since 1941 some 20 installations have been made in dairy plants. These installations have been primarily for the movement of raw milk, since those lines are generally the longest, and, therefore, the most difficult to clean. Complete recommendations are given for installing, cleaning and sterilizing glass pipe lines. C. J. Babcock

179. Proper lighting in the dairy plant. H. L. MITTEN, JR., Ohio State Univ., Columbus. Milk Dealer, **39,** 2: 48–49. Nov., 1949, *ibid.,* **39,** 3: 50–51, 74–76. Dec., 1949.

The benefits of proper illumination are better workmanship, increased production, improved housekeeping, less breakage, better utilization of floor space and fewer accidents. A table is presented showing the recommended minimum standards of illumination for the fluid milk industry. The distribution of light from windows is poor, since the intensity is great near windows and inadequate near the opposite wall. A chart is presented showing that when the illumination 4 ft. from a window is over 20 ft. candles it is approximately 2 ft. candles 24 ft. from the window. Artificial illumination, therefore, provides the only dependable means of controlling the intensity, quality and distribution of light.

Proper illumination is more than the correct intensity, for it must also be of good quality. Lighting quality is made up of intensity, absence of direct and reflected glare, absence of harsh shadows, uniform distribution, properly illuminated surroundings and color of light. Tables are presented showing the lumen output of 110–120 volt Tungsten gas-filled and fluorescent lamps.
C. J. Babcock

180. Dairy waste prevention and disposal. H. A. TREBLER AND H. G. HARDING. Can Dairy Ice Cream J., **28,** 9: 44, 84. Sept., 1949.

Where waste disposal is a problem, the following steps should be taken: (1) utilize all by-products, such as whey and buttermilk, or dispose of them by some method other than by dumping them down the drains; (2) reduce waste to a minimum by improved preventive maintenance by an educational campaign, by collecting all drips and rinses, by installing automatic pump stops, etc.; (3) install a separate septic tank for toilets; (4) equip evaporatory equipment with entrainment separators in such a way as to give absolute minimum boil-over and entrainment loss; (5) provide an automatic sampler of dairy plant waste and post results of analysis so that plant employees can see results; (6) reduce the volume of waste to a minimum by the installation of a hot water system and automatic shut-off nozzles on the hoses; and (7) install an aerated flow equalizing tank for the floor waste.
H. Pyenson

181. Treatment of controlled dairy waste in the milk plant. E. F. GLOYNA, Univ. of Tex. (in cooperation with Prewitt Creamery, Austin, Tex.) Sou. Dairy Prod. J., **46,** 4: 84–89. Oct., 1949.

A satisfactory high-capacity experimental trickling filter with centrifugal recirculation pumps is described. The filter flies which were present were controlled by the spraying of a commercial DDT solution. A thread-like segmented red earth worm would make its appearance whenever the plant was operating under septic conditions. The worm is known as the Dero worm. The bulk of the worms disappeared after washing the drain pan, detention tank and recirculation tank with tap water which had some residual chlorine in it. The remaining worms in the plant after tap water treatment were not very active.
F. W. Bennett

182. Dielectric defrosting. E. Ross, State College of Wash., Pullman. Milk Dealer, **38,** 12: 153–155. Sept., 1949.

The potential applications of dielectric defrosting in the dairy industry are: (a) rapid defrosting of bulk frozen fruit for ice cream manufacture, (b) dielectric defrosting of frozen milk and cream by equipment and methods described for frozen fruits and (c) sterilization of milk. A published report describes the dielectric heating of milk to 205° F. in 0.067 sec. after which it was vacuum-cooled to 135° F. in 0.2 sec. The bacterial count was found to be below 1% of that of normally pasteurized milk. Butterfat concen-

tration was unchanged, but apparent cream volume was reduced appreciably. Cost estimates run about 0.6¢/qt. C. J. Babcock

183. Scale formation and water. W. F. BENSON, Limex Corp. Indianapolis, Ind. Milk. Dealer, **39,** 2: 62–64. Nov., 1949.

Scale formation on and in equipment through which water is moving is one of the major headaches of industry. In most cases the bicarbonate alkalinity is the culprit and exists because of the CO_2 solution. There is a balanced relation between soluble $Ca(HCO_3)_2$, gaseous CO_2 and insoluble $CaCO_3$. Anything that causes a loss of the CO_2 promotes scale formation. These causes are usually in 1 or more of 3 categories—an increase in temperature, aeration or an increase in alkalinity. The first 2 are physical and the last a chemical means of causing the change. Evaporation is another physical change that is responsible for scale. The composition of water from different parts of the United States is discussed. Dehydrated complex phosphates slowly remove scale from equipment and keep it clean. Just how they work is not known. On clean equipment, a very thin gelatinous film forms and scale does not form on this film.

C. J. Babcock

184. Questions and answers for new men in refrigeration. J. D. CONSTANCE, Operating Eng., **2,** 12: 42–43. Dec., 1949.

Questions and answers on the fundamentals of compression systems are presented. The review is simplified by a diagram which includes many possible parts of a complete ammonia system. The 2-temperature installation is explained.

H. L. Mitten, Jr.

185. Today's pipe welding practices. F. C. FOUTZ, Midwest Piping and Supply Co., Inc., St. Louis, Mo. Heating, Piping and Air Cond., **21,** 11: 81–86. Nov., 1949 and **21,** 12: 87–88. Dec., 1949.

Various factors in pipe welding practices are discussed. H. L. Mitten Jr.

186. Drips and drains important parts of process and power piping jobs. G. W. HAUCK, Crane Co., Chicago, Ill. Heating Piping and Air Cond., **21,** 10: 76–79. Oct., 1949.

Omission of drips and drains for a piping system is an oversight which will cause added costs. Suitable drains should be provided to drain condensate from all sections of piping and equipment where it may collect. Drains also should be provided for emptying water lines or equipment containing water. At least 1 valve should be placed in each drain line.

Draining condensate from steam lines to auxiliaries before starting unit reduces wear on seating surfaces of control valves and eliminates possible damage from water slugs. The draining of lines adjacent to valves, draining valves in boiler leads, draining of steam headers, drainage of long lines, rises in steam lines and drips for superheated steam lines are discussed and illustrated.

Justification for stress laid upon drips and drains has been proved in practice. Adequate drainage is a safeguard, improves operations and is profitable investment. H. L. Mitten, Jr.

187. How to save power dollars. P. W. SWAIN. 330 W. 42nd St., New York 18, N. Y. Operating Engineer, **2,** 10: 19–34. Oct., 1949; Power, **93,** 10: 71–86. 1949.

Numbered items which may affect power costs are discussed very briefly. Divisions are steam generation, power generation by steam engines and turbines, steam distribution and application, diesels, gas engines, water power, mechanical-power transmission, air conditioning and heating, electricity and elevators, refrigeration, water services and compressed-air systems.

H. L. Mitten, Jr.

188. Combustion control. B. G. A. SKROTZKI, Power, 330 W. 42nd St., New York, N. Y. Power, **93,** 12: 71–106. Dec., 1949.

A review of combustion control equipment is presented. It is illustrated with 88 drawings and diagrams which aid in explaining the nature of control and the details of controls made by various manufacturers. H. L. Mitten, Jr.

