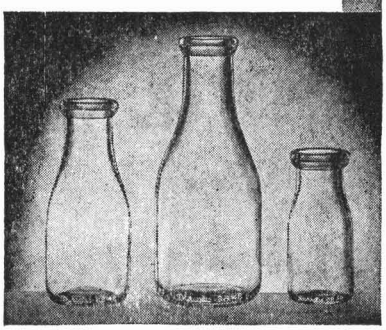
JOURNAL OF DAIRY SCIENCE

Contents

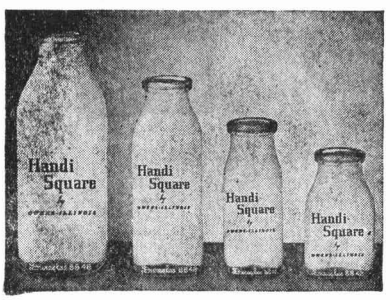
Vol. XXX, No. 5, May, 1947

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION



Standard Family—All sizes—all standard finishes. This line can be supplied with Plate Lettering, Plain, Blown lettered or ACL. The quart weight is 22 oz.

Handi-Round Line—Streamlined bottles available in all sizes, all standard finishes. Supplied Plain, Private Mold, Blown lettered or ACL. Quart weight is 17¾ oz.



Handi-Square Line—New modern containers—space-saving, easy-to-handle, easy-to-pour. Available in all sizes, all standard finishes . . . plain or ACL. Quart weight is 17¾ oz.

A Complete Dairy Container Service in

Duraglas

TRADE MARK REG. U.S. PAT. OFF.

MILK BOTTLES

Owens-Illinois offers three full lines of high-quality, high-trippage milk bottles to fill all dairy container needs.

Whichever line you choose, you will profit by these Owens-Illinois features:

The exacting Duraglas Technique of glass-making means additional strength, uniform capacity, practical light weight.

The exclusive Syncro-Flash Treatment assures maximum shock resistance at the lips of the bottle.

The broad Customer Service invites you to consult with us about any dairy problems you may have.

OWENS-ILLINOIS GLASS COMPANY
TOLEDO 1, OHIO
Branches in Principal Cities
Dairy Container Division

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION

Published at
NORTH QUEEN ST. AND MCGOVERN AVE., LANCASTER, PA.

F. E. NELSON, *Editor*
Ames, Iowa

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

Subscriptions for the British Isles and British Empire, except for Canada and Australia, should be ordered through our agents: Messrs. Bailliere, Tindall and Cox, 7 and 8 Henrietta Streets, Convent Garden, London, W. C. 2, England. Subscriptions for Australia should be sent to our agent: John H. Bryant, Herbert St., St. Leonards, N. S. W., Australia.

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

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

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

BETTER PAY

for the time YOU spend milking cows

Hundreds of Surge Users have written in to tell us that they are getting *more* milk in *less* time . . . with *less* hard work . . . since they SWITCHED TO SURGE! Your Surge neighbors are getting paid better than you are for the *time* and *effort* they spend to milk cows.

You can do a pretty good job of milking cows with almost any long-tube, claw-type machine . . . IF . . . *you give it enough help!* But if you don't give it enough help . . . if you let those teat cups *creep up* and *pinch off* the flow of milk . . . you're losing money every milking!

Surge teat cups don't creep! Surge does automatically what other machines have to be helped to do! *SURGE MILKING IS THE ONLY KIND OF MILKING YOU CAN AFFORD TO HAVE IN YOUR BARN!*

BABSON BROS. CO.

2843 W. Nineteenth St., Chicago 23, Ill.

SYRACUSE, KANSAS CITY, LOS ANGELES, HOUSTON, ATLANTA, SEATTLE, MINNEAPOLIS, TORONTO

Surge
DAIRY FARM EQUIPMENT

JOURNAL OF DAIRY SCIENCE

VOLUME XXX MAY, 1947 NUMBER 5

WITHIN-COW REGRESSION OF MILK-ENERGY YIELD ON AGE AND LIVEWEIGHT[1]

W. L. GAINES
Illinois Agricultural Experiment Station, Urbana
H. P. DAVIS AND R. F. MORGAN
Nebraska Agricultural Experiment Station, Lincoln

INTRODUCTION

Certain DHIA records of cows in Illinois farm herds (3, 4) showed that milk-energy yield is practically unaffected by age of cow, independent of liveweight. On the other hand, milk-energy yield is greatly affected by liveweight, independent of age. These results relate to Holstein and Jersey cows, separately by breed. In each breed some of the cows were registered animals and some were not.

A similar result was found (1) from certain more accurate records (*e.g.*, milk weighed at each milking instead of one day per month) in the Nebraska Station herd at Lincoln. The Nebraska data are for registered cows of the Ayrshire, Guernsey, Holstein, and Jersey breeds, all treated as one group. The lumping of the data for the four breeds quite possibly could disturb the general validity of the result, because the Holsteins were markedly larger than the other breeds and at the same time had a decidedly higher milk-energy yield per unit liveweight than the other breeds. The present paper presents a refinement of the analysis for the Nebraska data by finding the age-weight-yield relation within cow for the Holstein breed.

PROCEDURE AND RESULTS

The general principle of statistical procedure used is the same as that used by Dickerson (2) in finding the within-cow regression of milk-fat yield on age (liveweight ignored). The present procedure involves fitting a three-constant equation to the observations; accordingly, only cows with three or

Received for publication February 7, 1947.

[1] Published with approval of the Director as Paper no. 409, Journal Series, Nebraska Agricultural Experiment Station, and with approval of the Director of the Illinois Station. The original observations were made at the Nebraska Station, and the computations were made at the Illinois Station, utilizing IBM punched-card machines.

more lactations are used. The data provide 57 cows, each with 3 or more lactations, a total of 231 lactations distributed as follows:

Lactations	3	4	5	6	7	8	9
Cows	25	15	11	3	2	0	1

The following within-cow, within-breed, within-herd equations emerge, by least squares:

$$W = 917.4 + 9.822\,A - 0.04048\,A^2 \quad \text{(a)}$$

$$FCM = -1.69 + (0.0413 \pm 0.0045)\,W + (0.001 \pm 0.022)\,A \quad \text{(b)}$$

$$1{,}000\,FCM/W = 38.30 + (0.0012 \pm 0.0032)\,W + (0.004 \pm 0.016)\,A \quad \text{(c)}$$

$$1{,}000\,FCM/W = 31.00 + (0.245 \pm 0.044)\,A - (0.00142 \pm 0.00026)\,A^2 \quad \text{(d)}$$

W is liveweight in pounds, the average of three scale weighings on successive days within 31 days after calving. This particular stage of lactation for the measurement of liveweight is an essential feature of the present philosophy. Class units of one pound were used in the computations.

A is conceptual age of cow at calving in months, reckoned as 10 + birth age at calving in months, with all fractions dropped. The record of birth age at calving is accurate to a day but class units of one month were used in the computations.

FCM is milk-energy yield for the 8-month partial lactation in pounds of 4 per cent milk per day. The 8-month (243-day) partial lactation is used to avoid complications of advanced pregnancy. *FCM* is based on milk weights at each milking and monthly determinations of fat percentage. Class units of 0.1 lb. were used for *FCM* and 1,000 *FCM/W* in the computations.[2]

W, A, FCM, and 1,000 *FCM/W* are known for each lactation of each cow, and the equations deal with these items in the same lactation. For example, *FCM* is related to *W* of the same lactation, not *W* of some other lactation. The mean and range for the 231 lactations are as follows:

	A	A^2	*W*	*FCM*	1,000 *FCM/W*
Mean	72	5,920	1,385	55.6	40.2
Range	35–174	1,225–30,276	979–1,854	31.9–80.7	25.4–56.4

DISCUSSION

Accepting the observations and calculations as of a satisfactory order of accuracy, what biological interpretations are warranted by the equations?

[2] *FCM* = 0.4 × milk + 15 × milk fat, all in the same unit of weight. One pound *FCM* = 340 kilocalories of milk energy. The correlation between milk-energy yield in calories determined by use of direct calorimetry and milk-energy yield in calories estimated by use of the *FCM* formulas is of the order 0.997. If the milk-yield and fat-yield data are valid, the estimate of milk-energy yield in terms of 4 per cent milk by the *FCM* formula also is valid. *FCM* is a technic for estimating milk energy. It is not a correction for fat percentage in the same sense that mature equivalent is a correction for age.

In the first place the equations are within cow (and, by physical restriction, within breed and within herd), which should enhance their biological meaning.

By equation (a) $W = 1{,}212$ at $A = 35$, reaches a maximum of 1,513 at $A = 121$, and then declines to 1,401 at $A = 174$. (Birth age is approximately 9.5 months less than A.) Holsteins are a large breed and the present 57 Holsteins are large animals of the breed. The declining phase of equation (a) is not very reliable because of a sparse population at values of A beyond 121. Taken at face value, it may indicate a lack of condition (fatness) at calving at advanced ages. Also, the equation is bound to be affected by the individuality of the few cows having lactations at advanced ages.

Equation (b) expresses FCM as a function of W and A. The coefficient of W is nine times as large as its standard error and highly significant in a probability sense. On the other hand, the coefficient of A is smaller than its standard error, *i.e.*, it does not differ significantly from zero. According to equation (b), an increase of 100 lbs. in liveweight is accompanied by an increase of 4.13 in FCM, independent of age, which is 344 times as great as the increase in FCM which accompanies an increase of one year in age, independent of liveweight. One pound of liveweight is more potent than 3 years in age, by the equation.

This within-cow result is in general agreement with the previous findings (1, 3, 4) that milk-energy yield is influenced profoundly by liveweight, independent of age, and is substantially unaffected by age, independent of liveweight. If these are the true relations, then the system of correcting milk yield for age of cow at calving is biologically unsound and should be superseded by a system based on liveweight within 31 days after calving.

The foregoing statement is not intended to deny the statistical validity of age correction where W is unknown, because age and liveweight are to some extent correlated. In the present study of 231 lactations, the correlation between A and W is 0.48 in total, 0.31 between cows, and 0.62 within cow. But this does not alter the biological situation. Age represents time, which is required for the organism to attain size (liveweight). The procedure of equation (b) is to allow age and liveweight to take their natural values and depend on the liveweight and age terms of the equation, adjusted by least squares to the observations within cow, to segregate the independent influence of age and liveweight. This procedure allows both age and liveweight to express themselves in a natural way. If age is restricted to first lactations, the range of liveweight is restricted because the animals have not had time to grow fully and, of course, the within-cow relationships cannot be ascertained at all.

Equation (c) proceeds to the next logical step, namely, since equation (b) indicates that FCM is largely a multiple of W, with the other two terms of little consequence, FCM/W should be largely independent of both age

and liveweight. Equation (c) shows that such is the case. The coefficients of W and A are smaller than their respective standard errors. Neither one is significantly different from zero.

Milk-energy yield per 1,000 lbs. liveweight, 1,000 FCM/W, is here regarded as a quantitative measure of lactational drive, or the intensity of lactation metabolism, on the assumption that lactation metabolism is proportional to milk-energy yield and the amount of protoplasm (work stuff) involved in lactation is proportional to liveweight.[3]

FCM/W stands in its own right as a factual measure of lactational drive. It is not to be regarded merely, or primarily, as a substitute for age correction. It is, rather, a direct biological measurement which has no need of age correction. Clearly, the lactational-drive philosophy is very different from the mature-equivalent philosophy.

In a similar way FCM/W is not to be regarded as a correction for weight. It is, again, a factual biological measurement which has no need of weight correction. The evidence substantiating this statement is satisfactory as within breed (Holstein or Jersey) but as yet is not conclusive as between breeds (Holstein and Jersey). When all the evidence is collected, we may find FCM/W is greater for Jerseys than for Holsteins (as FCM/W is unmistakably greater for dairy goats than it is for dairy cows). On the other hand, FCM/W, as used here, may prove to be a biologically equitable measure of lactational drive or dairy development between dairy breeds as well as within breed. From this standpoint FCM/W should appeal to those agencies working with the dairy breeds collectively, as producers of milk.

Equation (d) requires a slight modification of the discussion under equation (c). In equation (c), FCM/W is expressed as a linear function of W and A, while in equation (d), FCM/W is expressed as a curvilinear function of A alone by introducing a term in A^2. The coefficients of A and A^2 both are significant as judged by their standard errors. By equation (d) 1,000 $FCM/W = 37.8$ at $A = 35$, reaches a maximum of 41.6 at $A = 86$, and then declines to 30.6 at $A = 174$. As in the case of W in equation (a), the declining phase is not very reliable and is of little practical importance because of the infrequent occurrence of lactations very far advanced on the descending limb of the curve. The descending limb is of some theoretical interest as indicating senescence in the intensity of lactation metabolism in old age.

[3] Generally speaking, it is permissible to say that the amount of body protein in cows of different liveweights is proportional to liveweight. But there is a good deal of assumption in saying that the amount of protoplasm involved in lactation is proportional to W as here defined. The assumption is encouraged by the fact that milk-energy yield is proportional to W in the present data, according to the fitted equations (b) and (c). It must be recognized, however, that W is affected by fatness (a body food reserve available for lactation needs) as well as by size in the sense of body dimensions. The problem is complicated. However, the weight of visceral organs need not be a factor of great importance because the visceral organs have a wide margin of safety above the point of being a limiting factor in the amount of lactation.

Equation (d) indicates that the regression of FCM/W on age is curvilinear and significant in the probability sense. Can the increase of 3.8 in 1,000 FCM/W from the youngest age to age of maximum be ignored? In consideration of this question it is of interest to see how age-corrected FCM behaves in relation to age in the same 231 lactations. Applying the official age-correction factors of the Holstein-Friesian Association to each of the 231 lactations, the following within-cow equation emerges:

$$A\text{–}CFCM = 49.76 + (0.260 \pm 0.069)\ A - (0.00154 \pm 0.00040)\ A^2 \qquad (e)$$

Equation (e) shows that the official age-correction factors do not completely remove age changes in FCM yield for these 231 lactations. According to the equation, age-corrected $FCM = 57.0$ at $A = 35$, increases to 60.8 at $A = 85$, and then decreases to 48.5 at $A = 174$. Comparison of equations (d) and (e) shows that FCM/W is practically as close to being independent of age as is age-corrected FCM for these 231 lactations, using the official age-correction factors.

The derivation of age-correction factors has long been a favorite occupation of investigators engaged with the biometric analysis of milk records. Following are two equations derived from the present 231 lactations:

$$\text{In total,} \qquad FCM = 23.26 + 0.7252\ A - 0.0033548\ A^2 \qquad (f)$$

$$\text{Within cow,} \qquad FCM = 24.42 + 0.7296\ A - 0.0036064\ A^2 \qquad (g)$$

Equation (f), dealing with the 231 lactations in total (the usual method of approach), indicates an age-correction factor of 1.35 for $A = 35$ (birth age 25.5 months). Equation (g), dealing with lactations within cow (theoretically a more refined method of approach), indicates an age-correction factor of 1.40 for $A = 35$. The official factor is 1.25.