Also see abs. no. 213, 227, 242.

DAIRY PLANT MANAGEMENT AND ECONOMICS

L. C. THOMSEN, SECTION EDITOR

189. Controlling wastage in milk plants. H. HELMBOLDT. Can. Dairy Ice Cream J., **28,** 10: 29–30, 70. Oct., 1949.

Wastage in milk plants can be controlled by: (1) having a butterfat accounting system, (2) eliminating wastage in miscellaneous items like washing powder, caustic, sanitary gaskets, fuel oil, chlorine, mops, dairy brushes, coveralls, gloves, paint, paper towels, hand soap and bottles in stock room, (3) eliminating wastage in bottle caps and hoods, (4) having an inventory control book, (5) having control of sewage disposal, (6) saving in hot and cold water, (7) savings in heat, (8) having proper plant maintenance and (9)

having proper training and cooperation of all men working in the plant. H. Pyenson

190. Elimination of waste through work simplification. H. G. DUNLAP. Can. Dairy Ice Cream J., **28,** 11: 70–72. Nov., 1949.

The object of any company is to eliminate but not to control waste. The thing to emphasize in a training program include waste of time, energy, materials, products, equipment and space. Time is wasted through poor planning, no planning or not planning far enough ahead. Energy is saved through work simplification training. The posting of material loss helps to cut down plant losses. Product loss can be cut down by elimination of leaky valves and fittings. Supervisors should know capacity of all equipment under their control. Efficient use of space and shelves helps to eliminate waste. Disorder is the lack of time, energy, materials and space and is the main cause of waste. Dirt is usually the accumulation of material not needed.

H. Pyenson

191. A method of double checking milk samples. W. W. FOSSETT, Sacramento, Cal. Milk Dealer, **39,** 2: 72–73. Nov., 1949.

A balance sheet similar to that used in banks is suggested. On one side of the balance sheet would be the fat credited to the patrons for a period of time. On the other side would be the total fat received by the dairy plant for the same period, based on tests made independently from those which determined the fat credited to the patrons. These 2 items should balance within the limits of error which need not be greater than 0.5% of the total amount of the fat handled over the period. Two samples are taken from each weighing, a plant composite and a patron composite. Since sampling is the crux of the system, each sample must be an aliquot portion of the quantity weighed. C. J. Babcock

192. Economic operation of an ice cream plant. R. WISE. Can. Dairy Ice Cream J., **28,** 10: 31–34. Oct., 1949.

Economic operation of an ice cream plant depends upon elimination of loss of product, leaks, poor drainage, dirty boilers, oil or air in refrigeration systems, inadequate lubrication, abuse of equipment, irregular maintenance and insufficient records. Over-production of merchandise is not nearly as serious as under-production of new ideas.

H. Pyenson.

193. Economic operation of an ice cream plant. ROBERT WISE, Nat'l. Ice Cream Co., East Boston, Mass. Sou. Dairy Prod. J., **46,** 6: 96, 98–99, 104. Dec., 1949.

The following suggestions for the economical operation of an ice cream plant are made: Quality and output consciousness of workers, utilization of labor-saving and fatigue-eliminating conveniences, planning of operations in advance, few changeovers, use of sugar in syrup form, simplified equipment, laboratory control of operations, inventory control to have on hand at the proper time all items in proper packages, economical use of ice cream storage space, efficient modern refrigeration equipment, well-designed refrigeration truck bodies with compressor hold-over plates and stainless steel finish, 2–5 deliveries/wk. with cash-on-delivery policy, good public relations from supplying good products in desired packages at fair prices, sanitary control, rodent and insect elimination, safety program, pleasant supplier relations, purchases at low prices but not in excessive quantities, conservative purchases of equipment and ingenuity and inventiveness of the manager.

F. W. Bennett

194. Cutting materials handling cost in the ice cream plant. Anonymous. Ice Cream Rev., **33,** 4: 39, 54, 56, 58. Nov., 1949.

Present manual methods of handling materials in many ice cream plants are time consuming, expensive and a hazard to the health of workers. Modern methods, involving lift trucks and pallets or skid platforms for materials handling, are being used in a number of large ice cream plants at the present time with complete satisfaction. Many users of this system estimate that the installation cost of trucks, pallets and skid platforms can be recovered within a period of 90 d. through the savings effected.

New developments in the field of materials handling of interest to the ice cream manufacturer are: (1) single service pallets made of paper which can be shipped out with the load by truck or rail and need not be returned, (2) trucks with load grab arms which can be used for handling materials without pallets, (3) stacker for ice cream cabinets on racks which facilitates handling of the cabinets and effects a considerable saving in storage space, (4) a stacker equipped with a stainless steel dumping hopper for dumping sugar into vats.

W. J. Caulfield

195. Cost of processing and distributing milk and ice cream. L. C. ANDERSON. Can. Dairy Ice Cream J., **28,** 10: 38–42. Oct., 1949.

A table gives the costs of individual products for processing expense, delivery expense, selling expense and administrative and general expense.

H. Pyenson

196. Bookless bookkeeping. J. A. GRUNDY,

Remington Rand, Inc. Milk Dealer, **38,** 12: 48–49, 90–92. Sept., 1949.

A description is given of the multi-matic Accounting Board System which consists primarily of a board with a movable gripping arm to hold the journal, ledger and other sheets and carbon papers, color and check devices and cards with movable celluloid signal tabs to call attention to such things as overdue accounts, stock shortages, etc.

A journal sheet, the basic bookkeeping document, is inserted in the multi-purpose accounting board. Next, the carbon paper, ledger cards and statement forms are added, for creating 3 bookkeeping records in 1 operation. Posting of identifying information and charge amounts or other data has to be in the right columns, thanks to the color and number guides at the head and base of of the board. With 1 part of the posting operation completed, the holding bar or arm is shifted to the next position. Filling in of billing amounts on 1 form also serves to create the basic control information for the customer's ledger card and the journal sheet. C. J. Babcock

197. Variables make "Fleet cost per mile" an undependable yardstick. A. E. FRIEDGEN, A. E. Friedgen, Inc., N. Y. Milk Dealer, **39,** 1: 44, 104–108. Oct., 1949.

A chart is given showing the operating costs per mile per period of 4 wk. of a single fleet. Fleet costs are influenced by variable weather condtions, summer resort business and other factors such as sporting events, horse races and conventions. Any fleet operator who does not get detailed costs for each truck for each period works in the dark. Costs cannot be efficiently controlled by any such general yardstick as fleet cost per mile.
C. J. Babcock

198. Reducing delivery expense. J. C. BEDFORD, Armstrong College, Berkeley, Cal. Milk Dealer, **38,** 11: 43, 83–84. Aug., 1949.

Seven points are discussed which can serve as a guide to milk dealers in reducing the operating costs in the service shop and at the same time assure a fleet of trucks on the routes every day at a minimum of expense. They are: (a) check all trucks daily, (b) charge supplies to each truck, (c) replace out-of-date trucks, (d) periodically check all trucks, (e) keep a perpetual inventory of supplies, (f) maintain repair kits by makes of trucks and (g) keep the service shops clean.
C. J. Babcock

199. Ice cream on milk routes. Anonymous. Milk Dealer, **38,** 11: 44, 105. Aug., 1949.

Based on the experience of the Polk Sanitary Milk Co. of Indianapolis, Ind., a milk dealer must have enough routes to cover a city completely if he is to distribute ice cream on milk routes successfully. Polk distributes ice cream 3 times a week and offers 4 flavors in container sizes not less than a pint. The price is approximately the same as store prices. Canvas packers did not stand up. Metal boxes insulated with 1 in. of cork, with outside dimensions $28 \times 14 \times 14$ in., holding approximately 10 gal. of ice cream and 2 lb. of dry ice as the refrigerant are used. The ice cream is packed in a specially designed wire basket which can be pulled up so as to give ready access to the entire contents. Ice cream has given the company an added item on the route to help carry overhead and enable the route man to earn a more satisfactory commission. C. J. Babcock

200. Where can profits in the drug store be increased? H. H. ROBBINS, Paraffined Carton Research Council. Sou. Dairy Prod. J., **46,** 6: 18, 62–65. Dec., 1949.

The operations of 8 independent drug stores located in neighborhood shopping districts in separate cities in different parts of the country are the basis of the following data. The soda fountain accounted for 39.2% of the stores' sales transactions. Written prescriptions led the other departments in both gross and net earnings. Soda fountains in the group of stores showed an average net profit of 1.7%. The average of profits of 4 profitable fountains was 12.4%, while the 4 unprofitable fountains suffered an average loss of 9.1%. Data on costs and transaction selling times for various items are presented. F. W. Bennett

201. Design and color in life of your package. C. H. WILLIS. Can. Dairy Ice Cream J., **28,** 9: 48–50, 52. Sept., 1949.

The pull of color is one of the greatest powers on earth. If used correctly it will increase production by increasing sales. It is not possible to separate packaging from production any more than it is possible to separate merchandising from packaging. H. Pyenson

202. Food consumption trends in the United States. B. A. CAMPBELL. Can. Dairy Ice Cream J., **28,** 10: 48–54. Oct., 1949.

Consumption of milk products increased 23% from 1942–1948. The per cent of the weekly earnings spent for food was less for higher income groups. The weekly expenditure by items showed that milk and other dairy products, butter excluded, accounted for 15.8% of total food expenditure for an average family of 2.98 persons.

Butter took another 3% of weekly expenditure. For dairy products there is a gradual increase in consumption as income increases. Average per capita consumption of fluid milk and cheese showed a steady increase as income increased. Consumption of ice cream increased and consumption in the highest income group was 3.5 times the average in the lowest group. Consumption of evaporated milk showed a reverse trend to most other dairy products, with consumption declining as income increased. H. Pyenson

203. Employee pension plans. H. E. NYHART, Indianapolis, Ind. Milk Dealer, **39,** 1: 47, 80–84. Oct., 1949.

The biggest step yet taken toward maximum cooperation between employer and employee is to show the employee that he belongs to the organization by adopting a properly designed retirement plan. A pension plan should be actuarially sound, practical, flexible, attractive and profitable to both employer and employee. A retirement plan is profitable because it makes possible the graceful elimination of superannuated employees who no longer render efficient performance, tends to reduce labor turnover, enables a company to attract and hold a higher type of employee on a career basis and improves the productive efficiency of employees. C. J. Babcock

FEEDS AND FEEDING

W. A. KING, SECTION EDITOR

204. Observations on the calcium-phosphorus requirements of dairy cattle. I. R. JONES, J. R. HAAG, J. H. BYERS AND P. H. WESWIG. Oregon State College, Corvallis. Proc. 30th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc., pp. 69–72. 1949.

The results of preliminary studies failed to reveal a significant relationship between the phosphorus levels of the whole blood of dairy cows and either the stage of lactation or the level of milk production. No correlation was observed between rate of consumption of free-choice minerals (bone meal and disodium phosphate) and level of milk production. N. L. Jacobson

205. Experiments in rearing calves without whole milk and with limited amounts of skim milk. H. T. CONVERSE, Bur. of Dairy Ind. U.S.D.A. Cir. no. 822. Sept., 1949.

This publication reviews some of the literature of experiments on raising calves with limited amounts of milk and gives results of experiments conducted on this subject over a period of years at the U.S.D.A. Beltsville Station. A method is outlined for raising calves without salable whole milk and with only 200–400 lb. of skim milk. The calves are fed a mixture of home grown grains and good-quality, fined-stemmed leafy alfalfa hay. Two to 4 teaspoons daily of cod-liver oil is fed with the skim milk to supply vitamin A until the calf is eating about 1 lb. of hay daily.

R. N. Davis

206. Once-a-day versus twice-a-day feeding for dairy cows. J. R. DAWSON AND D. V. KOPLAND. U. S. Dept. Agr. Circ. 830. 7 pp. 1949.

Two groups of 5 cows each received grain, alfalfa hay and corn silage at a morning feeding, or divided equally into a morning and an evening feeding for 3 50-d. periods (by the double reversal method) and were milked twice daily. The grain (barley, oats, mill feed and soybean meal) provided 15.3% of digestible crude protein and 76.9% T.D.N. Each cow received 1 lb. of grain/4 lb. of milk, 30 lb. of silage daily and a hay offering to allow only a 10% refusal. Records for the first 10 d. of each period were discarded as preliminary.

When fed twice daily, cows ate 10% more hay, produced 6% more milk and required 70% more labor for feeding than when fed once daily—small differences distinctly favoring twice-a-day over once-a-day feeding. R. B. Becker

207. Seasonal adaptation of three methods of curing and storing grass and legume forage as reflected in the milk production of dairy cows. W. B. LUTZ AND A. R. WOLCOTT. Mich. Agr. Expt. Sta. Quart. Bull., **32,** 2: 231–239. Nov., 1949.

Mixed alfalfa-and-quack grass was made into field-cured or barn-dried hay or into field-wilted silage without added preservative. The field-cured hay was 3-wk. more mature at harvest, with a larger proportion of alfalfa. Digestible nutrients were estimated, based on percentages of alfalfa and grass and on chemical analyses. Ten Holstein cows, divided into 3 groups, were fed the respective roughages in 7-d. preliminary and 15-d. experimental periods, with only salt and water extra. Feed of each lot was changed in 3 consecutive periods. Twenty-five per cent more 4% fat-corrected milk was produced on the silage cut in late June than on field-cured hay cut in Aug., and 12% more than on barn-dried hay cut in mid-July.

R. B. Becker

Also see abs. no. 159.

GENETICS AND BREEDING

N. L. VAN DEMARK, SECTION EDITOR

208. Breeding efficiency in the Michigan State College dairy herds. R. C. LEWIS AND R. E. HOR-

WOOD. Mich. Agr. Expt. Sta. Quart. Bull., **32,** 1: 152–155. Aug., 1949.

Breeding efficiency affects calving interval, lactations per cow, season of calving and young stock available, with an assumed ideal of a 10-mo. lactation and 2-mo. dry period per cow. Sixty-five bulls of 5 breeds were at East Lansing, in natural and artifical service, while 11 Holsteins at Chatham and 17 Guernseys at the Kellogg sub-station were in natural service only. In natural use, 2.11 services were required per conception, and 2.63 in artifical use, varying with breeds. The differences were not considered breed characteristics, however, from the limited data. R. B. Becker

209. Effect of inbreeding on body size, anatomy and producing capacity of grade Holstein cows. W. W. SWETT, C. A. MATTHEWS AND M. H. FOHRMAN. U. S. Dept. Agr. Tech. Bull. 990. 1949.