Equation (g) appears to be a better way of deriving the age-yield relation generalized for the same cow than is the ratio method of Sanders (5), but the authors have no desire to add to the multiplicity of age-correction factors now in the literature. Consequently, use of lactational drive, measured as 1,000 FCM/W which has no need of age correction (and no need of weight correction within breed or probably within species), is advocated.

SUMMARY AND CONCLUSIONS

This paper deals with 57 registered Holstein cows in the Nebraska Station herd at Lincoln, Nebraska, each cow having three or more lactations, a total of 231 lactations. Age at calving (A), liveweight within 31 days after calving (W), milk-energy yield per day for the 243-day partial lactation (FCM), and lactational drive (1,000 FCM/W) are accurately known for each lactation of each cow. Various equations have been fitted by least squares to the observations, both in total and within cow. The within-cow

equations are presumed to give the best insight of the relationships between the variables from a biological point of view.

When *FCM* is expressed as a linear function of *W* and *A*, within cow, the coefficient of *W* is relatively large and highly significant while that of *A* is very small and not significantly different from zero. The constant term is very small. The independent effect on *FCM* of one pound in *W* is equal to the independent effect of 3.44 years in *A*. From this within-cow result it is concluded that for these 231 lactations, dealing with *A*, *W* and *FCM* as they actually exist under natural conditions, it is biologically unsound to correct yield for age because age has no effect on yield independent of live-weight.

When lactational drive (1,000 *FCM/W*) is expressed as a linear function of *W* and *A*, the constant term is large and the coefficients of *W* and *A* both are small, each being smaller than its own standard error, or neither one is significantly different from zero. From this within-cow result it is concluded that lactational drive (1,000 *FCM/W*, as defined) is a directly comparable measure of dairy development or intensity of lactation metabolism within these 231 lactations, being completely independent of both age and live-weight.

From the present within-cow equations, from previous equations, and from a metabolic or dynamic point of view, the conclusion is reached that lactational drive (as defined) affords a biological common denominator for dairy cattle as a whole, with respect to yield of milk.

REFERENCES

(1) DAVIS, H. P., MORGAN, R. F., AND GAINES, W. L. Live Weight and Milk-Energy Yield in the Nebraska Station Dairy Herd. Jour. Dairy Sci., 26: 625–641. 1943.

(2) DICKERSON, G. E. Estimates of Producing Ability in Dairy Cattle. Jour. Agr. Res., 61: 561–586. 1940.

(3) GAINES, W. L., RHODE, C. S., AND CASH, J. G. Age, Live Weight and Milk-Energy Yield in Illinois Cows. Jour. Dairy Sci., 23: 1031–1043. 1940.

(4) GAINES, W. L., RHODE, C. S., AND CASH, J. G. Age, Live Weight and Milk-Energy Yield—a Correction. Jour. Dairy Sci., 25: 15–18. 1942.

(5) SANDERS, H. G. The Variations in Milk Yields Caused by Season of the Year, Service, Age, and Dry Period. Part III. Age. Jour. Agr. Sci., 18: 46–67. 1928.

EFFECTS OF HIGH VITAMIN A INTAKE ON MILK AND FAT YIELDS AND ON VITAMIN A CONSTITUENTS IN MILK, BLOOD, AND LIVERS OF DAIRY COWS[1]

G. H. WISE AND F. W. ATKESON
Department of Dairy Husbandry
M. J. CALDWELL, D. B. PARRISH, AND J. S. HUGHES
Department of Chemistry
Kansas Agricultural Experiment Station, Manhattan

Recognition of the importance of vitamin A constituents in the diets of dairy cattle has resulted in extensive investigation of the effects of various vitamin A supplements on the health of the cow and on the properties of milk. A summary (2) of reports on the effects of feeding crude cod-liver oil and menhaden fish oil to lactating cows indicates that when these oils are given in sufficient quantities to augment the vitamin A potency of the milk, the percentage of fat is reduced. In recent years the feeding of vitamin A supplements such as shark liver oil and vitamin A concentrates has come into common use for certain classes of livestock. The addition of these high potency vitamin A materials to the diets of cows has increased, in varying degrees, the concentrations of this vitamin in the blood (5, 8, 9, 15), in the milk (1, 2, 7, 8, 10, 15, 18, 21), and in the liver (6), but has produced discrepant effects on yields of milk and of fat (1, 2, 7, 8, 10, 15, 18, 21, 23, 24).

The variability and the diversity of the results reported warranted further study of the effects of feeding vitamin A supplements to dairy cows maintained in a good state of nutrition. Hence, in an investigation designed to ascertain the effects of prolonged supplementation of massive amounts of vitamin A on the course of mastitis, additional observations were made on the yields of milk, the percentage of fat, and the concentrations of vitamin A in the milk, the blood, and the liver. The results from this phase of the investigation are reported herein.

EXPERIMENTAL PROCEDURES AND RESULTS

Grouping and Care of Experimental Animals

Experimental cows. Two comparable groups of dairy cows, the control and the supplemented, were used in this trial. The following factors, in the order listed, were considered in grouping the cows: breed, mastitic history, daily milk yields, stages of gestation and lactation, and body weights. Each group at the beginning of the trial consisted of nine mature cows, two Ayrshires, two Guernseys, and five Holsteins. Six of the cows in each group were lactating, being past the stage of peak production but not sufficiently

Received for publication February 20, 1947.

[1] Contribution no. 165, Department of Dairy Husbandry, and no. 328, Department of Chemistry.

advanced in gestation to accentuate the rate of decline in yield; the remaining three cows, two Ayrshires and a Holstein, were in the early stages of the dry rest period, from 44 to 52 days prepartal. These dry cows were included to determine the effects of prepartal supplementation on postpartum changes.

In addition, two non-lactating Ayrshire cows in the last month of gestation were used to study in detail the effects of level of vitamin A intake on the changes in carotenoids and vitamin A of the serum during the terminal stages of gestation and early period of lactation. The two cows had practically the same carotenoid and vitamin A content of the serum before they were subjected to experimental conditions.

Feeding and management. Prior to the initiation of the trial and throughout the experimental period of 12 weeks, during the months of November, December, and January, all cows of the two groups received a standard milking herd ration consisting of a 16 per cent protein concentrate mixture, Atlas sorgo silage, and alfalfa hay. The carotenoid content of the hay, on the moisture-free basis, ranged from 0.06 mg./g. in the early part of the trial to 0.03 mg./g. in the latter. The lactating cows were fed daily 1 lb. of concentrate mixture for each 4 lbs. of 4 per cent fat-corrected milk, 20 to 25 lbs. of silage per 1,000 lbs. body weight, and hay *ad lib.* The dry cows were fed daily 8 lbs. of the concentrate mixture per 1,000 lbs. of body weight and the roughages, the same as for the lactating cows. In addition to the barn feeds, the cows of the two major groups grazed on rye pasture 30 to 40 days before initiation of the experiment and 16 days following.

Throughout the experimental period, all cows (both the dry and the lactating) in the supplemented group received daily 1,250,000 USP units of vitamin A in a powdered medium.[2] Since this vehicle, described as a "soybean oil meal like" product, supplied nutrients in addition to vitamin A, the cows of the control group received soybean oil meal in quantities equal to the amount of vitamin A supplement fed to the other group. These additional feeds and supplements were given once daily in combination with the concentrate mixture. Considerable quantities of the vitamin A supplemented mixture were refused during the first several days of feeding, but after the cows became accustomed to the foreign flavor, no consumption difficulties were encountered.

All cows were subjected to standard herd management, which included feeding and milking twice daily, exercise whenever weather conditions permitted, and free access to water, common salt and hay in the same paddock.

Yields of Milk and Concentrations of Fat and of Vitamin A Constituents

Milk yields and fat percentages. Detailed records of the milk yields of individual cows were made throughout the experimental period. Samples

[2] "Dry vitamin A", having 2,500–2,700 USP units per gram.

of milk were collected during two consecutive milkings each week for the determination of fat concentration by means of the standard Babcock procedure. The weekly milk and fat yields of the respective groups were sum-

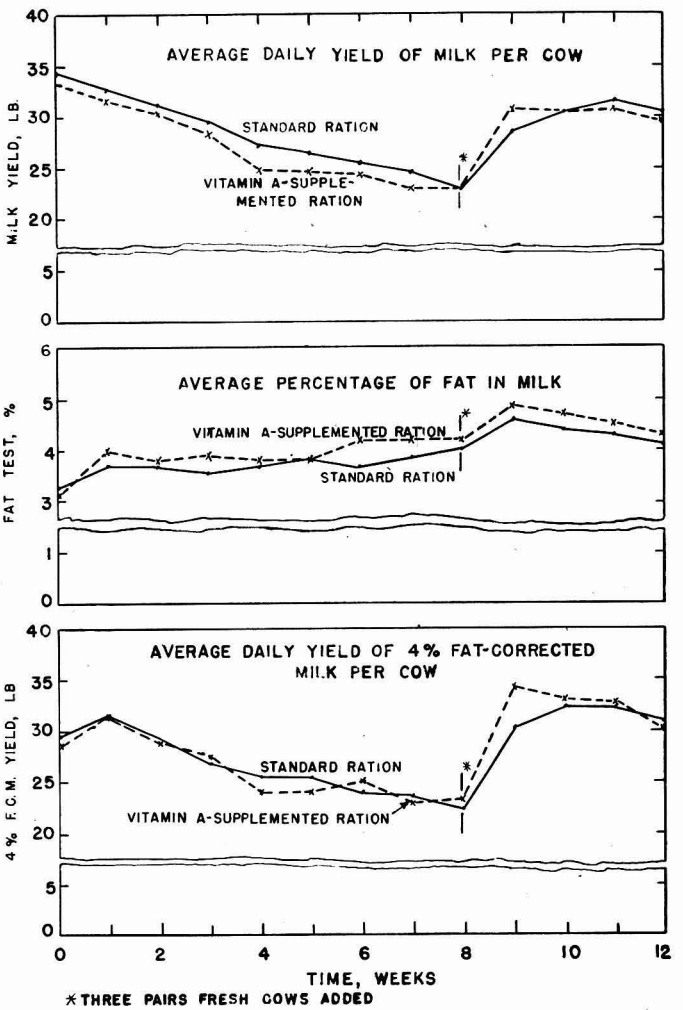


FIG. 1. The effects of dietary supplementation of vitamin A on milk yields and on fat percentages.

marized and subsequently converted to a 4 per cent fat-corrected basis according to the Gaines (11) formula. The yields of milk and fat (fig. 1) revealed no marked differences that could be ascribed to the rations fed.

Initiation of vitamin A supplementation during the early stages of the dry rest period revealed no advantage in production during the first month of lactation. Thus it appears that the daily addition of massive amounts of "dry vitamin A" to the dairy ration used in this experiment neither augmented total milk yield nor suppressed the fat percentage of the milk.

Concentration of carotenoids and vitamin A in the milk fat. During the terminal week of the experiment, a 1-day composite sample of milk was collected from each of seven individual cows in the respective groups for assays of carotenoids and vitamin A. (Milk from two pairs of cows was excluded because of mastitis complications.)

The analytical method employed was a modification of the double extraction procedure of Boyer *et al.* (4). A total of 70 ml. of ether was used in extracting vitamin A and carotenoids, and the volumes of wash solutions were adjusted accordingly. The washed solution of extracted vitamin A

TABLE 1

Average concentrations of vitamin A and carotenoids in the milk fat of cows on different levels of vitamin A intake

Daily supplement of vitamin A	Breed of cows	No. of cows	Vit. A and carotenoids of milk fat	
			Vitamin A	Carotenoids
			γ/g.	γ/g.
None	Guernsey	2	6.4	5.8
	Holstein	3	7.3	3.4
	Ayrshire	2	7.8	4.1
1,250,000 USP units	Guernsey	2	24.1	2.5
	Holstein	3	30.5	4.1
	Ayrshire	2	36.1	1.9

and carotenoids was dried by means of anhydrous sodium sulphate, and the ether was removed from the extract by suction while heating in a water bath at 50–60° C. The residue was dissolved in 15 ml. of Skellysolve B. A 10-ml. aliquot was used for the final determination of carotenoids and of vitamin A. Shaking the ether solution with 5 ml. of a saturated solution of sodium chloride, as outlined in the original method, was omitted. Photometric measurements were made on a Coleman spectrophotometer, model 11, modified to reduce light intensity. Since the fat percentage in the samples was variable, the carotenoid and the vitamin A values were expressed as concentration per unit of milk fat.

The average, by breeds, of vitamin A in the milk fat from supplemented cows was approximately four times higher than that from the control cows. The carotenoids throughout were low, but, in accord with other reports (2, 8, 9, 10, 15), tended to be lower in the milk fat from vitamin A supplemented cows. There was, however, an exception in the case of two of the three pairs of cows of the Holstein breed; hence the average for this breed did not reveal

the reduction (table 1). Since preliminary assays were not made, individual differences could account for these exceptions.

Concentration of Carotenoids and Vitamin A in Blood Serum

Total carotenoids and vitamin A were measured in the serum of venous blood. Since the cows were on a high carotenoid intake during the early stages of the experiment, the non-saponification method of Boyer *et al.* (3) was chosen in lieu of the more generally used Kimble (16) procedure, which is recognized to be inaccurate for vitamin A measurements in the presence of high concentrations of carotenoids (15). Though the non-saponification method of Boyer *et al.* (3) apparently is unsuitable for dog blood, which is presumed to be high in the ester form of vitamin A, this procedure was reported to be applicable to normal bovine blood.

TABLE 2

Average concentrations of vitamin A and carotenoids in the blood serum of cows on different levels of vitamin A intake

Daily supplement of vitamin A	Breed of cows	No. of cows	Vitamin A and carotenoids in serum*			
			Dec. 11–26, 1944		Jan. 22–26, 1945	
			Vitamin A	Carotenoids	Vitamin A	Carotenoids
			γ/100ml.	γ/100ml.	γ/100ml.	γ/100ml.
None	Guernsey	2	23.2	1007	22.8	487
	Holstein	5	20.2	617	18.6	385
	Ayrshire	2	8.7†	279†	21.6	340
1,250,000 USP units	Guernsey	2	23.5	501	27.1	239
	Holstein	5	26.0	310	24.6	177
	Ayrshire	2	23.6†	234†	33.9	245

* Boyer *et al.* (3) non-saponification procedure.
† One week postpartum.