Seventy-one grade Holstein cows, for which measurements of body size, anatomy and producing capacity were available, were divided into 4 groups on the basis of the intensities (coefficients) of inbreeding. Analyses of available data were made to determine the effect of inbreeding on magnitude and variability of more than 30 items representing measurements of body weight and skeletal size, size of organs and endocrine glands and milk and butterfat production.

Inbreeding resulted in declines, decreases or reductions in body weight or mass, weight of internal organs (notably the heart), size of endocrine glands (except thyroids), weight of udder, milk production, butterfat production and size of the cows. Inbreeding resulted in increases in the weight of lungs and thyroids, the relation of capacity to weight of udder and proportion of organs and body parts as related to total animal structure. Inbreeding caused little or no significant change in skeletal size, length of intestines, size of pineal and adrenal glands and udder capacity. Inbreeding apparently did not decrease variability in body mass, skeletal dimensions, internal organs, milk production and butterfat production. Inbreeding caused high variability to be observed in the endocrine gland items and in weight and capacity of udders. J. W. Stull

HERD MANAGEMENT

H. A. HERMAN, SECTION EDITOR

210. What becomes of the calves in purebred dairy herds? R. E. HORWOOD AND E. WEAVER. Mich. Agr. Expt. Sta. Quart. Bull., **32,** 1: 149–151. Aug., 1949.

Ultimate disposal of living male and female calves of 5 dairy breeds born in Michigan State College dairy herd over 19 yr. was tabulated. Of 598 heifers and 610 bulls born alive, 77.8% of heifers entered the milking herd, 11.2% were sold for dairy purposes, 2.5% were vealed or slaughtered and 8.3% died, while 53.4% of the bulls were retained or sold for breeding, 38.4% were vealed or slaughtered and 8.2% died. Proportions sold varied with breeds according to local demands. R. B. Becker

211. Losses of calves in dairy herds. E. WEAVER, R. E. HORWOOD AND E. S. SMILEY. Mich. Agr. Expt. Sta. Quart. Bull., **32,** 1: 42–47. Aug., 1949.

Calf records were analysed from Michigan State College herd over 16 yr.; 9 yr. at Chatham and at the Kellogg Farm Guernsey herd. Of 1,467 calves born, 5.5% were dead (including abortions), 1.1% died at birth and 7.1% died within 10 mo. Losses ranged between 23.6 and 2.6%, reduction in losses accompanying segregation, feeding from nipple pails, expanded steel calf mats and sulfa drugs when needed. Thirty per cent of the deaths occurred in the 1st wk., and 39.4% more before the 3rd mo. of age. Mortality decreased with age. The herd was brucellosis-free. R. B. Becker

212. An estimate of the quarterly calving rate of heifers in Welsh counties and the percentage annual replacements in the principality. Part III. The method of calculation. R. PHILLIPS, University College of Wales, Aberystwyth. British Vet. J., **105,** 11: 415–421. Nov., 1949.

Methods are described in the calculation of calving rates in Welsh counties. The calculations involved the 3-yr. totals of calvings of in-calf heifers, yearly total of calvings from the 3-yr. total and the quarterly totals of calvings from the yearly and 3-yr. totals supplemented by returns from the Ministry. The methods of calculation are illustrated by examples and tables.

B. B. Morgan

213. Design of a milk house. J. S. BOYD. Can. Dairy Ice Cream J., **28,** 10: 62–66. Oct., 1949.

A good milk house will save time and labor on a dairy farm and will make the production of high quality milk easier. The essential equipment of a milk house includes: (a) a milk cooler, (b) a double wash vat, (c) a water heater, (d) a can rack. A dairy producing 6–8 cans of milk should have a minimum of 100 ft.^{2} in the milk house, which should be located as close to the barn as possible. Locating the milk house in the barn is

desirable if there is no direct opening to the stable, if a tight wall is constructed between the milk house and stable and if the location is approved by the inspector buying the milk. H. Pyenson

Also see abs. no. 132, 134, 206.

ICE CREAM

C. D. DAHLE, SECTION EDITOR

214. Acidity in ice cream mixes. W. A. KRIENKE, Fla. Agr. Expt. Station, Gainesville. Ice Cream Field, **54,** 4: 96, 128, 129. Oct., 1949.

Tritratable acidity is used more commonly by the ice cream industry as an index of quality than is pH. Several modifications of the original Manns acidity test are outlined and the necessity for standardization of procedure is indicated. It is easy to standardize the procedure used in the acidity test, except for the determination of the exact "pink end point." Ability of individuals to detect the "end point" varies considerably. Proper illumination during titration is stressed, also. It is difficult in some cases and may be impractical in the case of colored mixes to depend upon seeing the development of a pink color at the proper end point where phenolphthalein is used as the indicator. The acidity test, as performed in some commercial plants has little or no value. In such cases it would be better to depend upon taste, rather than acidity test, as a measure of quality. When properly performed, titratable acidity tests using phenolphthalein as an indicator give reliable results and "electrometric titration extend the usefulness of titrable acidity values to those ice cream mixes that are colored to the extent that the phenolphthalein pink end point is impractical." W. C. Cole

215. Serum solids concentrates. W. J. CAULFIELD AND W. S. ROSENBERGER, Iowa State College, Ames. Ice Cream Field, **54,** 5: 46, 68, 69, 70. Nov., 1949.

Three low heat skim powders were compared with extra grade non-fat dry milk solids and sweetened condensed whole milk for use in ice cream. The whipping properties of mixes prepared from low heat powders were equal to or better than comparable mixes prepared with extra grade skim powder or sweetened condensed whole milk. No significant differences in body and texture or meltdown quality of ice cream were observed which could be associated with the type of serum solids concentrate used.

Ice cream prepared with sweetened condensed whole milk was superior in flavor to that prepared with the non-fat dry milk solids, but the flavor score of ice cream prepared with low heat powders was consistently better than that prepared with high heat powders. It also was observed that the flavor of ice cream was better when the mixes were compounded with milk and cream rather than when made with cream and water, irrespective of the type of non-fat dry milk solids used. W. C. Cole

216. Trends in the ice cream industry. J. H. DUPLAN. Can. Dairy Ice Cream J., **28,** 12: 31–33. Dec., 1949.

Synthetic ice cream made with vegetable fats is threatening the stability of the ice cream industry. Consumers must be convinced that ice cream is a delicious and inexpensive food. The sales tax on ice cream in Canada is a discrimination and should be repealed or the consumption of ice cream will decrease. H. Pyenson

217. Shrinkage, a progressive report. J. C. LANDO AND C. D. DAHLE, Penn. State College, State College. Ice Cream Field, **54,** 5: 42, 44, 71. Nov., 1949.