Effect of the diet on the concentration of vitamin A and carotenoids in the blood serum. The carotenoid and the vitamin A values in table 2 are averages of assays of blood serum samples collected from individual cows of the three breeds in the respective groups. The first period of collection, a span of 14 days, was 6 weeks after the initiation of the trial and approximately 1 month after discontinuing rye pasture; the second period of 7 days was 1 month later, near the termination of the trial.

The vitamin A content of the blood serum of the supplemented cows was higher than in the controls, but the carotenoid values were lower. The magnitude of the difference in vitamin A concentration tended to vary with breeds, being least in the Guernsey and greatest in the Ayrshire.

The concentration of carotenoids in the serum from the Guernsey and the Holstein breeds decreased from the first period to the second, but the vitamin A values showed no significant changes. This marked decline of the carotenoids probably was due to the continued reduction of reserves fol-

lowing removal from rye pasture and to a decrease in the carotene content of the hay consumed. Though the Ayrshires were subjected to the same dietary regime as the other two breeds, the vitamin A was low during the first period as a result of a reduction associated with parturition (5, 17, 22). With postpartum physiological readjustments, the vitamin A concentration increased to a decidedly higher level, whereas the carotenoids changed very little.

Relation of the analytical procedure to vitamin A values of serum. Since the differences in vitamin A concentration in the serum from cows of the respective groups were not of the magnitude observed in similar experiments by other investigators (9, 15), the non-saponification procedure of Boyer *et al.* (3), by which the values in table 2 were obtained, was compared with

TABLE 3

Comparison of methods of determining vitamin A in the serum of cows on different levels of vitamin A intake

Daily supplement of vitamin A	Breed of cows	No. of cows	Vitamin A values by different methods		
			Kimble	Boyer *et al.**	Difference
			γ/100ml.	γ/100ml.	γ/100ml.
None	Guernsey	2	22.6	21.5	1.1
	Holstein	1	20.7	18.7	2.0
	Ayrshire	2	20.5	18.1	2.4
	Av.	5	21.4	19.6	1.8
1,250,000 USP units	Guernsey	2	29.7	23.7	6.0
	Holstein	1	39.6	30.5	9.1
	Ayrshire	2	45.1	32.9	12.2
	Av.	5	37.8	28.8	9.0

* Non-saponification method.

the Kimble (16) method. The comparison was made near the termination of the trial when the carotenoid content of the blood serum was sufficiently low to minimize interference.

The Kimble (16) procedure yielded higher values throughout than did the non-saponification method of Boyer *et al.* (3), but the average difference was greater in the vitamin A supplemented group, 31.3 per cent, than in the non-supplemented group, 9.2 per cent (table 3). Further comparisons of the results revealed that the average values for the supplemented cows were 76.6 per cent higher by Kimble but only 46.9 per cent higher by Boyer *et al.* The lower values by the non-saponification method of Boyer *et al.*, particularly in serum from cows receiving dietary vitamin A, suggested that either this procedure failed to include all the vitamin A or the Kimble method yielded excessively high values. Recent observations (19) indicate that as the vitamin A content of serum increases from vitamin A feeding, the values obtained by the non-saponification procedure of Boyer *et al.* tend to be too low. In view of this, it is probable that the total vitamin A in the serum of

the cows receiving the vitamin A supplemented ration was nearer the level indicated by the Kimble method than that by the Boyer *et al.* This phase of the problem is being investigated further.

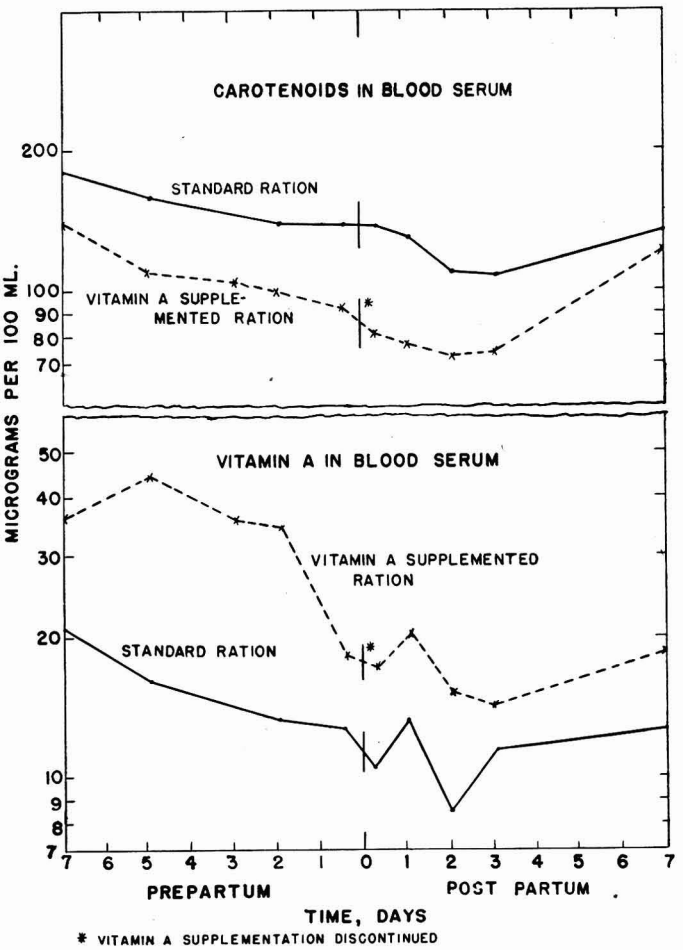


FIG. 2. The effect of prepartal dietary supplementation of vitamin A on the carotenoid and the vitamin A concentration in the blood serum of the dairy cow during the stages of terminal gestation and initial lactation.

A preferable method would have been the saponification procedure outlined by Boyer *et al.* (3), but early attempts to apply it yielded spurious results. Subsequent investigation revealed that the difficulty was due to a contaminant, presumably aldehyde (12), in the alcohol used.

Effect of prepartal vitamin A intake on the changes of carotenoids and

vitamin A in the serum of the parturient cow. As suggested by the average vitamin A values in the serum from cows of the Ayrshire breed (table 2), the vitamin A supplementation did not prevent the usual gestational reduction but did maintain a higher level than observed in the control cows. This is illustrated further (fig. 2) by the prepartum and the postpartum changes in the blood serum of an Ayrshire cow from each of the two dietary groups, control and vitamin A supplemented. Though the two cows selected had about the same carotenoid and vitamin A levels prior to supplementation, dietary vitamin A increased the vitamin A of the blood serum but reduced the carotenoids, as measured by the Kimble method (16) of analysis. The curves, on a semi-logarithmic scale, show that in both animals the prepartum rate of vitamin A decline was more pronounced than that of the carotenoids. The drop of vitamin A, however, was more precipitous in the serum of the cow receiving vitamin A. A temporary rise in the concentration of vitamin A was noted in both cows the day following parturition. Further data (19) indicate that this phenomenon also is common in other cows, but the frequency of occurrence is unknown and the factors involved are obscure. The minimum postpartum concentration usually occurred about the third day unless complicated by infections (5). Whether or not continued postpartum supplementation would have accelerated the rate of recovery when adequate liver stores were available is problematical.

Concentration of Vitamin A in the Livers and in the Serum of Cows Slaughtered

Livers were salvaged from seven cows to determine the effect of vitamin A intake on storage. During the week prior to slaughtering, blood samples were collected for vitamin A determinations. The assay procedure for livers was a slight modification (25) of the Guilbert and Hart (13) method, and for blood serum the non-saponification procedure of Boyer *et al.* (3) was used. With the exception of one animal, no. 169, vitamin A supplementation was continued to within 24 hours of slaughtering.

When an abundance of vitamin A was present in the daily ration, the cows accumulated pronounced liver reserves of this vitamin, approximately four times the amount detected in the livers of cows on unfortified rations (table 4). Though several of the livers had isolated abscesses, this pathological condition apparently did not interfere with vitamin A storage. If it is assumed that prior to cessation of supplementation the liver reserves of cow no. 169 had reached the same general level as in the other cows of her group, the rate of depletion of vitamin A stores was rapid. The vitamin A concentration in the serum from the individual cows revealed, in accord with the report of Braun (6), no correlation between the liver reserves and the levels in the blood serum.

TABLE 4

Concentrations of vitamin A in the livers and in the serum of cows on different levels of vitamin A intake

Daily supplement of vitamin A	Breed of cows	Herd no.	Wt. of liver	Vitamin A		Remarks
				Liver	Serum	
			kg.	*γ/g.**	*γ/100ml.*	
None	Holstein	104A	8.2	150	26.4	Non-breeder. Healthy liver.
	Ayrshire	222A	7.5	142	23.4	Brucellosis reactor. Healthy liver.
	Jersey	332A	5.2	138	19.3	Brucellosis reactor. Healthy liver.
1,250,000 USP units	Holstein	144	9.5	600	28.8	Non-breeder. Mastitic. Abscesses in liver.
	Holstein	161	8.6	733	23.8	Mastitic. Healthy liver.
	Holstein	169	8.9	421	27.2	Vitamin A withheld 20 days preceding slaughter. Mastitic. Abscesses in liver.
	Holstein	173	9.8	867	23.2	Mastitic. Malignant growths in carcass.

* Wet basis.

DISCUSSION

The data presented on milk and milk fat confirm reports by other investigators (2, 10, 15, 18, 21) indicating that production is not stimulated by vitamin A supplementation when the lactating cows are in a good state of nutrition. Probably when favorable responses are elicited by vitamin A feeding (1, 7, 8, 23, 24) either this vitamin *per se* or some other nutrient for which an increased level of vitamin A tends to compensate is the limiting factor. The apparent adequacy of rations for lactating cows at any particular time may be misleading unless cognizance is taken of their nutritional history, productive capacity, and feed consumption. Wilson (24) suggested that access to good quality roughages high in carotene does not insure adequate intake, particularly by high producing cows that have much of their feed capacity utilized by rations low in vitamin A active substances. It is conceivable that in many herds a slight submarginal deficiency of vitamin A may prevail as a result of unrecognized depletion. In these cases a favorable production response to vitamin A feeding would be expected.

Since "dry vitamin A" supplementation did not depress the milk fat percentage, as is observed commonly when cod-liver oil is fed, it is probable that the unsaturated fatty acids that are believed to cause the toxic reaction were not present in sufficient amounts to affect the mammary function. This indicates that the vitamin A concentrate used in this investigation may be

fed in sufficient quantities to increase the vitamin A potency of the milk without adversely affecting the fat content.

The observed increases in the vitamin A potency of the milk from dietary supplementation are in accord with the findings of others (1, 2, 7, 8, 9, 10, 15, 18, 21, 24). This means of fortifying milk, however, is uneconomical since the efficiency of secretion of ingested vitamin A is exceptionally low (8, 9, 15). Moreover, the concomitant reduction of carotene with increases in vitamin A (2, 8, 9, 10, 15) suggests that dietary vitamin A possibly reduces the nutritional value of carotenoids in the ration, thus presenting a provocative problem.

The interference of carotenoid metabolism has been ascribed to vitamin A *per se* rather than to other associated constituents (9, 20). Several possible explanations of this phenomenon have been presented. According to Hickman (14), " *in vitro* experiments show that vitamin A is a specific prooxidant for beta-carotene, lycopene, and probably zeaxanthin." Data supplementary to those already presented showed that the carotenoid concentration in a composite sample of feces from cows on a standard ration was approximately the same as in a similar sample from vitamin A supplemented cows. The vitamin A content of the feces from the latter group, however, was about 60 per cent higher. Either vitamin A was not a factor affecting the carotenoids in the bowel or it simultaneously suppressed absorption and accelerated oxidation. Recent studies (20) with chickens revealed retarded pigmentation of the shanks after cessation of vitamin A supplementation. Deuel *et al.* (9) noted a similar post-supplementation lag in recovery of carotenoid levels in dairy cows. The foregoing observations indicate that the carotenoid suppression is not exclusively an intestinal phenomenon.

A further explanation advanced by Deuel *et al.* (9) is that increases of vitamin A accelerate the destruction of carotenoids in the tissues through the development of a new enzyme system. It was suggested also that this enzyme system may destroy vitamin A. If this proves to be correct, feeding massive amounts of vitamin A over a prolonged period may be detrimental to the organism instead of beneficial.

Another viewpoint is that vitamin A may aid in the conversion of certain carotenoids to this vitamin, thus enhancing the accumulation of a maximum reserve. If it is assumed further that the capacity for storage in the body is limited, the suggested reduction of vitamin A (20) might be an accelerated elimination after the threshold is reached instead of a process of systemic destruction.

Though a decline of carotenoids and vitamin A of the blood seems to be a normal accompaniment of parturition (17, 22), the specific causes of this depression are obscure. A drop occurs regardless of the prepartal intake, but Kuhlman and Gallup (17) observed that the percentage decrease of carotene was related directly to its level in the plasma. This, as indicated by data reported herein, seems to apply to vitamin A levels also.

Attempts to associate these changes of carotenoid and vitamin A concentrations of the blood with mammary function have yielded negative results. Although the secretion of colostrum withdraws vast amounts of nutrients from the blood, Sutton *et al.* (22) found no statistical correlation between levels of carotene and vitamin A of plasma and the output of these constituents in colostrum. Braun (5) reported that a temporary reduction of vitamin A occurred when cows aborted, under which conditions colostrum secretion would be negligible. Similar reductions of carotenoids and vitamin A were observed in a mammectomized cow following premature calving (26). As suggested by Sutton *et al.* (22), many factors and complex interrelationships may be involved. Investigation of the endocrinological aspects of the problems may aid in clarification.

The regulatory role of the liver in maintaining vitamin A concentrations in the blood, particularly in advanced gestation and early lactation, has not been elucidated. The reserves in this organ apparently are not a limiting factor except at subnormal storage levels. The changes in the vitamin A concentrations of the liver during this critical transitory period in the reproductive cycle merit study.

The amount of vitamin A in the livers of cows can be modified, as noted by others (6, 13), by dietary means. Data presented by Braun (6) suggested an optimum level for storage in this organ, but a comparison of his results with those reported herein indicates a wide margin between the optimum and the possible maximum levels attainable. Though the concentrations in the livers of the supplemented cows were at a uniformly high level, this does not indicate that the maximum was attained. Present information on the subject raises the question of whether or not the maximum attainable concentration of vitamin A in the liver is the same from carotenoid feeding as from vitamin A supplementation.

Most nutritional studies with dairy cattle have been directed toward determinations of effects of deficiencies and the establishment of minimum requirements. The results of this study suggest the need for considering the results from optimum and/or excess quantities of nutrients in the diet.

SUMMARY

The effects of daily supplementary feeding of 1,250,000 USP units of vitamin A in the form of a dry concentrate ("dry vitamin A") to individual lactating cows over a period of 3 months were compared with the results from similar cows on a standard dietary regime. The following conclusions were reached:

1. Vitamin A feeding had no significant effect on total milk and fat production.

2. The "dry vitamin A" concentrate did not depress the milk fat percentage.

3. The high intake of vitamin A increased the concentration of this vitamin markedly in the milk fat but tended to suppress the carotenoid content.