Results are given of investigations on mix protein distribution and mix protein proteolysis as related to ice cream shrinkage. Formol titration conducted potentiometrically was used as a measure of mix protein proteolysis. In the case of 12 commercially shrunken samples of ice cream studied, 10 showed formol titration in excess of the titration for the control mix of the same nitrogen content. Mixes to which trypsin had been added and then held at 40° F. for periods up to 72 hr. showed little or no shrinkage in the resulting ice cream held in a cabinet at +5° F. Considerable shrinkage did occur, however, with the ice cream made from the same mix and held for a week in a cabinet at +5° F., if the mix were allowed to incubate at 40° F. for a period of 96 hr. before freezing. It is stated that the albumin-globulin hydrolysis did not begin until about 84 hr. of incubation and it was felt that this was of major importance. When natural unaltered albumin-globulin was added properly to ice cream mixes, shrinkage of the resulting ice cream was reduced. W. C. Cole

218. Formulas for making sherbets with whey on a commercial scale. F. E. POTTER AND D. H. WILLIAMS, Bureau of Dairy Industry, U.S.D.A., Washington, D. C. BDIM-Inf.-88. Jan., 1950.

Four formulas for using different whey products are given, along with general directions for processing the resultant mixes. F. E. Nelson

219. Consumer clinics. H. B. GRANT. Ice Cream Field, **54,** 4: 80, 120. Oct., 1949.

Consumer preference is more important than manufacturer's perference in deciding the type of

ice cream that should be manufactured and sold. Reference is made to the "Consumer Clinic" created by the Robert T. Smith Dairy Laboratory of Scranton, Pa. and it is suggested that similar clinics throughout the industry would be desirable. The method of evaluating samples used by the Smith Consumer Clinic is outlined. W. C. Cole

220. Bulk vs. package. J. H. FRANDSEN, A. SHIPLEY AND D. H. NELSON, Univ. of Mass. Amherst. Ice Cream Field, **54,** 5: 38, 40, 65–67. Nov., 1949.

The authors point out certain advantages of packaged over bulk ice cream. Factory-filled packages have a distinct advantage so far as sanitation is concerned. Prevention of shrinkage loss and saving of time during dispensing also are mentioned as advantages of factory-filled packages. Shrinkage losses as a result of dipping or hand filling packages increased from 33.9% with 80% overrun ice cream to 42.3% with 100% overrun ice cream and to 46.4% with 120% overrun ice cream. The body and texture score of freezer packaged ice cream stored at a low temperature was 1.5–2 points higher than ice cream packaged by hand at a higher temperature. W. C. Cole

221. England's ice cream industry. C. W. ENGLAND, C. Y. STEPHENS, Dairy and Poultry Industries, Washington, D. C. Sou. Dairy Prod. J., **46,** 4: 144, 146. Oct., 1949.

Ice cream is considered a luxury and it is necessary to buy an established business in order to manufacture ice cream as no additional allocations are permitted. Fat is supplied from oleomargarine, sweet fat and evaporated milk. Sources of serum solids are skim milk powder, Syrol, evaporated milk and sweet fat. Sweet fat is 30% oleomargarine fat, 50% sugar, 15% skim milk powder and 5% dextrose. Syrol contains 84% lactose, 16% albumin and milk salts and apparently is from cheese whey. The finished product contains approximately 31% T.S.

All equipment is of English manufacture, only the pasteurizer differing radically from that used in the U. S. The pasteurizer is of the water-jacketed type, heated by a gas burner at the bottom, and the pasteurizer also is used for cooling.

A part of the water, the ice cream powder, Syrol and skim milk powder are heated in the pasteurizer to 195° F. Additional water is added and the mix cooled to 160° F., starch digesting enzymes (bacterase) added and held for 10 min. The remainder of the ingredients then are added and the complete mix pasteurized at 160° F. for 30 min., homogenized and cooled.

Restrictions on the use of whole milk for ice cream making were lifted for the summer only.

F. W. Bennett

222. Holland's dairy and ice cream industries. C. W. ENGLAND, C. Y. STEPHENS, Dairy and Poultry Industries, Washington, D. C. Sou. Dairy Prod. J., **46,** 5: 60, 62, 64, 66. Nov., 1949.

The annual/capita consumption of frozen dairy products is about 1/10th of the annual consumption in the U. S. The principal product manufactured by most of the ice cream plants is similar to our ice milk. Available ingredients include milk, cream, skim milk powder, allocated sugar, sterilized milk, imitation egg white, gelatin, sodium alginate, carboxy methyl cellulose, emulsifiers and vanilla flavor which lacks fine character. Mix is pasteurized by the holder method and has a negative Storch test. Most of the freezers observed were vertical brine machines. Overrun is usually 20–40%. Much ice cream is sold in bars made in 1–1. brick pans. Holland has a very active retail ice cream manufacturers' association.

Milk received from farms averages 3.3% fat and is standardized to 2.5% fat for retail. There are 3 grades of milk: bottled milk, pasteurized at 167° F. for 13 sec., loose milk, pasteurized at 185° F. for 2 sec. and sterilized milk, heated under pressure to 239° F. for 30 min. and bottled in qt. beverage bottles with metal crown caps.

Sanitary stainless steel pipe lines usually are installed permanently. Pipe lines and HTST pasteurizers are cleaned by circulation with steam and chlorine used for sterilization. Results of bacteriological checks are surprisingly good. Parctically all equipment is of European manufacture. Plant construction is much the same as in the U. S. F. W. Bennett

Also see abs. no. 173, 176, 192, 193, 194, 195, 199, 200.

MILK AND CREAM

P. H. TRACY, SECTION EDITOR

223. "Flavor insurance" for your bottled milk. S. J. WEESE AND KYLE WELLS, West Viriginia Univ., Morgantown. Milk Dealer, **39,** 2: 58–59. Nov., 1949.

Flavors and odors present in the atmosphere of home refrigerators are of great practical significance in affecting changes in flavor of milk held in these refrigerators in bottles without caps. The flavor absorbed may be very strong and typical of the material from which it originated. Using different fruits and vegetables, cucumbers gave the milk the lowest flavor score, followed by onions, honeydew melons and strawberries.

C. J. Babcock

224. Comparison of raw milk grades as determined by the methylene blue test and the sediment test. J. C. BOYD, Idaho Agr. Expt. Sta. and

LESTER HENDRIX, Idaho State Dept. of Agr. Milk Dealer, **38,** 12: 64–68. Sept., 1949.

The effectiveness of the sediment test as compared with the methylene blue test in detecting milk of poor quality was studied. In conducting the methylene blue test the samples were not inverted after the milk and dye were mixed. Comparisons of the methylene blue test and the sediment test on 602 individual cans of milk from 5 representative milk processing plants showed 26% of the milk sampled to be of poor sanitary quality (decolorized methylene blue in 20 min. or less) and that 14.5% of the milk sampled contained excessive amounts of sediment. No correlation was found between the milk containing excessive amounts of sediment and that which reduced methylene blue in 20 min. or less. Much of the milk containing excessive amounts of sediment is not detected by the methylene blue test. Neither the sediment test nor the methylene blue test, when used alone, is entirely effective in determining whether milk should be accepted. The routine use of both the sediment test and the methylene blue or some similar quality test would be very helpful in a milk grading program in those areas where milk is being produced for the manufacture of butter, cheese, evaporated milk, milk powder and other products. The use of some other quality test, along with the sediment test in those areas is strongly recommended. C. J. Babcock

225. Going grade A. E. THOM. Milk Dealer, **38,** 12: 45–46, 108–116. Sept., 1949.

A description is given of how the milk dealers in Evansville, Indiana, obtained the cooperation of the Extension Service of Purdue University, county agents, health authorities, consumers, city officials and others in promoting a Grade A milk program. The construction costs for converting Evansville area farms into Grade A units has been between $300 and $1,100, the amount varying depending upon how much work the farmer does himself. The results of the program are shown by the fact that in 1945 not 10 producers in the area could have qualified under the U. S. Public Health Service Grade A program. Today, 475 are qualified and from 200 to 250 additional producers have done some necessary remodeling. When the program was first introduced, 100 marginal producers not seriously in the dairy business dropped out of the market rather than comply with requirements. C. J. Babcock

226. Tank trucks for farm pick-up of milk. G. E. SARTAIN, Bryant and Chapman Dairy, Hartford, Conn. Milk Dealer, **38,** 11: 64–69. Aug., 1949.

As of April 1, 1949, the Bryant and Chapman Dairy had installed tanks on 6 farms. The farm tanks vary in size from 200–600 gal. and are rectangular in shape. They are owned by the company and the producer pays a small rental for their use. The tanks are equipped with coolers that reduce the temperature of the milk from 95° to a range of 55–38° F. within 5 min. The milk is mechanically agitated until it reaches 38° and then the compressor and agitator shut off. They automatically start if the temperature of the milk rises to 42° F. The milk is agitated and samples for testing taken before being pumped into the pick-up 2-compartment insulated tank. The milk pump driven by a power take-off from the truck engine is located on the truck. The milk is pumped through a heavy guage brewer hose with sanitary fittings. The farmers who now have these tanks installed feel that this is the first time in the history of marketing milk that a new idea and parctice has been so beneficial to both the farmer and his distributor. C. J. Babcock

227. Equipment problems and efficiency of operation. H. PUTNAM. Can. Dairy Ice Cream J., **28,** 11: 80–84. Nov., 1949.

The efficiency of equipment operation in a fluid milk plant is given and means of solving equipment problems are listed. Employees and foreman should thoroughly understand the machine in new installations. Plant operating conditions should be examined from the standpoint of obtaining an orderly operation. Mechanical agitators in weigh cans properly operated assures a more uniform mixture of the product than some other methods of agitation. Composite samples should be stored in a mechanical refrigerator. In planning equipment efficiency, the following equipment should be given consideration: sanitary pumps, mechanical can-washing, storage tanks, ice builders, water cooling, evaporative condenser, steam plant, bottle washer, bottle filling, H.T.S.T. pasteurizer and homogenizer. H. Pyenson

228. Lift trucks. Anonymous. Milk Dealer, **38,** 11: 48, 90–99. Aug., 1949.

Lift trucks save manpower and money for milk dealers. They are being used at several plants. At the Whiting Milk Co. in Charlestown, Mass., 36 cases are loaded on a pallet for storage in the milk cooler and are moved out of the cooler to delivery trucks, still stacked on the pallets, by means of lift trucks. The general results of handling loaded milk cases and empties at the Whiting plant are as follows: (a) space required for semi-trailer parking was reduced by two-thirds; (b) trailer hold-up time was cut down from 40 min. with 6 men to 30 min. with 1 man; (c) number of semi-trailers required for moving the loads

over the streets was reduced from 5 to 2 and breakage of bottles was reduced considerably; (d) a big advantage to this system is that it saves floor space.

The size and capacity of the lift truck selected depends upon maximum weight and maximum size of loads to be carried, *i.e.*, plant floor conditions (inclines or ramps, elevators, aisles, doorways, etc.) and the size and capacity of trucks now in use. C. J. Babcock

229. Whipped cream in upstate New York. A. C. DAHLBERG AND F. V. KOSIKOWSKY. Can. Dairy Ice Cream J., **28,** 9: 35. Sept., 1949.

Most cream mixes were whipped by instantaneous release of the mix from the pressure of N_2O. This instantaneously whipped cream generally contained about 20% butterfat. It often contained a small amount of added nonfat milk solids. The sugar content averaged about 6% and vanilla flavoring usually was present. About 400% overrun was obtained per pint container. The whipped cream prepared by mechanical agitation contained 29% butterfat, and 7% sugar and the overrun averaged slightly below 200%. The creams whipped instantaneously by N_2O gave av. logarithms counts of 299,000 bacteria/ml. and 193 coliform bacteria/ml. Mechanical whipped samples averaged in the millions for total bacteria. H. Pyenson

230. Ten traits that make a stream-lined salesman. M. O. MAUGHAN, Northwestern Univ. Milk Dealer, **38,** 11: 51, 98–102. Aug., 1949.

The 10 most important characteristics are: (1) he builds confidence, (2) he sells benefits, (3) he talks facts which are built on a thorough knowledge of his merchandise, (4) he practices showmanship, (5) he renders definite and tangible service during each interview, (6) he practices creative selling, (7) he emphasizes quality, (8) he constantly grows and develops himself, (9) he knows the art of dealing successfully with people and (10) he uses system in his presentation. A description of how a salesman can present his case in 5 talking steps as well as 7 possible methods of closing are discussed. C. J. Babcock

Also see abs. no. 147, 169, 189, 191, 195, 198, 199.

MILK SECRETION

V. R. SMITH, SECTION EDITOR

231. Some studies of the circulatory system of the cow's udder. W. W. SWETT AND C. A. MATTHEWS, U. S. Dept. Agr. Tech. Bull. 982. 36 pp. June, 1949.

Correlations between udder veining, milk veins, milk well size and production records of 106 Holstein-Friesian and 89 Jersey cows at Beltsville, Md. were low and considered insignificant. Extensive veining tended to occur on the surface of tight, compact, closely attached udders more frequently than on loose and flexible ones.

Arteries were injected with red liquid latex and veins with blue liquid latex, hardened by injecting a solution containing 2% of acetic acid and 10% in formalin which hardened the latex, so that tissues could be dissected away. Impressions of valves indicated direction of blood flow. Tissues were dissected away from the larger vessels in 1 udder, while 25 udders were sectioned for observation. Frequent anastomoses were found between arteries and between veins within the separate halves of the udder. Transmedian anastomoses were found between veins of 12 udders in front of the fore teats, in 5 between the fore and rear teats, and in 10 udders in the rear portion, including those between the perineal veins. Fewer transmedian arterial anastomoses were found. Major arteries and veins were described. Main entry of blood was through the external pudic artery in each half of the udder. Both veins and lymph vessels occurred as the surface vessels on udders of 17 living cows.

The external pudic and subcutaneous abdominal veins carried venous blood outward. All valves in the perineal vein, except in immediate proximity to the vulva, pointed toward the udder, indicating blood circulation in that direction.

R. B. Becker

232. Weight and capacity of the dairy cow udder in relation to producing ability, age and stage of lactation. C. A. MATTHEWS, W. W. SWETT AND M. H. FOHRMAN. U. S. Dept. Agr. Tech. Bull. 989. 1949.