4. Prolonged dietary supplementation of vitamin A increased the level of this vitamin in the blood serum but reduced the carotenoid values. The apparent magnitude of the vitamin A values varied with the analytical procedure used in the assay.

5. Supplemental feeding of vitamin A throughout the terminal stages of gestation did not prevent the characteristic declines at parturition but did maintain a higher level at this period than observed in non-supplemented cows.

6. The differences in vitamin A intake were reflected in the concentrations of vitamin A in the liver. There was no evidence of a correlation between vitamin A levels in the blood and in the liver of any of the cows that were slaughtered.

The authors are grateful to Distillation Products, Inc., Rochester, New York, for supplying the vitamin A supplements ("dry vitamin A"), and to John Morrell and Company, Topeka, Kansas, for their cooperation and assistance in obtaining liver samples.

REFERENCES

(1) ARCHIBALD, J. G., AND PARSONS, C. H. The Effect of Feeding Vitamin A Supplement to Dairy Cattle. Mass. Agr. Expt. Sta. Bul. 357. 1939.

(2) BLAXTER, K. L., KON, S. K., AND THOMPSON, S. Y. The Effect of Feeding Shark-liver Oil to Cows on the Yield and Composition, and on the Vitamin A and Carotene Content of the Milk. Jour. Dairy Res., 14(3): 225–230. 1946.

(3) BOYER, P. D., PHILLIPS, P. H., AND SMITH, J. K. The Separation of Carotene from Vitamin A for the Determination of Vitamin A in the Blood Plasma. Jour. Biol. Chem., 152(2): 445–452. 1944.

(4) BOYER, P. D., SPITZER, R., JENSEN, C., AND PHILLIPS, P. H. Determination of Vitamin A and Carotene in Milk. A Rapid Extraction Procedure. Indus. and Engin. Chem., Analyt. Ed., 16(2): 101–102. 1944.

(5) BRAUN, W. Studies on the Carotenoid and Vitamin A Levels in Cattle. I. Seasonal Changes of the Carotenoid and Vitamin A Levels and the Normal Carotenoid-Vitamin A Ratio of the Blood. Jour. Nutr., 29(1): 61–71. 1945.

(6) BRAUN, W. Studies on the Carotenoid and Vitamin A Levels in Cattle. II. Carotenoids and Vitamin A in the Liver, Their Ratio and Their Relationship to Blood Levels. Jour. Nutr., 29(1): 72–79. 1945.

(7) DEUEL, H. J., JR., HALLIDAY, N., HALLMAN, L. F., JOHNSTON, C., AND MILLER, A. J. The Effect of Vitamin A Intake on Vitamin A Content of Butterfat. Jour. Biol. Chem., 139(1): 479–480. 1941.

(8) DEUEL, H. J., JR., HALLIDAY, N., HALLMAN, L. F., JOHNSTON, C., AND MILLER, A. J. The Production of High Vitamin A Milk by Diet. Jour. Nutr., 22(3): 303–313. 1941.

(9) DEUEL, H. J., JR., HALLMAN, L. F., JOHNSTON, C., AND MATTSON, F. The Effect of a High Vitamin A Intake on the Blood and Milk Carotene of Holstein and Guernsey Cows. Jour. Nutr., 23(6): 567–579. 1942.

(10) FOUNTAINE, F. C., AND BOLIN, D. W. The Milk and Butterfat Production Responses to Shark Liver Oil in the Ration. Jour. Dairy Sci., 27(2): 155–158. 1944.

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

(12) GALLUP, W. D., AND HOEFER, J. A. Determination of Vitamin A in Liver. Indus. and Engin. Chem., Analyt. Ed., 18(5): 288–290. 1946.

(13) GUILBERT, H. R., AND HART, G. H. Storage of Vitamin A in Cattle. Jour. Nutr., 8(1): 25–44. 1934.

(14) HICKMAN, K. Quotation from a personal communication cited in Science, 103(2680): 585. 1946.

(15) JENSEN, C., BOYER, P. D., PHILLIPS, P. H., RUPEL, I. W., AND LUNDQUIST, N. S. The Effect of Shark Liver Oil on Milk and Butter Fat Production. Jour. Dairy Sci., 25(11): 931–937. 1942.

(16) KIMBLE, M. S. The Photoelectric Determination of Vitamin A and Carotene in Human Plasma. Jour. Lab. and Clin. Med., 24(10): 1055–1065. 1939.

(17) KUHLMAN, A. H., AND GALLUP, W. D. Changes in Blood-plasma Carotene Associated with Parturition and Lactation of Jersey Cows. Jour. Dairy Sci., 27(8): 633–634. 1944.

(18) LUCAS, H. L., LOOSLI, J. K., AND MAYNARD, L. A. A Study of the Effect of Dietary Fat and Fat-soluble Vitamins upon Milk and Fat Secretion. N. Y. (Cornell) Agr. Expt. Sta. Mem. 251. 1943.

(19) PARRISH, D. B., WISE, G. H., AND HUGHES, J. S. Unpublished Data. Kans. Agr. Agr. Expt. Sta. 1946.

(20) RUBIN, M., AND BIRD, H. R. The Apparent Antagonism between Vitamin A and Carotenoids in the Fowl. Science, 103(2680): 584–586. 1946.

(21) RUSOFF, L. L., SKIPPER, H. E., AND DIX ARNOLD, P. T. Shark Liver Oil and the Vitamin A Potency of Milk. Jour. Dairy Sci., 25(9): 807–813. 1942.

(22) SUTTON, T. S., KAESER, H. E., AND SOLDNER, P. A. Changes in the Level of Vitamin A and Carotene in the Plasma of Dairy Cows Associated with Parturition and Beginning Lactation. Jour. Dairy Sci., 28(12): 933–939. 1945.

(23) WILSON, L. T. Feeding Vitamin A to Dairy Cows to Increase Milk Production. Certified Milk, 17(197): 5. 1942.

(24) WILSON, L. T. Vitamins for More and Better Milk. Certified Milk, 19(223): 3. 1944.

(25) WISE, G. H., CALDWELL, M. J., AND HUGHES, J. S. The Effect of the Prepartum Diet of the Cow on the Vitamin A Reserves of Her Newborn Offspring. Science, 103(2681): 616–618. 1946.

(26) WISE, G. H., PARRISH, D. B., FRANK, E. R., AND LEASURE, L. L. Unpublished Data. Kans. Agr. Expt. Sta. 1946.

COBALT IN COWS' MILK[1]

J. G. ARCHIBALD
Massachusetts Agricultural Experiment Station, Amherst

In continuation of a comprehensive project on the minerals of cows' milk, three reports on which have been published (1, 2, 3), the effect of feeding cobaltous acetate on the cobalt content of milk has been investigated. The feeding trials were conducted during the winter of 1943–44, but because of difficulty in finding a sufficiently sensitive method for the determination of extremely minute amounts of cobalt, the analytical work has been completed only recently.

Comparatively little information is recorded regarding the cobalt content of milk. Probably because of the difficulties of analysis, some of the earlier investigators (5, 7, 8, 13, 14) either do not report cobalt as a constituent of milk or else claim it to be absent, although one pair of workers (7) notes that "the complete absence of cobalt is somewhat unexpected, for it is an element with active biological properties." In 1933, Stare and Elvehjem (10) concluded that the cobalt content of milk is less than 0.01 mg. per 100 g. (100 μg. per liter of milk). By 1938, methods had been sufficiently refined so that Underwood and Elvehjem (12) report a range of 8–18 μg. per liter with an average of 11 μg. The most recent value noted is that given by Ellis and Thompson (9) in 1945, who report 0.64 μg. per liter. Other values recorded range from 1 μg. per liter (11) to 10–15 μg. per liter (5).

Data relative to the influence of the amount of cobalt in the feed on the cobalt content of milk are limited. In 1942, Askew (4) reported that cows having access to cobaltized salt licks produced milk containing 0.020–0.022 p.p.m. (20–22 μg./l.) of cobalt, as compared to 0.010–0.015 p.p.m. (10–15 μg./l.) in the milk of control animals. In the light of recent refinements of method, these values are probably too high, but the relative relationship is of interest. Comar *et al.* (6) noted a very small, unspecified amount of cobalt in milk when the radioactive element was introduced into the blood stream of cows. However, when it was introduced directly into the rumen, cobalt was not detected in the milk.

EXPERIMENTAL

The procedure was similar to that described in an earlier paper (1). Eight cows were divided into two groups of four each, each group consisting of an Ayrshire, a Guernsey, a Holstein, and a milking Shorthorn. Three of the breed pairs were matched with respect to stage of lactation, none being beyond the 12th week in lactation when the trial was started. The fourth

Received for publication February 21, 1947.

[1] Contribution no. 616 of the Massachusetts Agricultural Experiment Station.

pair (the Shorthorns) were in the 8th and 18th week of lactation, respectively, at the start, a matched pair not being available. One group received the supplement during December and January; the other group received it during February and March. The amount of cobaltous acetate fed was 500 mg. daily or the approximate equivalent of 120 mg. of elemental cobalt. Except for the feeding of the supplement, the rations and management of the two groups were identical.

Composite 2-day milk samples of two liters each were taken from each cow once a month. Cobalt was determined in triplicate on 500-ml. portions of each sample by the method of Ellis and Thompson (9), using the alternate carbamate extraction procedure. This method, although requiring much preliminary procedure in the purification of reagents, extreme precautions in technique and the scrupulous cleaning of glassware in order to avoid contamination, proved to be very satisfactory. The standard curve for cobalt established at the start was checked twice throughout the course of the work and was found to give good agreement; recovery of added amounts of cobalt ranged from 97 to 104 per cent of theory. A Model 11 Coleman spectrophotometer was used at a wave length of 345 millimicrons with filter PC6 and absorption tubes 50 mm. long and 10 mm. in diameter, with a capacity of approximately 3 ml. Final volume of the unknown solution was usually between 4 and 5 ml. A continuous glass still for production of double distilled water is a prerequisite for this type of work.

Previous to adoption of this method an older method which makes use of nitroso-R salt as the specific reagent for cobalt was given extensive trial, but proved quite unsuited to the purpose. Spectrographic analysis also was tried but was abandoned when it failed to reveal the presence of cobalt in dilutions of the magnitude anticipated. At already noted, other investigators (5, 13) also have been unable to identify cobalt in milk ash by means of the spectrograph.

RESULTS

The values obtained are summarized in table 1. The amount of cobalt occurring naturally in these milks averaged about 0.6 μg. per liter, with a range from 0.2 to 1.14 μg. These values are of the same order of magnitude as those reported by Ellis and Thompson (9) and Sylvester and Lampitt (11). There was some tendency for the amount of cobalt in the control milks to diminish as the season advanced. A similar tendency was noted in earlier work on manganese (1). The question raised at that time regarding that element appropriately may be raised with respect to cobalt, *viz.:* Does this mean that possibly, during the pasture season, cows store a reserve of the element which tends to become depleted as the winter season on dry feed proceeds?

Without exception, the milk from a cow receiving supplemental cobalt was higher in the element than the milk from her breed mate not receiving

TABLE 1

Effect on cobalt content of the milk of feeding cows cobaltous acetate
(Micrograms of cobalt per liter of milk)

Month	Cows on control ration					Cows receiving supplemental cobalt				
	1st half of the season									
	*A327	G658	H581	S62	Average of all four	A298	G640	H567	S38	Average of all four
December	1.0	1.0	0.6	0.9	0.9	2.3	1.6	1.0	1.5	1.6
January	0.8	0.7	0.5	0.3	0.6	2.6	2.9	1.4	1.8	2.2
Av. 1st half	0.9	0.9	0.6	0.6	0.7	2.5	2.3	1.2	1.6	1.9
	2nd half of the season									
	A298	G640	H567	S38	Average of all four	A327	G658	H581	S62	Average of all four
February	0.9	1.1	0.5	0.4	0.7	2.5	2.3	1.4	5.9†	3.0
March	0.2	0.2	0.2	0.2	0.2	2.7	2.9	0.9	5.0†	2.9
Av. 2nd half	0.6	0.7	0.4	0.3	0.5	2.6	2.6	1.2	5.4	2.9
Av. entire season	0.7	0.8	0.5	0.4	0.6	2.6	2.4	1.2	3.5	2.4

* The initial letter prefixed to each cow's number indicates the breed.

† Although there is nothing in the history of these two samples that would lead one to suspect contamination, they are so much out of line with the other values obtained that their validity may be open to question. However, since a high value for this cow was obtained in two successive months, the results are included in the average.

it. The increase ranged from less than two-fold (1.7—Holsteins—December) to twenty-five-fold (Shorthorns—March). As noted in the table, the latter value may be questioned. Of more interest is the average increase which was four-fold, a value which is highly significant statistically.

Although some variations between breeds are evident, the only consistent differences are the relatively low values for cobalt in Holstein milk, both when the cows were on the control ration and when they were receiving the supplement.

The obvious possible significance of these results lies in their application to calf nutrition. In our experience, young stock have shown greater susceptibility to the nutritional anemia which is characteristic of cobalt deficiency than have older cattle. In the light of these results it would seem that in areas where cobalt deficiency is common, the requirements of calves for this element might most naturally and logically be supplied through the milk of cows whose rations have been fortified with supplemental cobalt. Since many of our feed manufacturers now include cobalt regularly in the formulation of ready mixed rations for dairy cows, the use of such rations would tend to automatically supply the needs of the young calf for cobalt. Under ordinary circumstances the calf's requirements for cobalt may not be met since some of the control milks in this investigation contained less cobalt than was found in the drinking water supplied to the cows (0.21 μg./l. as compared with 0.26 μg./l.).

SUMMARY

Cobaltous acetate was fed as a supplement (500 mg. daily) to the rations of eight cows for a period of 2 months by the double reversal method and the milk was analyzed for cobalt. The results revealed that feeding the supplement consistently raised the amount of cobalt in the milk. The average increase was four-fold. The milk from cows receiving the supplement averaged 2.4 μg. of cobalt per liter in contrast with 0.6 μg. per liter when the cows were on the control ration. The possible significance of the results is discussed briefly.

Acknowledgment is made of valuable help and suggestions from Drs. K. C. Beeson and G. H. Ellis of the United States Plant, Soil, and Nutrition Laboratory, Ithaca, N. Y., in connection with the search for a satisfactory method for determining such extremely small amounts of cobalt.

REFERENCES

(1) ARCHIBALD, J. G. Manganese in Cows' Milk. Milk Plant Monthly, 30(9): 36. 1941.

(2) ARCHIBALD, J. G. Zinc in Cows' Milk. Jour. Dairy Sci., 27: 257–261. 1944.