Data on the udders of 473 cows (Holsteins, grade Holsteins and Jerseys) were used in numerous group and correlation studies to determine the relationships between udder size and producing ability and the effect of age, breed, stage of lactation and length of dry period on the weight and capacity of the udder. Group averages and correlation studies showed definite increases in udder weight and capacity with age. Advance in the stage of lactation was associated with variable but definite decreases in udder weight and less definite decreases in capacity. Increases in the length of dry period were associated to some extent with decreases in udder weight and capacity.

Highly significant correlations between producing ability and udder weight and capacity were found in both groups of lactating cows and in both groups of dry cows. The ratios calculated by

dividing udder capacity by empty weight of udder had no consistent significant relationship within all groups with the effects of age, lactation cycle or producing ability. However, there were significant positive correlations between this ratio and advance lactation for cows lactating 2 mo. or less and cows lactating over 2 mo.

J. W. Stull

233. Weights and capacities of udders from dairy heifers of different ages. C. A. MATTHEWS, W. W. SWETT AND M. H. FOHRMAN. U. S. Dept. Agr. Tech. Bull. 993. Nov., 1949.

Studies of empty weight were made on udders from 71 heifers, and studies on capacity were made on 42 syringe-filled udders and 54 pressure- or gravity-filled udders. Weights of udders of heifers 3–30 mo. of age increased at an average of approximately 0.59 lb./mo. Capacities of 33 pressure- or gravity-filled udders from heifers 9–30 mo. increased at an average of approximately 0.44 lb./mo.

Capacities of 36 syringe-filled udders between birth and 9 mo. of age increased definitely but at a rate out of line with that calculated from pressure- or gravity-filled udders. Heifers over 30 mo. of age and heifers in which pregnancy had terminated early in the gestation period had udders lower in average weight and capacity than heifers 24–30 mo. There was no definite trend with age in the ratio of capacity to weight in udders from heifers 9–30 mo. of age. The average ratio of capacity to weight was lower for udders from heifers 24–30 mo. old than in younger heifers and considerably lower for heifers over 30 mo. and heifers once pregnant. R. N. Davis

NUTRITIVE VALUE OF DAIRY PRODUCTS

R. J. JENNESS, SECTION EDITOR

234. Nutritive value of milk and milk products sold in Montreal. M. BLAIS, R. BEARDOIN AND M. SANDERSON. Can. Dairy Ice Cream J., **28,** 11: 110–114. Nov., 1949.

Ca and P content of fluid milks sold in Montreal over a 9-mo. period averaged 109–127 mg. % for Ca, with a mean value of 114, and from 86–94 mg. % P with a mean of 88. Pasteurization and homogenization did not effect the content of these minerals in fluid milk. Chocolate dairy drink contained less Ca but more P than milk. Buttermilk had slightly greater amounts of Ca and P than raw milk. Ice cream is a moderately good source of Ca, but not as good as fluid milk when considered on a per serving basis.

H. Pyenson

235. The chemistry of fats in relation to their nutritional significance. E. L. JACK AND L. S. OLSEN. Univ. of Cal., Davis. Proc. 30th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc., pp. 42–46. 1949.

This report summarizes some of the more recent research on the dietary interrelationships between fat and other nutrients and on the nutritional significance of the chemical constitution of fats. N. L. Jacobson

236. Recent advances in nutrition. L. A. MAYNARD. Can. Dairy Ice Cream J., **28,** 9: 32–33. Sept., 1949.

Recent advances in nutrition are reviewed.

H. Pyenson

PHYSIOLOGY AND ENDOCRINOLOGY

R. P. REECE, SECTION EDITOR

237. Blood levels of certain constituents in normal and spasmophilic calves. T. H. BLOSSER, G. W. SCOTT, JR., U. S. ASHWORTH, R. E. ERB AND A. O. SHAW, Washington State College, Pullman. Proc. 30th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc., pp. 61–68. 1949.

A disease of dairy calves which the authors describe as spasmophilia is discussed. It is characterized by spasmodic seizures followed by exhaustion and high mortality. Blood analyses which included protein, phosphorus and sugar in the plasma and Ca, Mg, and citric acid in the serum, as well as hemoglobin, failed to reveal the cause of this disorder. N. L. Jacobson

238. Quantitative aspects of the diabetogenic and the growth-promoting activities of pituitary preparations. P. M. COTES, E. REID AND F. G. YOUNG, University College, London, England. Proc. Soc. Endocrinol., 12th Ordinary Meeting, Oct. 21, 1948, pp. 14, 15. (in J. Endocrinol, **6,** 2. Oct., 1949.)

Studying ox pituitary extracts, the authors interpreted their results to mean that pituitary diabetogenic and growth-promoting activities are due to the same substance. V. Hurst

239. The influence of thiouracil on reproduction and growth in the rat. S. B. BARKER, Dept. of Physiology, State Univ. of Iowa, Iowa City. J. Endocrinol., **6,** 2: 137–144. Oct., 1949.

Thiouracil administration as 0.2% of the ration depressed the reproductive capacity of females and retarded the growth rates of the young. The earlier the young received thiouracil, the more

evident was the ability of thiouracil to retard growth. Rats returned to a normal diet following prolonged periods of thiouracil administration regained their reproductive capacity and produced normal offspring. V. Hurst

SANITATION AND CLEANSING

K. G. WECKEL, SECTION EDITOR

240. Effect of the condition of the milk can on the microbial content of prepasteurized milk. N. A. MILONE AND W. D. TIEDEMAN, N. Y. State Dept. of Health, Albany, N. Y. J. of Milk and Food Technol., **12:** 332–347, 369. Nov.-Dec., 1949.

The authors claim there was no appreciable effect on the bacterial content of prepasteurized milk poured into milk utensils that have been properly sanitized and dryed. A high thermoduric bacterial count in milk cans may contribute to unsatisfactory reduction efficiencies on HTST or LTLT pasteurization methods. It appears a producer must be very careless with his milk cans in order to grossly contaminate milk poured therein; except in extreme instances, high microbial content of the milk generally was not attributed to the milk can. H. H. Weiser

241. Bottle washing studies under plant conditions. C. N. STARK, R. F. HOLLAND, J. C. WHITE AND M. J. GURDIAN, Cornell Univ., Ithaca, N. Y. Can. Dairy Ice Cream J., **28,** 9: 36, 38. Sept., 1949.

A bacteriologically satisfactory milk bottle can be obtained by using the concentrations of alkali and the corresponding holding time and temperatures suggested by Levine for washing bottles under commercial plant conditions. The preferred soaking temperature is 160° F. Tetrasodium pyrophosphate was essential to obtain satisfactorily rinsed bottles. The addition of trisodium phosphate, in the amounts used, did not improve the washing process. The measurements made on surface tension, specific gravity and carbonate alkalinity in most instances did not correlate with the satisfactory rinsing of the bottles or the number of surviving bacteria found in the bottles. Soaker solution temperatures of 170° F. or higher are not needed to obtain a clean, excellent appearing, low bacterial count bottle.
H. Pyenson

242. Special equipment improves cleaning operation and reduces plant costs. J. R. PERRY, Sealtest Inc., New York, N. Y. Milk Dealer, **39,** 3: 46–47, 89–94. Dec., 1949.