(3) ARCHIBALD, J. G., AND LINDQUIST, H. G. Manganese in Cows' Milk. Jour. Dairy Sci., 26: 325–330. 1943.

(4) ASKEW, H. O. Mineral Content of Pastures. Investigations at the Cawthron Institute. New Zeal. Dept. Sci. and Indus. Res., Ann. Rpt., 16: 13–15. 1942.

(5) BLUMBERG, H., AND RASK, O. S. The Spectrographic Analysis of Milk Ashes. Jour. Nutr., 6: 285–288. 1933.

(6) COMAR, C. L., DAVIS, G. K., TAYLOR, R. F., HUFFMAN, C. F., AND ELY, R. E. Cobalt Metabolism Studies. II. Partition of Radioactive Cobalt by a Rumen Fistula Cow. Jour. Nutr., 32: 61–68. 1946.

(7) DINGLE, H., AND SHELDON, J. H. A Spectrographic Examination of the Mineral Content of Human and Other Milk. Biochem. Jour., 32: 1078–1086. 1938.

(8) DREA, W. F. Spectrum Analysis of Milk Ashes. Jour. Nutr., 8: 229–234. 1934; also, 16: 325–331. 1938.

(9) ELLIS, G. H., AND THOMPSON, J. F. Determination of Cobalt in Biological Materials with Nitrosocresol. Indus. and Engin. Chem., Analyt. Ed., 17: 254–257. 1945.

(10) STARE, F. J., AND ELVEHJEM, C. A. Cobalt in Animal Nutrition. Jour. Biol. Chem., 99: 473–483. 1933.

(11) SYLVESTER, N. D., AND LAMPITT, L. H. The Determination of Cobalt in Foods. Soc. Chem. Indus. Jour., Trans. and Commun., 59: 57–60. 1940.

(12) UNDERWOOD, E. J., AND ELVEHJEM, C. A. Is Cobalt of Any Significance in the Treatment of Milk Anemia with Iron and Copper? Jour. Biol. Chem., 124: 419–424. 1938.

(13) WRIGHT, N. C., AND PAPISH, J. The Inorganic Constituents of Milk. Science, 69: 78. 1929.

(14) ZBINDEN, C. The Infinitely Small Quantities of Certain Elements in Milk and Their Detection by the Spectrographic Method. Lait, 11: 114. 1931.

THE NUTRITIVE VALUE OF FRACTIONS OF BUTTERFAT PREPARED BY COLD CRYSTALLIZATION[1]

R. P. GEYER, B. R. GEYER, P. H. DERSE, H. NATH,[2] V. H. BARKI, C. A. ELVEHJEM, AND E. B. HART

Department of Biochemistry, College of Agriculture, University of Wisconsin, Madison

In past work the following methods have been employed to concentrate and characterize the factor(s) in butterfat responsible for its superior nutritive value as compared with corn oil: lead soap separation and steam distillation of butterfat fatty acids (2, 10), fractional distillation of the methyl esters of butterfat fatty acids (5), and chromatographic procedures (3). Since many of these require conditions conducive to chemical changes, cold crystallization of an acetone solution of butterfat was selected as a procedure most likely to yield fractions which had undergone little chemical transformation.

Henry *et al.* (7) reported the nutritive value of three fractions of butterfat prepared by cold crystallization from an acetone solution of 0° C. Two of these products with iodine numbers of 19 and 47 were fed to rats in a skimmed milk ration. The rate of growth was best on the diet containing the liquid fraction, but the authors stated that the small differences in gains between groups were without statistical significance. In 1946 Jack *et al.* (8) published the results on the nutritive value of five different fractions of butterfat prepared by low-temperature crystallization from hexane. Successive temperatures of −7, −13, −23, and −53° C. were used, and in each case the precipitate was removed. The final filtrate was concentrated and yielded the fifth fraction. To test the effect of solvent treatment on the nutritive value of the fat, butterfat was dissolved in hexane and the solvent removed by distillation. The fractions as well as the treated and untreated butterfat were incorporated into a synthetic type ration and fed to groups of rats. The poorest gain was made by the animals receiving the −7° C. precipitate (m.p. 53° C.) and the best gain was made by the animals fed either the untreated butterfat or the −53° C. filtrate rations. The solvent-treated butterfat proved to be definitely inferior to the untreated fat.

Received for publication February 28, 1947.

[1] Published with the approval of the Director of the Wisconsin Agricultural Experiment Station.

This work was supported in part by funds granted by the National Dairy Council, Chicago, on behalf of the American Dairy Association; by funds granted by the Evaporated Milk Association, Chicago; also by funds from the Wisconsin Alumni Research Foundation.

We are indebted to Merck and Co., Inc., Rahway, New Jersey, for supplies of some of the synthetic B vitamins and α-tocopherol.

[2] Government of India Research Fellow.

The experiments described in the present paper concern the application of cold crystallization to samples of butterfat obtained at various times throughout the year. The nutritive value and some chemical and physical constants of the fractions prepared are reported.

EXPERIMENTAL

The butterfat used in these experiments was prepared by decantation and filtration of melted (65° C.) unsalted sweet cream butter obtained from the University Creamery. The acetone was redistilled in an all glass still from calcium chloride before being used. One kilogram of melted butterfat was dissolved in 10 liters of acetone, and after being thoroughly stirred, the solution was cooled to −4° C. and kept at this temperature for 24 hours. Filtration of the yellow supernatant liquid from the white granular precipitate was accomplished by means of a submerged pressure filter. The precipitate was recrystallized twice from 5 liters of acetone at −4° C. The filtrates were combined and concentrated under partial vacuum, using a nitrogen ebullition tube. The temperature was kept below 20° C. except during the removal of final traces of solvent, when more heat was applied and a vigorous stream of nitrogen was used. The residue was reinforced with the proper amounts of the fat-soluble vitamins and then was stored at −6° C. This preparation was designated as butterfat fraction 2 (BF–2). The solid fraction remaining after the recrystallizations was freed of solvent and was vitaminized and stored at −6° C. This product was designated as butterfat fraction 1 (BF–1). The butterfat used in Expt. 1 was obtained in September, 1945; the fractions made at that time were stored for a number of weeks before use. Melting points were determined by a modified Wiley method and iodine numbers by the Hanus method. To eliminate the possible effect that the acetone treatment might have on the nutritive value of the fat fractions, a sample of butterfat was dissolved in acetone and after several hours the solvent was removed as described above.

Corn oil[3] was separated into two fractions in the following manner: 1 kg. of corn oil was dissolved in 5 liters of Skellysolve A and the mixture was cooled to −45° C. by use of an acetone–dry ice bath. After 5 hours at this temperature filtration was accomplished by means of the submerged filter. Because of the "waxy" nature of the precipitate some difficulty was encountered at this stage. Two recrystallizations of the solid material were made from 2,500-ml. portions of solvent at −45° C. The filtrates were combined, concentrated and vitaminized as previously described, and were designated corn oil fraction 2 (CO–2). Similar treatment of the solid product yielded corn oil fraction 1 (CO–1). A sample of corn oil was dissolved in the solvent and then freed of it after several hours to give a solvent-treated corn oil (CO–S).

[3] Mazola brand. Corn Products Refining Co.

Groups of six male weanling rats of the Sprague-Dawley strain weighing 40–45 g. were placed on rations containing each of the following fats: butterfat (BF), corn oil (CO), solvent-treated butterfat (BF–S), solvent-treated corn oil (CO–S), and the fractions BF–1, BF–2, CO–1, or CO–2. The basal ration consisted of:

Casein (alcohol extracted)[4]	20%
Fat	28%
Sucrose	48%
Salts IV (7)	4%
Vitamins per 100 g. of ration:	
Thiamine	200 gamma
Riboflavin	300 gamma
Pyridoxine	300 gamma
Ca pantothenate	1500 gamma
Choline hydrochloride	100 mg.
β-Carotene[5]	560 gamma
α-Tocopherol	2240 gamma
Calciferol[6]	14 gamma
2-methyl-1,4-naphthoquinone	210 gamma

Food consumption was unrestricted. Weekly weight records were kept over a 6-week period, and the results are given in table 1. Because of a marked difference in the appearance of the feces of the rats fed the two fat fractions, feces were collected from each group and analyzed for total fat, ash, and bound fatty acids. The latter determination was carried out by warming the ether-extracted feces with dilute HCl (1:4) for 30 minutes and extracting again with ether. The following results were obtained:

Group	Description of feces			
	Color	% Ash	% Neutral fat	% Bound fatty acids
BF–1	White	15.8	7.8	66.7
BF–2	Black	24.7	15.5	32.4
BF	Mixed	17.8	11.0	50.8

Because of the rapid rate of growth of the animals fed the BF–2 ration, studies were undertaken to investigate this phenomenon further. Fractions similar to those used in Expt. 1 were prepared using butterfat made from butter of December, 1945, and from February, June, July, and September of 1946. In all cases the butter was obtained directly after churning, and the fractionations and animal feeding trials were made without delay. In addition, butter obtained from the Quartermaster Corps of the Army and rated by them as June, 1945, also was tested. In a few instances additional

[4] Extracted for three 2-hour periods with boiling alcohol.

[5] 90 per cent β-carotene and 10 per cent α-carotene.

[6] Crystalline irradiated ergosterol.

fractions were prepared. The nutritional value of these fats and their fractions was tested by incorporating them in the basal diet used in Expt. 1 and

TABLE 1

Results of cold crystallization experiments
(Each figure represents the average of six rats)

Expt. no.	Group	Description of fat portion	m.p. °C.	Iodine no. (Hanus)	Av. gain	
					4 wks.	6 wks.
					(*g.*)	(*g.*)
1	BF*	Sept., 1945	34.0	33	101	158
	BF–S	Acetone treated	34.0	33	97	146
Sept., 1945	BF–1	– 4° C. ppt.	42.1	27	50	86
	BF–2	– 4° C. filtrate	8.0	47	139	204
	CO*	Mazola	.....	114	88	121
	CO–S	Skellysolve A treated	.....	114	86	125
	CO–1	– 45° C. ppt.	.....	109	88	122
	CO–2	– 45° C. filtrate	.....	121	85	116
2	BF	Dec., 1945	.....	.....	112	163
	BF–1	– 4° C. ppt.	42.5	.....	90	.....
Dec., 1945	BF–2	– 4° C. filtrate	7.6	.....	117	171
3	BF	Feb., 1946	34.1	.....	129	.....
	BF–S	Acetone treated	34.0	.....	123	.....
Feb., 1946	BF–1	– 4° C. ppt.	41.9	.....	116	.....
	BF–2	– 4° C. filtrate	7.5	.....	124	.....
	BF–1a	7° C. ppt.	47.1	11	67	.....
	BF–2a	– 4° C. ppt. minus fraction BF–1a	28.0	17	108	.....
	BF–3a	Combined filtrates from 1a and 2a	7.2	49	113	.....
4	BF–M	March, 1946	.....	.....	126	.....
	BF–J	June, 1946	33.0	.....	120	.....
June, 1946	BF–1–J	– 5.5° C. ppt.	41.8	.....	109	.....
	BF–2–J	– 5.5° C. filtrate	9.9	.....	129	.....
5	BF	July, 1946	.....	.....	128	189
	BF–1	– 5.5° C. ppt.	.....	.....	104	153
July, 1946	BF–2	– 5.5° C. filtrate	.....	.....	125	186
	BF–3	– 5.5° C. filtrate minus the recrystallization filtrates from BF–1	.....	.....	127	188
6	BF	Sept., 1946	.....	.....	101	173
	BF–1	– 5.5° C. ppt.	.....	.....	111	168
Sept., 1946	BF–2	– 5.5° C. filtrate	.....	.....	130	197
7	BF–J	June, 1945, Quartermaster Corps	.....	.....	115	172
	BF–1–J	– 5.5° C. ppt.	42.8	.....	75	.....
June, 1945	BF–2–J	– 5.5° C. filtrate	12.4	.....	125	187
	BF–M	March, 1946	.....	.....	119	181

* BF = butterfat; CO = corn oil.

feeding each ration to a group of six male weanling rats. The results are given in table 1. Feces collections and food consumptions were made in Expts. 3, 4, and 7, and analyses were made for neutral fat and combined

TABLE 2

Fecal excretion data for animals fed fats and fat fractions
(All data are based on 3-day pooled samples from six-rat groups, unless otherwise indicated)

Expt. no.	Group	Description of fat portion	Food ingested	Fat intake	Neutral fat excreted	Bound* fatty acids excreted	Lipid excreted	Fat absorbed
			(*g.*)	(*g.*)	(*g.*)	(*g.*)	(*g.*)	(%)
3	BF	Feb., 1946	246	68.8	0.91	5.95	6.86	91.2
	BF–1	Acetone treated	228	64.0	1.01	5.23	6.24	91.8
Feb., 1946	BF–1	–4° C. ppt.	204	56.9	1.04	7.64	8.68	84.8
	BF–2	–4° C. filtrate	213	59.6	0.63	3.54	4.16	93.0
	BF–1a	7° C. ppt.	167	46.7	4.01	6.62	10.60	77.3
	BF–2a	–4° C. ppt. minus the 7° ppt.	176	49.2	1.03	6.09	7.11	85.8
	BF–3a	Combined filtrates	203	56.9	0.66	3.69	4.35	92.3
4†	BF–J	June, 1946	321	90.0	1.76	8.64	1.04	88.5
	BF–J–1	–5.5° C. ppt.	329	92.0	0.94	3.86	4.81	94.8
June, 1946	BF–J–2	–5.5° C. filtrate	221	62.0	0.43	3.86	4.28	93.1
	BF–M	March, 1946	342	95.9	0.97	3.56	4.53	95.3
7	BF–Q‡	June, 1945	152	42.6	1.11	3.30	4.41	89.6
	BF–Q–1	–4° C. ppt.	144	40.2	2.82	5.69	8.51	78.8
	BF–Q–2	–4° C. filtrate	198	55.5	0.50	3.57	4.07	92.7
	BF–M	March, 1946	227	63.6	0.97	4.84	5.89	90.2

* Ether extractable material liberated by HCl treatment.
† 7-day pooled samples.
‡ U. S. Army Quartermaster Corps.

fatty acids. The latter analysis was made as described previously. The results of these analyses are given in table 2. The values for the per cent absorption of the various fats are not corrected for "metabolic" fat excretion.

DISCUSSION

Separation of butterfat into two fractions by means of cold crystallization from an acetone solution yielded in Expt. 1 a liquid fraction which allowed a very rapid rate of growth of rats when incorporated in a sucrose diet. During a 6-week period these animals averaged 4.9 g. per day, a rate of growth above that usually obtained with Sprague-Dawley rats fed similar synthetic type diets (4). The solid fraction of the butterfat proved to be very low in nutritional value, for the rats gained only an average of 2 g. per day over the 6-week period. From the iodine number of 27 which this fraction possessed, it is evident that unsaturated acids were present; however, these acids were not identified. It seems doubtful that linoleic acid deficiency could have caused the slow rate of growth which occurred even during the first week of the experiment. The fecal analyses show that the rat was able to hydrolyze the fat, but that the fatty acids liberated were not well absorbed. The melting point of 42° C. was not too high, for fairly good absorption occurred in subsequent experiments in which analogous fractions were employed.

The wide differences in nutritive value between the two fractions prepared from September, 1945, butter were not evident in any of the subsequent fractionation trials in which the butterfat used was prepared from butter obtained in June and December of 1945, and February, June, July, and September of 1946. In most cases, however, the rats fed the butterfat fraction 1 ration grew at a rate slightly inferior to that of the control groups, and they excreted more total ether-extractable material in their feces. Growth of the rats fed the BF–2 rations was uniformly good in all experiments and the per cent absorption of this fat was always above 89 per cent. Henry *et al.* (7) concluded that there was no significant difference between the nutritive value of two fractions of butterfat which were obtained by a procedure similar to the one described in this paper. The iodine numbers of their fractions are in close agreement with those given in table 1. It should be noted that the growth of the animals used by the English workers was far below the usual growth of the animals used in the present study; also, a different ration was used.

The growth of the rats fed the two corn oil fractions was nearly identical to that of the corn oil control groups, and the gain in weight by the animals receiving either of the treated fats was equal to that of those fed the nontreated fats. This latter finding is in disagreement with the observation of Jack *et al.* (8), who showed that the treatment of butterfat with hexane decreased its nutritive value.

No reason is apparent for the fact that only in the first experiment were significant differences between the nutritive value of the two fractions obtained. Perhaps a more detailed separation of butterfat will be needed to secure consistent results as far as an extremely active fraction is concerned. In view of the finding of Jansen's group of workers (1, 9) that vaccenic acid (11, 12-cladic acid) has growth-promoting properties, it would be of interest to analyze the various fractions for this compound.

SUMMARY

Butterfat prepared from butter made in various months of the year has been fractionated into two fractions by cold crystallization from an acetone solution. A liquid fraction obtained from September, 1945, butter allowed rats to grow at a superior rate, while a solid fraction prepared from this butter caused a very slow rate of growth. This phenomenon was not repeated to the same degree in subsequent trials using other samples of butter.

Corn oil was separated into two fractions by a similar procedure but rats grew equally well when fed either of these fractions or corn oil itself.

The treatment of either fat by solvent had no deleterious effect on its nutritive value.

REFERENCES

(1) BOER, J., JANSEN, B. C. P., AND KENTIE, A. Further Investigations on a Fat-soluble Growth-promoting Substance Present in Summer Butter. Nature, 158: 201. 1946.

(2) BOUTWELL, R. K., GEYER, R. P., ELVEHJEM, C. A., AND HART, E. B. The Effect of Hydrogenation on the Nutritive Value of the Fatty Acid Fractions of Butter Fat and of Certain Vegetable Oils. Jour. Dairy Sci., 24: 1027–1034. 1941.

(3) BOUTWELL, R. K., GEYER, R. P., ELVEHJEM, C. A., AND HART, E. B. Effect of Flavor on Nutritive Value of Fats. Soc. Expt. Biol. and Med. Proc., 55: 153–155. 1944.

(4) BOUTWELL, R. K., GEYER, R. P., ELVEHJEM, C. A., AND HART, E. B. Studies on the Interrelation of Fats, Carbohydrates, and B-Vitamins in Rat Nutrition. Arch. Biochem., 7: 143–157. 1945.

(5) GEYER, R. P., AND BOUTWELL, R. K. Unpublished.

(6) HEGSTED, D. M., MILLS, R. C., ELVEHJEM, C. A., AND HART, E. B. Choline in the Nutrition of Chicks. Jour. Biol. Chem., 138: 459–466. 1941.

(7) HENRY, K. M., KON, S. K., HILDITCH, T. P., AND MEARA, M. L. Comparison of the Growth-promoting Value for Rats of Butter Fat, of Margarine Fat, and of Vegetable Oils. Jour. Dairy Res., 14: 45–58. 1945.

(8) JACK, E. L., HENDERSON, J. L., REID, DELLA F., AND LEPKOVSKY, S. Nutritional Studies on Milk Fat. Jour. Nutr., 30: 175–181. 1945.

(9) KENTIE, A. Eeu Nieuw Vitamine in Boter. Doctorate Thesis, Universiteit von Amsterdam. 1946.

(10) SCHANTZ, E. J., BOUTWELL, R. K., ELVEHJEM, C. A., AND HART, E. B. The Nutritive Value of the Fatty Acid Fractions of Butter Fat. Jour. Dairy Sci., 23: 1205–1210. 1940.

STUDIES ON KETOSIS IN DAIRY CATTLE. IX. THERAPEUTIC EFFECT OF ADRENAL CORTICAL EXTRACTS

J. C. SHAW

Department of Dairy Industry, Storrs Agricultural Experiment Station, Storrs, Connecticut

There are some similarities between ketosis in cattle and Addison's disease in humans. Both subjects exhibit hypoglycemia and hypersensitiveness to insulin injections. The symptoms in both often are apparent at glucose levels which do not produce symptoms in normal subjects. Also in both, the blood glucose response to epinephrine injections is slight. There are a number of dissimilarities, but the positive relationships appeared to warrant some preliminary studies as to the possible rôle of the adrenal cortex in the development of ketosis in cattle.

EXPERIMENTAL

Four cases of uncomplicated ketosis were selected for study. Adrenal cortical extracts (Wilson) were injected subcutaneously at frequent intervals over short periods of time. Insofar as was possible, the cows were maintained on their customary feeding and management regime. Blood samples for glucose and acetone body determinations were drawn at frequent intervals before and during the course of treatment. Observations also were made of the behavior of the cows during the experimental periods. Blood glucose and acetone bodies were determined by methods previously cited (2).

Cow D. E. 259 was under observation for 3 days before treatment was initiated. The blood glucose, which was already at a low level on the first day of observation, decreased still more, and the blood acetone bodies increased from an already high level of 38.0 mg. per cent (fig. 1). The cow had refused all grain and ate but sparingly of hay during this period. Twenty milliliters of Wilson's extract were injected the evening of the third day. The following morning the cow appeared ravenous, quickly consuming 10 lbs. of hay and 5 lbs. of concentrate. A full bucket of grain containing approximately 10 lbs. of concentrate was fed and eaten rapidly. The blood glucose increased rapidly within the next 24 hours. Concurrently, the blood acetone bodies decreased.

The cortical extract was injected again on the fourth and fifth days, but the cow went off feed, apparently the result of over-feeding. On the seventh day, when the blood glucose and acetone bodies indicated a relapse and the appearance of the animal had worsened, injections again were initiated. Six injections, totaling 200 ml., were given within a 3-day period. The appetite of the cow again improved markedly; the blood picture likewise im-

Received for publication March 1, 1947.

proved. Milk production tended to parallel the blood sugar curve rather closely, increasing during both periods of treatment (fig. 1). The cow recovered without further treatment.

Cow D. E. 262, from which the data for figure 2 were obtained, also had shown symptoms of ketosis several days before treatment was initiated. This animal had been off feed for several days, exhibited incoordination and

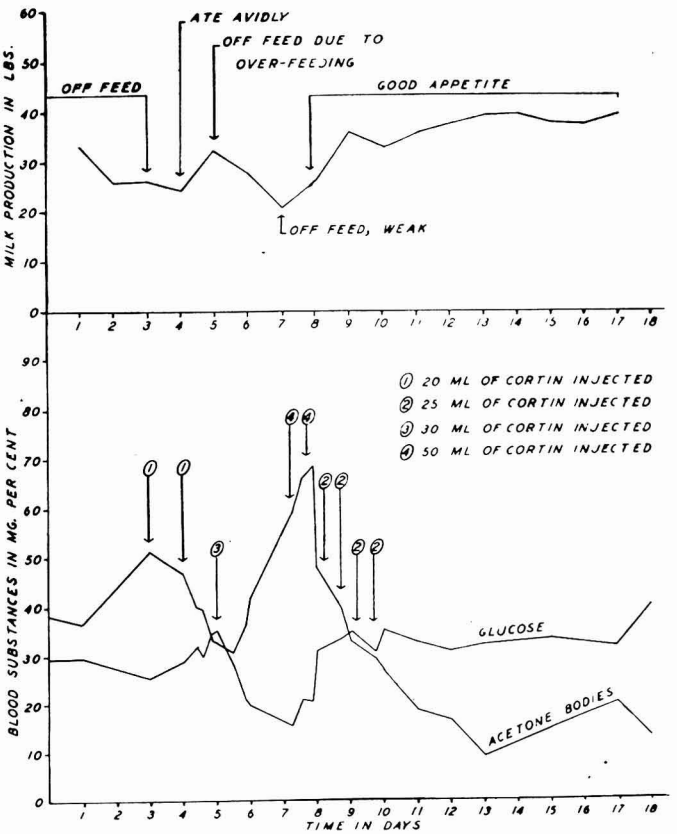


FIG. 1. Ketosis—cortin therapy (Cow D. E. 259).

general paresis, and was becoming emaciated. Milk production increased at first and then began to decrease rapidly, apparently with the onset of ketosis (fig. 2).

During a 3-day period, 375 ml. of Wilson's adrenal cortical extract were injected subcutaneously. An improvement in appetite was observed within 24 hours. The blood picture also improved, the blood glucose and acetone bodies approaching normal levels within 5 days. Within 4 days of the last

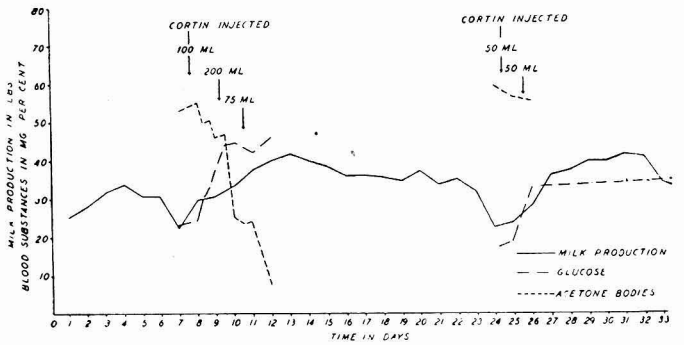


FIG. 2. Ketosis—cortin therapy (Cow D. E. 262).

injection, milk production, which had almost doubled following the initial injections, again began to decrease, indicating a relapse. Once more the animal refused all feed. An injection of 50 ml. of the adrenal cortical extract was made and repeated on the following day. Improvement in appetite, milk production, blood glucose, and blood acetone bodies was prompt. A week later, when the appearance of the animal denoted a possible relapse, glucose was injected intravenously.

In figures 3 and 4, data are presented graphically on the response to injections of adrenal cortical extracts of two cows exhibiting less advanced stages of ketosis. In both cases the ketonemia and hypoglycemia were marked, and both animals exhibited inappetence. The response to injections of the ad-

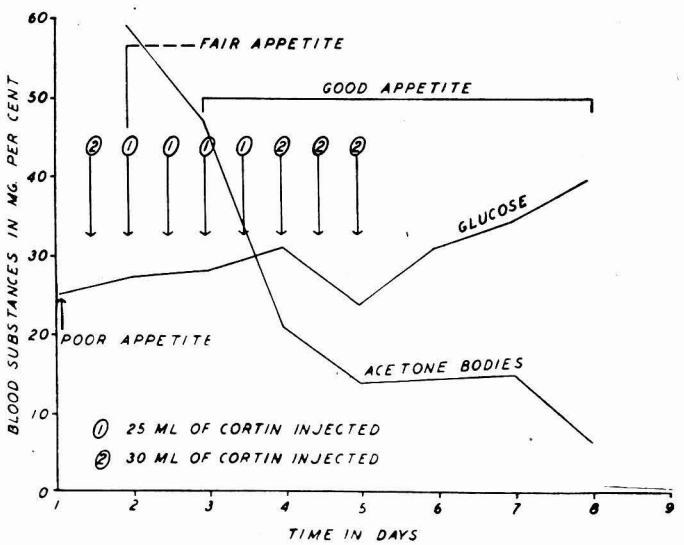


FIG. 3. Ketosis—cortin therapy (Cow D. E. 264).

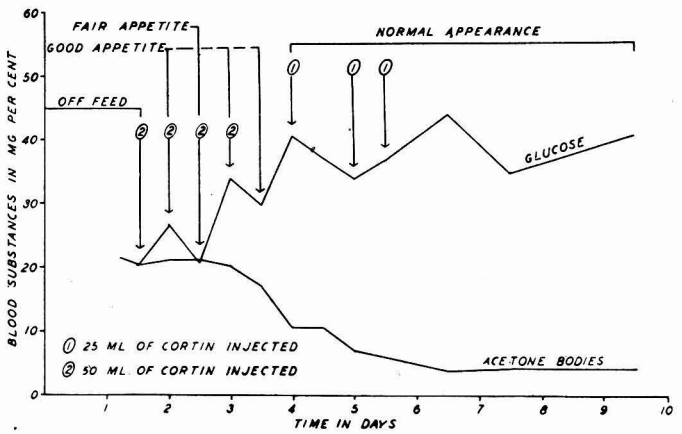


FIG. 4. Ketosis—cortin therapy (Cow D. E. 267).

renal cortical extract was prompt in the two animals. The appetite and general appearance of the two cows appeared normal within 3 to 4 days. No further treatment of any kind was required.

DISCUSSION

Caution must be exercised in drawing conclusions as to the effectiveness of any substance in promoting recovery of cows suffering from ketosis, since they recover from time to time without treatment and without any apparent change in management and feeding (2). The marked improvement following each injection period in each of the four cases studied appears to be significant however. It appears unlikely that four such cases selected at random all would improve so quickly purely by chance happening. Rather, it appears that the adrenal cortical extract did have a specific effect in promoting recovery.

This does not necessarily mean that ketosis in cattle is due to an adrenal insufficiency, since extracts of the adrenal cortex promote glyconeogenesis even in normal animals. The effect could have been strictly a therapeutic one in which improvement was due to an increased liver glycogen and/or blood glucose. There appeared to be little actual measurable increase in the blood sugar until after the appetite had improved, though it is possible that more carbohydrate was being made available to the body tissues.

The following observations on cows are similar to those observed in Addison's disease (3) and favor the view that an adrenal insufficiency may be involved: (a) Ketosis in dairy cows is a hypoglycemic condition. (b) There is a definite lowering of the glucose threshold at which symptoms become manifest (1). (c) Adrenal cortical extracts have elicited a favorable response in each of the four cases studied. (d) Cows with ketosis are more

sensitive to insulin injections than normal cows (unpublished). (e) The blood glucose response to adrenalin injections is slight (1).