For general rinsing as a part of the cleaning operation, water with a temperature of 115° F. is desirable. This may be supplied satisfactorily by a hot and cold water blending or tempering valve. To obtain satisfactory rinsing, there should be a sufficient quantity of water at the right pressure for the rinsing job to be done. A uniform pressure at every outlet and hose station is not satisfactory. In most plants it is desirable to have available rinse water in adequate quantity at all locations and at varying pressures.

A variety of water pressures in a plant can be simply had, provided the entering supply has enough pressure. The water should reach the points of use at a pressure somewhat in excess of the highest pressure needed; in each location where a lesser water pressure is desirable, a pressure-regulating valve and a pressure guage may be installed. This is not an expensive way to arrange water pressure and the better rinsing as well as the saving of water will justify the small investment in pressure regulators and guages. A 0.5″ special lightweight hose with a whip-end and shut-off valve is recommended.
C. J. Babcock

243. Detergent-sanitizers to improve milk quality. M. A. COLLINS. Can. Dairy Ice Cream J., **28,** 9: 45–47. Sept., 1949.

The one-solution detergent-sanitizer in liquid form proved satisfactory for washing and sterilizing metal pails and strainers and for maintaining low bacterial counts in the raw milk. Even in cold water it is unlikely that any milk or chemical film will develop on the metal surfaces with properly washed metal utensils using the detergent-sanitizer. The one-solution method for cleaning and sanitizing utensils and udders is inexpensive. A 140–150 p.p.m. solution of active disinfectant did not irritate the cows teats or the hands of the milker. It prevented the spread of an infection which developed due to injury of one quarter of a cow's udder. H. Pyenson

244. The use of hypochlorite and quarternary ammonium compounds in the routine washing of cows udders prior to machine milking. E. M. KESLER, C. B. KNODT, G. H. WATROUS AND P. S. WILLIAMS, Penn. State College, State College. J. of Milk and Food Technol., **12:** 350–353. Nov.-Dec., 1949.

A comparison was made of the bacterial count on udder washes containing hypochlorite and quaternary ammonium compounds in controlling the plate count of milk obtained by machine milking. When 400 p.p.m. and 200 p.p.m. of quarternary ammonium compound, 400 p.p.m. and 200 p.p.m. chlorine and water alone were used they showed no appreciable differences in the

microbial counts of the milk produced. However, differences among cow groups were found to be significant. H. H. Weiser

245. A new method for the evaluation of quaternary ammonium detergent sanitizer compounds. G. R. Goetchius and W. E. Botwright, Rohm and Haas Co., Philadelphia. Soc. Am. Bact., Abs. of Papers, p. 56. May, 1949.

To simulate milking machine conditions, sterile rubber strips are immersed in a milk suspension of the test organism. These are allowed to dry partially and then are immersed in the use-dilution of the detergent sanitizer that has been prepared in natural hard water. The sanitizing solution is contained in a beaker placed over a magnetic stirrer. After sanitization, the strips are dipped in tap water and placed in sterile petri dishes which are poured with T.G.E. agar containing an inactivator for the quarternary compound. *Escherichia coli, Streptococcus fecalis* and *Pseudomonas aeruginosa* were selected as being most typically resistant to quartenary ammonium germicides. As a control, tap water is substituted for the sanitizing solution. An acceptable detergent sanitizer will show 99% reduction in bacterial count over the control. The laboratory method correlated well with field tests on milking machines and other dairy equipment. D. P. Glick

246. Rationalizing the failure of a quarternary ammonium compound to detect true germicidal activity in sanitizing glass containers. H. E. Lind and D. Allan, Sias Research Laboratories, Brookline, Mass. Food Tech., **3,** 9: 304–306. 1949. 1949.

Six oz. screw cap bottles were washed in a hot detergent solution, rinsed in hot water and the bottles and caps immersed in a solution containing 100, 200 and 400 p.p.m. of a quarternary ammonium compound (Roccal) for periods of <0.2, 5 and 10 min. After the bottles had drained, 50 ml. of a rinse diluent were added to each bottle and the capped bottles were shaken 25 times; 1-ml. aliquots of the rinse liquid were plated on standard tryptone agar; after 48 hr. incubation at 37° C. the colonies present were counted.

The use of a neutralizer rinse was essential to demonstrate optimum performance of the quarternary ammonium compound. Unbuffered and buffered distilled water, sodium thioglycollate broth and Letheen broth were unsatisfactory as rinse diluents. It was found that 0.2% ascolectin in 2% Tween 80 was very satisfactory as a neutralizer diluent. More than 85% of the bottles in each trial showed a residual plate count of less than 100/ml. and the percentage of kill/bottle exceeded 99.9%. E. R. Garrison

247. Insect control—The general situation. H. H. Schwardt. Can. Dairy Ice Cream J., **28,** 9: 52. Sept., 1949.

Flies have developed a strong resistance to several of the new insecticides such as D.D.T., methoxychlor and chlordane. Continuous development of new insecticides or improvement of older ones must be expected. It is possible that an alternation of insecticides over periods of years will take care of the resistance problem. Toxicity studies will be made on all new insecticides offered for sale from now on. Lindane is the pure gamma isomer of benzene hexachloride. Lindane kills flies faster than D.D.T. but its residual effect is of shorter duration. Eight lb. of 25% wettable powder or 1 gal. of 25% emulsifiable lindane should be used in each 100 gal. of spray. It is safer than D.D.T. since it does not accumulate in the body above the level of daily intake. Where roaches are a problem around milk plants, chlordane should be used. H. Pyenson

248. Proper formulation of insecticides in food plants. H. E. Whitmire, Whitmire Research Lab., Inc., St. Louis, Mo. Sou. Dairy Prod. J., **46,** 4: 106–107. Oct., 1949.

The possible health hazards of insecticides are more important than the insect control properties. Most pest control materials are not developed for use in food processing establishments. Reactions may occur between certain base oils and insecticidal chemicals, resulting in higher toxicity than possessed by either the oils or insecticidal ingredients alone. Many synthetic organic chemicals have unknown toxic properties. There are toxicity differences between chemically pure and technical grades of insecticidal chemicals. Presumably inert vehicles have been fatal in some instances. Insecticides of known or unknown toxicity which may be hazardous, should not be permitted upon the premises of a food processing plant.

Two proven insecticidal agents are dihydrorotenone (hydrogenated rotenone) described in U. S. Patent no. 1,945,312 and pyrethrin-like esters developed by R. C. Roark and associates. F. W. Bennett

249. A bug's eye view of dairy plant architecture. Ed. M. Searls, National Dairy Products Co., Inc. Milk Dealer, **39,** 3: 42, 43, 100–104. Dec., 1949.

A discussion is given of the effect of plant location and construction on insect and rodent con-

trol. The presence or absence of insects and rodents is one of the most readily available and most reliable indices of sanitation. Insect prevention in milk processing plants, previously the unique responsibility of the entomologist, has greatly increased in scope until today it also requires the best cooperative efforts of the dairy products plant architect. C. J. Babcock

250. Protection afforded consumer against added chemicals in food. W. B. WHITE. Can. Dairy Ice Cream J., **28,** 11: 75–79. Nov., 1949.

A survey of the protection afforded consumers against added chemicals in food in the United States is given. Some of the chemicals mentioned are diethylene glycol, ethylene glycol, D.D.T. and other insecticides and fungicides.

H. Pyenson

Also see abs. no. 155.

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