The following are not in accord with the view that an adrenal insufficiency is involved in the development of ketosis in dairy cows: (a) The plasma sodium and potassium appear to be normal (unpublished). (b) The intravenous glucose tolerance curve of cows with ketosis (1) is not typical of that of adrenal insufficiency in other species (3). (c) Cows with mild cases of ketosis and many with relatively severe cases frequently recover following a single intravenous injection of glucose.

Preliminary work indicates that both the plasma sodium and potassium are normal, although more data are needed to establish this with certainty. The secretion of the carbohydrate principle could still be affected abnormally, of course, without affecting the sodium and potassium relationship.

CONCLUSIONS

Four cows with ketosis, when treated with an extract of the adrenal cortex, responded immediately with an improvement in appetite and a return of the blood glucose and acetone bodies toward the normal values. However, an adrenal insufficiency is not necessarily believed to be indicated.

REFERENCES

(1) SHAW, J. C. Studies on Ketosis in Dairy Cattle. V. The Development of Ketosis. Jour. Dairy Sci., 26: 1079–1090. 1943.

(2) SHAW, J. C. Studies on Ketosis in Dairy Cattle. VIII. Spontaneous Recovery. Jour. Dairy Sci., 29: 151–155. 1946.

(3) THORN, G. W., KOEPF, G. F., LEWIS, R. A., AND OLSEN, E. F. Carbohydrate Metabolism in Addison's Disease. Jour. Clin. Invest., 19: 813–832. 1940.

THE INFLUENCE OF A SYNTHETIC THYROPROTEIN WHEN FED TO DAIRY COWS OVER AN EXTENDED PERIOD[1]

RALPH P. REECE

Department of Dairy Husbandry, New Jersey Agricultural Experiment Station, New Brunswick

INTRODUCTION

The development *in vitro* of a highly active thyroprotein by Reineke and Turner (2) has made possible the determination, by a number of investigators, of the influence of thyroprotein on milk secretion in dairy cattle. The results of these investigations rather consistently have shown an increase in milk and milk-fat production accompanied by an increase in heart rate and a decrease in body weight.

The feeding of a moderate daily dose of thyroprotein during a 3-week period was found to increase the fat content without greatly augmenting milk production (1). The present study was made to determine the influence of feeding thyroprotein over an extended period.

EXPERIMENTAL PROCEDURE

Nine dairy cows in various stages of declining lactation and gestation were fed daily either 10 or 15 g. of thyroprotein (Protamone[2]), which was incorporated in the grain ration. During the entire feeding period, daily milk weights (milking twice daily) were recorded, and milk samples were taken on two consecutive days each month. Individual milk samples were tested for their butterfat content by the Babcock method. Body weights and heart rates (measured with a stethoscope) were determined on two consecutive days each month. The part of the lactation during which thyroprotein was fed is compared with a similar segment of either a previous or a subsequent lactation. In giving information on reproductive performance, the last breeding date is listed as the date of conception. In tables 1 and 2 are included results from five cows used in the first experiment (1).

EXPERIMENTAL RESULTS

Immediate changes in milk production following the feeding of thyroprotein. Nine cows that received 10 g. of thyroprotein showed an average initial increase of 7.6 per cent, whereas five cows fed 15 g. of thyroprotein increased 19.7 per cent in milk production. These results are summarized in table 1.

Received for publication March 7, 1947.

[1] Journal Series Paper of the New Jersey Agricultural Experiment Station, Rutgers University, Department of Dairy Husbandry.

[2] The Protamone was generously supplied by the Cerophyl Laboratories, Kansas City, Missouri, through the courtesy of Dr. W. R. Graham, Jr.

TABLE 1

Immediate changes in milk production following the feeding of thyroprotein

Cow no.	Av. daily production (lbs.) for 7 days prior to feeding	Av. daily production (lbs.) for highest 7 days after feeding	% change in production
		10 g./day	
H37	29.3	34.0	+16.0
492	23.5	25.8	+ 9.8
383	22.3	25.6	+14.8
H41	15.2	15.7	+ 3.3
627	26.1	28.4	+ 8.8
621	64.3	66.8	+ 3.9
378	31.0	34.4	+11.0
485	23.0	24.2	+ 5.2
611	31.7	31.7	0.0
Av.	29.6	31.8	+ 7.6
		15 g./day	
628	15.8	21.5	+36.1
619	17.7	26.6	+50.3
H41	27.3	32.3	+18.3
492	29.1	32.5	+11.7
642	27.4	27.5	+ 0.4
Av.	23.5	28.1	+19.7

Milk production following the withdrawal of thyroprotein from the ration. Thyroprotein was withdrawn from the ration of five cows that had been receiving 10 g. per day. The average daily milk production for the last 7 days of feeding was 25.0 lbs. as compared with 20.1 lbs. for the second 7-day period after withdrawal, a decrease of 19.5 per cent. The daily milk production of three cows receiving 15 g. of thyroprotein decreased from 14.8 lbs. to 9.8 lbs., a decrease of 34.2 per cent following the withdrawal of thyroprotein from the ration (table 2).

TABLE 2

Milk production following the withdrawal of thyroprotein from the ration

Cow no.	Av. daily production (lbs.) for last 7 days of feeding	Av. daily production (lbs.) for second 7-day period after withdrawal	% change in milk production
	10 g./day		
H37	34.0	29.0	-14.7
492	24.9	21.1	-15.3
383	22.9	16.8	-26.6
H41	14.6	10.3	-29.5
627	28.4	23.3	-18.0
Av.	25.0	20.1	-19.5
	15 g./day		
619	10.9	4.6	-57.8
628	10.9	9.8	-10.1
621	22.7	14.9	-34.4
Av.	14.8	9.8	-34.2

Milk production following the withdrawal and the refeeding of thyroprotein. To determine whether thyroprotein was exerting a stimulating influence on milk secretion after a prolonged feeding period, it was withdrawn from the ration of four cows for 7 days and then included again. In each instance, a sharp decline in milk production followed the withdrawal of thyroprotein. When thyroprotein again was fed, three of four cows attained the pre-withdrawal level of milk production. The cow (378) that failed to return to the pre-withdrawal level of milk production had been receiving 40 g. of thyroprotein daily, and when refed was given only 15 g. daily. These results are summarized in table 3.

TABLE 3

Milk production following the withdrawal and the subsequent feeding of thyroprotein

Cow no.	Av. daily production by 7-day periods	Thyroprotein fed daily
	(*lbs.*)	(*g.*)
619	23.9	15
	19.5 (15.9*)	None
	17.9	15
	24.0	15
378	13.9	40
	13.1	40
	9.8 (5.5*)	None
	8.0	15
	7.4	15
611	13.1	15
	10.2 (7.1*)	None
	10.2	15
	13.2	15
642	22.1	15
	19.3 (16.6*)	None
	18.7	15
	22.1	15

* Lowest daily production for the period.

Influence of feeding thyroprotein from 3 to 17 months. A Holstein-Friesian cow (H–41; born 10–27–39; calved 2–7–43; conceived 4–27–43; aborted 8-month fetus 1–3–44; cow infected with *Brucella abortus*) received 15 g. of thyroprotein daily for 2.5 months. Milk production increased from 27.3 lbs. to 32.3 lbs. (table 1) and the butterfat percentage increased from 3.11 to 4.32 in the first month of the feeding period. Body weight increased during thyroprotein feeding, and heart rate showed a maximum increase of 16 beats per minute. Increasing the dose of thyroprotein from 15 to 30 g. for 15 days did not prevent the decline in milk production which was occurring at that time. Body weight had increased by 106 lbs. and heart rate had decreased by 14 beats per minute 22 days after the removal of thyroprotein from the ration. These results are summarized in table 4. In 3 months of a control lactation cow H–41, calving at 4 years and 2 months,

TABLE 4

Influence of thyroprotein in the ration of cow H–41

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1943*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
Feb. (19 days)	56.7	.....	.....	.....	.....	.....
March	68.9	2.43	3.53	.....	.....	.....
April	66.1	1.98	3.00	.....	.....	.....
May	64.6	1.74	2.70	.....	.....	.....
June	45.5	1.25	2.75	.....	.....	.....
July	34.1	1.06	3.11	1271	67	.....
Aug.	29.3	1.27	4.32	1306	80	15
Sept.	22.8	0.95	4.20	1377	83	15
Oct.	12.7	0.58	4.59	1374	82	15*
Nov. (6 days)	6.9	.....	.....	1480†	68†	.....

* Thirty grams of thyroprotein daily from Oct. 15 to Nov. 1.

† Determinations made 22 days following the removal of thyroprotein from the ration.

produced 1,853 lbs. of milk with a 3.58 per cent test; in a similar segment of a lactation following calving at 3 years and 3 months, she produced 1,984 lbs. of milk with a 4.33 per cent test when thyroprotein was fed.

An Ayrshire cow (485; born 5–18–38; calved 5–6–42; conceived 6–26–42; calved normally 3–28–43) was fed 10 g. of thyroprotein daily for 4 months. Milk production increased only slightly (table 1); however, the fat content of the milk increased markedly. Body weight decreased and then increased, and by the end of the feeding period the cow had gained 63 lbs. in body weight. Although heart rate varied, in 3 of the 4 months it was considerably higher than in the month prior to thyroprotein feeding. Table 5 presents a summary of these results. This cow calved at 3 years and 1 month

TABLE 5

Influence of thyroprotein in the ration of cow 485

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1942*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
May (20 days)	28.5	.....	.....	.....	.....	.....
June	26.0	.....	.....	.....	.....	.....
July	22.9	0.93	4.04	.....	.....	.....
Aug. (15 days)	23.3	0.92	3.94	1027	64	.....
Aug. (16 days)	24.0	1.10	4.60	.....	.....	10
Sept.	21.3	0.98	4.58	980	78	10
Oct.	16.6	0.85	5.14	1013	65	10
Nov.	12.2	0.61	5.00	1033	92	10
Dec. (20 days)	7.3	0.39	5.33	1090	86	10

and in a 4-month segment of her lactation she produced 2,492 lbs. of milk with a 4.14 per cent test. In a similar segment of a subsequent lactation, calving at 3 years and 11 months, she produced 2,255 lbs. of milk with a 4.80 per cent test when fed thyroprotein.

A Brown Swiss, first-calf heifer (628; born 8–22–39; calved 9–28–42; conceived 12–7–42; calved normally 9–16–43) received 15 g. of thyroprotein daily for 4 months. This heifer had declined considerably in milk production after calving and it was evident that she was increasing in body weight at the expense of milk production. Milk production increased from 15.8 lbs. to 21.5 lbs. per day (table 1), and in the first 3 months of thyroprotein feeding this animal produced more milk than she had in the 3 months prior to thyroprotein feeding. Although milk production did not decline sharply

TABLE 6

Influence of thyroprotein in the ration of cow 628

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1942*)	(*lbs.*)	(*lbs.*)	(*%*)	(*lbs.*)	(*per min.*)	(*g.*)
Oct. (27 days)	24.7	1.19	4.80	.....	.....	.....
Nov.	21.4	0.83	3.90	.....	.....	.....
Dec.	17.9	0.83	4.65	.....	.....	.....
(*1943*)						
Jan.	17.3	0.81	4.70	.....	.....	.....
Feb.	16.2	0.75	4.64	.....	55	.....
March	19.5	0.97	4.98	1187	72	15
April	20.7	1.11	5.36	1126	66	15
May	20.5	1.02	4.98	1083	93	15
June	13.8	0.78	5.65	.....	.....	15
July	9.5	0.48	5.07	1137	78	.....

after the withdrawal of thyroprotein (table 2), there were other indications that the heifer had received stimulation from the thyroprotein in the last month of the trial. The butterfat content of the milk increased following the inclusion of thyroprotein in the ration and decreased when thyroprotein was removed. From the first month to the third month of thyroprotein feeding, there was a decrease of 104 lbs. in body weight. When the feeding of thyroprotein was discontinued, body weight increased. However, 15 days after the withdrawal of thyroprotein from the ration, body weight was still 50 lbs. below the weight prior to feeding. Heart rate increased by 17 beats per minute during the first month of the feeding period and, following thyroprotein withdrawal, a marked decrease in heart rate occurred. A summary of these results is given in table 6. This animal received thyroprotein during 4 months of her first lactation, having calved at 3 years and 1 month. In these 4 months she produced 2,274 lbs. of milk with a 5.21 per cent test. In a similar segment of her following lactation, having calved at 4 years and 1 month, she produced 1,788 lbs. of milk with a 5.07 per cent test.

A Brown Swiss cow (619; born 4–19–36; calved 12–2–42; conceived 2–13–43; calved 11–30–43, the calf being dead when first observed) received 15 g. of thyroprotein daily for 4.5 months. Milk production increased from 17.7 lbs. to 26.6 lbs. per day (table 1). Thyroprotein was removed from the ration in the second month of the feeding period, and the average daily milk production decreased from 10.9 lbs. to 4.6 lbs. The fat content of the milk varied greatly but this was more apparent than real, since the cow was of a nervous nature and frequently failed to milk-out completely. A decrease in body weight was followed by an increase, the increase occurring when milk production was decreasing rapidly. The heart rate was increased by thyroprotein feeding and it remained above the pre-feeding level during the entire feeding period. These results are summarized in table 7. In 4 months of a

TABLE 7

Influence of thyroprotein in the ration of cow 619

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1942*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
Dec. (27 days)	36.3	1.46	4.01	.....	.....	.....
(*1943*)						
Jan.	36.7	1.14	3.10	.....	.....	.....
Feb.	28.1	0.56	2.00	.....	.....	.....
March (13 days)	19.4	0.90	4.63	1222	59	.....
March (18 days)	21.0	.....	.....	.....	.....	15
April	25.2	0.99	3.92	1216	70	15
May	21.4	0.89	4.17	1141	71	15*
June	18.8	0.66	3.51	.....	.....	15
July	11.5	0.52	4.56	1178	75	15
Aug. (18 days)	6.1	.....	.....	.....	.....	.....

* Thyroprotein withdrawn from ration for 7 days.

control lactation period, having calved at 5 years and 7 months, no. 619 produced 3,161 lbs. of milk testing 4.05 per cent. In a similar segment of a lactation period when thyroprotein was fed, this animal, calving at 6 years and 7 months, produced 2,341 lbs. of milk with a 4.00 per cent test.

An Ayrshire cow (492; born 1–11–39; calved 4–16–43; conceived 8–10–43; calved normally 5–19–44) received 15 g. of thyroprotein daily for 5.5 months. Milk production increased from 29.1 lbs. to 32.5 lbs. per day (table 1). The fat test increased from 3.28 per cent prior to thyroprotein feeding to 4.07 per cent in the third month of thyroprotein feeding. In the following 2 months the fat content of the milk decreased to the pre-feeding level, even though milk production was falling rapidly. The fat content of the milk showed an increase only when the stimulus to secrete milk was low. The decrease in the fat content of the milk was associated with an increase in

body weight. There was an initial loss in body weight; however, in the fifth month of thyroprotein feeding, no. 492 was 100 lbs. above her pre-feeding weight. Heart rate increased and then decreased. Table 8 presents a summary of these results. Similar segments of 5 months each of two lactations were available for comparison. Calving at 4 years and 3 months, no. 492 produced 3,274 lbs. of milk with a 3.82 per cent fat test when thyroprotein was fed; calving at 5 years and 4 months, she produced 2,912 lbs. of milk with a 3.30 per cent fat test when thyroprotein was not fed.

A Jersey cow (378; born 1–5–39; calved 9–1–42; conceived 2–25–43; aborted 7-month fetus 9–23–43; cow infected with *Brucella abortus*) was fed 10 g. of thyroprotein daily for 4 months, after which increasing amounts were fed until a dose of 40 g. was attained in the sixth month of thyroprotein

TABLE 8

Influence of thyroprotein in the ration of cow 492

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1943*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
April (11 days)	33.5	.....	.....	.....	.....	.....
May	39.6	1.36	3.45	.....	.....	.....
June	35.7	1.12	3.15	.....	.....	.....
July	30.9	1.01	3.28	1010	75	.....
Aug.	31.0	1.18	3.80	989	82	15
Sept.	26.0	1.02	3.93	1006	76	15
Oct.	21.1	0.86	4.07	977	69	15
Nov.	19.6	0.74	3.75	1007	70	15
Dec.	9.4	0.30	3.22	1110	69	15
(*1944*)						
Jan. (13 days)	3.2	0.12	3.83	.....	.....	15

feeding. Milk production increased from 31.0 lbs. to 34.4 lbs. (table 1) soon after the inclusion of thyroprotein in the ration and then declined rather rapidly. However, this lack of persistency also was observed in a previous lactation. An attempt to prevent further decrease in milk production by increasing the thyroprotein dose did not meet with success. Butterfat percentage increased, but this increase probably was a result of the advance in the stage of lactation, since the fat content of the milk secreted during thyroprotein feeding was about the same as that secreted in a similar segment of a previous lactation. Body weight increased gradually until the last month of the feeding period. At that time body weight decreased slightly, and this decrease in body weight was accompanied by an increase in heart rate by 11 beats per minute. These results are summarized in table 9. Calving at 2 years and 8 months, no. 378 produced 2,757 lbs. of milk with a 3.97 per cent test in 6 months. In a similar segment of a subsequent lactation, calving at 3 years and 8 months, this animal produced 3,978 lbs. of milk with a 4.05 per cent test when thyroprotein was fed.

TABLE 9

Influence of thyroprotein in the ration of cow 378

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1942*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
Sept. (20 days)	33.6	1.21	3.60	.....	.....	.....
Oct.	31.9	1.12	3.52	830	82	.....
Nov.	33.1	1.23	3.72	848	79	10
Dec.	26.8	1.10	4.12	859	82	10
(*1943*)						
Jan.	23.6	0.93	3.93	859	74	10
Feb.	18.8	0.82	4.38	878	74	10
March	15.5	0.66	4.26	889	76	*
April	13.6	0.57	4.22	872	87	*

* Thyroprotein gradually increased from 10 g. per day to 40 g. per day.

A Brown Swiss, first-calf heifer (642; born 11–8–40; calved 5–2–43; conceived 7–2–43; calved normally 5–11–44) was fed 15 g. of thyroprotein daily for 6 months. Milk production was not augumented (table 1); however, by the third month of thyroprotein feeding the fat test had increased from 3.51 to 4.12 per cent. In the second month of the trial, thyroprotein was withdrawn from the ration for 7 days. Milk production decreased from 22.1 lbs. to 18.7 lbs. (lowest daily production was 16.6 lbs.). The addition of thyroprotein to the ration resulted in the return of milk production to the prewithdrawal level (table 3). Increasing the grain allowance by 2 lbs. per day, in the fourth month of the feeding period, resulted in a further increase in the fat content of the milk. This increase in the fat content of the milk was accompanied by an increase in body weight. These results are presented in table 10. Similar segments of 6 months each, of two lactations, are avail-

TABLE 10

Influence of thyroprotein in the ration of cow 642

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1943*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
May (25 days)	33.1	1.16	3.50	.....	.....	.....
June	31.9	1.02	3.20	.....	.....	.....
July	28.4	1.00	3.51	927	77	.....
Aug.	25.6	0.98	3.84	910	63	15
Sept.	20.8	0.83	4.01	906	64	15*
Oct.	21.5	0.89	4.12	905	58	15
Nov.	21.7	0.99	4.58	972	59	15
Dec.	19.5	0.90	4.59	1027	61	15
(*1944*)						
Jan.	18.5	0.79	4.27	1088	62	15
Feb. (9 days)	15.6	.....	.....	.....	.....	.....

* Thyroprotein withdrawn from ration for 7 days.

able for comparison. Calving at 2 years and 6 months, no. 642 produced 3,909 lbs. of milk with a 4.22 per cent fat test when thyroprotein was fed; calving at 3 years and 6 months, she produced 6,039 lbs. of milk with a 4.03 per cent fat test when thyroprotein was not fed.

A Brown Swiss cow (621; born 12–10–36; calved 8–6–42; conceived 11–25–42; calved normally 8–31–43) received 10 g. of thyroprotein daily for 4 months and then 15 g. daily for 4 months. There was an initial increase in milk production from 64.3 lbs. per day to 66.8 lbs. (table 1). Fat production in the fifth month of thyroprotein feeding (eighth month of lactation) was similar to that in the month of peak fat production, which was just

TABLE 11

Influence of thyroprotein in the ration of cow 621

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1942*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
Aug.	56.9	2.03	3.56	.....	.....	.....
(23 days)						
Sept.	61.3	2.15	3.51	.....	.....	.....
Oct.	66.4	2.27	3.42	1358	80	.....
Nov.	64.7	2.25	3.48	1342	78	10
Dec.	61.5	2.48	4.04	1302	75	10
(*1943*)						
Jan.	59.3	2.40	4.04	1297	76	10
Feb.	55.9	2.09	3.73	1364	75	10
March	53.9	2.20	4.09	1324	76	15
April	50.6	1.95	3.86	1339	77	15
May	43.2	1.94	4.49	1339	75	15
June	29.7	1.41	4.74	.....	.....	15
July (14 days)	16.7	0.82	4.88	1397	68	.....

prior to the addition of thyroprotein to the ration. The fat content of the milk did not increase until the second month of thyroprotein feeding. Body weight decreased slightly and then gradually increased. By the seventh month of the feeding period, this animal had not attained a body weight equal to that recorded in the month prior to thyroprotein feeding; at that time she was in the sixth month of pregnancy. There was no increase in heart rate. It is believed, however, that heart rate was higher than it would have been had thyroprotein not been fed, since heart rate decreased following the removal of thyroprotein from the ration. These results are summarized in table 11. No. 621, calving at 5 years and 8 months, produced 12,671 lbs. of milk (4.00 per cent test) in 8 months when thyroprotein was fed. In a similar segment of a subsequent lactation, calving at 6 years and 8 months, she produced 9,398 lbs. of milk (4.00 per cent test).

A Brown Swiss cow (611; born 8–24–34; calved 5–14–42; not pregnant) received 10 g. of thyroprotein daily for 6.5 months and 15 g. daily for an additional 10.5 months. There was no increase in milk production, but there

was a substantial increase in the fat content of the milk. Average daily fat production remained fairly constant during the first 9.5 months of the feeding period, after which it gradually decreased. Increasing the dose of thyroprotein from 10 to 15 g. per day did not increase either milk or milk-fat production. The withdrawal of thyroprotein from the ration for 7 days in the fourteenth month of the feeding period resulted in a sharp decline in milk production (table 3), indicating that thyroprotein had been stimulating milk production. The feeding of thyroprotein during the summer months did

TABLE 12

Influence of thyroprotein in the ration of cow 611

Date	Av. daily production		Fat test	Body weight	Heart rate	Thyroprotein fed daily
	Milk	Butterfat				
(*1942*)	(*lbs.*)	(*lbs.*)	(%)	(*lbs.*)	(*per min.*)	(*g.*)
May (9 days)	29.7	.....	.....	.....	.....	.....
June	28.1	.....	.....	.....	.....	.....
July	30.3	1.13	3.72	.....	.....	.....
Aug.	32.5	1.25	3.85	1233	60	.....
(15 days)						
Aug.	31.2	1.22	3.92	.....	.....	10
(16 days)						
Sept.	30.3	1.26	4.16	1171	63	10
Oct.	28.4	1.29	4.54	1169	59	10
Nov.	28.8	1.28	4.45	1180	72	10
Dec.	26.9	1.27	4.72	1192	60	10
(*1943*)						
Jan.	24.7	1.12	4.55	1185	58	10
Feb.	23.3	1.12	4.81	1208	53	10
March	23.5	1.15	4.90	1204	58	15
April	23.7	1.16	4.91	1195	66	15
May	23.9	1.14	4.78	1116	88	15
June	19.5	0.93	4.75	.....	.....	15
July	16.9	0.78	4.61	1159	87	15
Aug.	15.5	0.68	4.41	1182	59	15
Sept.	11.8	0.54	4.61	1207	59	15*
Oct.	12.6	0.60	4.77	1202	54	15
Nov.	12.1	0.59	4.89	1259	58	15
Dec.	8.2	0.39	4.80	1303	54	15
(*1944*)						
Jan. (11 days)	3.6	.....	.....	1387	64	15

* Thyroprotein withdrawn from ration for 7 days.

not prevent a decrease in fat test, although the fat tests probably were higher than they would have been had thyroprotein not been fed. Body weight and heart rate fluctuated considerably, the lowest body weight being recorded when the heart rate was highest. Body weight remained below the pre-feeding weight until the sixteenth month of the feeding period. At the end of the feeding period, at which time milk production was declining rapidly, the cow weighed 154 lbs. more than she weighed prior to the feeding of thyroprotein. A summary of these results is presented in table 12. It was possible to compare 305 days of the experimental lactation with a similar seg-

ment of a previous lactation. Calving at 6 years and 6 months, no. 611 produced 6,704 lbs. of milk with a 4.39 per cent test in 305 days of a normal lactation; calving at 7 years and 8 months, she produced 8,161 lbs. of milk with a 4.55 per cent test in 305 days when thyroprotein was fed.

DISCUSSION

The feeding of 10 g. of thyroprotein daily to dairy cows resulted in an initial increase in milk production of 7.6 per cent. Perhaps the most striking observation is the variation in response (from no response to + 14.8 per cent). One would anticipate, however, some variation in response, since the cows differed in age, stage of lactation, level of milk production, and breed. When 15 g. of thyroprotein were fed daily, the initial increase was more than twice as great as that obtained with 10 g. In addition, the variation in response also was greater, from + 0.4 to + 50.3 per cent.

The per cent decrease in milk production on the withdrawal of thyroprotein from the ration was greater than the per cent increase following the feeding of thyroprotein. The number of cows from which the averages were obtained, however, is not the same. Five cows that received 10 g. of thyroprotein daily and from which the thyroprotein eventually was removed showed an average increase of 11 per cent in milk production following feeding and an average decrease of 19.5 per cent following removal. In certain cases, after the withdrawal of thyroprotein from the ration, the level of milk production in the second week was lower than in the third week. In one instance (no. 383), the average daily milk production for the second 7-day period after withdrawal was 16.8 lbs. but in the third week after removal it was 18.4 lbs. The magnitude of the decrease in milk production following thyroprotein withdrawal appears to be associated with the stage of lactation and the degree of stimulation received during the feeding period. These observations suggest that, from the standpoint of milk and milk-fat production, after thyroprotein is included in the ration it should not be withdrawn until one desires to terminate lactation. Lactation will cease rapidly following thyroprotein withdrawal.

Of the nine cows receiving thyroprotein from 3 to 17 months, six weighed more and three weighed less at the end of the feeding period than at the beginning. In three instances in which observations were made, body weight increased rapidly following thyroprotein removal. Two of three cows that decreased in body weight during thyroprotein feeding failed to secrete milk with a higher fat content than that observed in a similar segment of a control lactation. The question may be raised as to whether it is undesirable to have cows continue to lose in body weight after the peak of lactation is passed. If this continued loss is undesirable, the additional feed intake required to prevent it must be determined. Since body weight increases rapidly following thyroprotein withdrawal, it should not be too difficult to

attain the desired body weight before the next calving. Another point to consider would be whether the latter part of the lactation plus the dry period or the dry period alone is the most desirable time to replenish the body reserves of a cow.

Body weight losses may not be severe following thyroprotein feeding, but the fat content of the milk may decrease despite an initial increase (no. 492). Increasing the feed intake may result in a further increase in the fat content of the milk (no. 642). This suggests the desirability of increasing the feed intake of an animal when thyroprotein feeding is started if a maximum response is desired.

SUMMARY

The daily feeding of 10 g. of thyroprotein to nine cows resulted in an initial increase of 7.6 per cent in milk production; five cows receiving 15 g. of thyroprotein daily increased 19.7 per cent in milk production.

The average daily milk production in the second week after the withdrawal of thyroprotein was 19.5 per cent below that of the last week of thyroprotein feeding in five cows receiving 10 g. of thyroprotein; in three cows receiving 15 g. of thyroprotein the decrease was 34.2 per cent.

In three of four cows receiving thyroprotein, the withdrawal and refeeding of thyroprotein resulted in a marked decrease in milk production and then a return to the pre-withdrawal level. The cow not returning to the pre-withdrawal level was not fed thyroprotein at the previous level.

Of nine dairy cows that received either 10 or 15 g. of thyroprotein daily for periods varying from 3 to 17 months, six secreted milk with a higher fat content and six produced more milk than that secreted in a similar segment of either a previous or a subsequent lactation. Of the three cows not showing an increase in milk production during the entire thyroprotein feeding period, only one failed to show an initial response in milk production.

The author is indebted to Dr. H. J. Metzger of the New Jersey Agricultural Experiment Station for the determination of *Brucella abortus* in two of the animals.

REFERENCES

(1) REECE, R. P. The Influence of a Synthetic Thyroprotein when Fed to Dairy Cows over a Three-week Period. Jour. Dairy Sci., 27(7): 545–550. 1944.

(2) REINEKE, E. P., AND TURNER, C. W. Formation in Vitro of Highly Active Thyroproteins. Their Biologic Assay, and Practical Use. Mo. Agr. Expt. Sta. Res. Bul. 355. 1942.

ASSOCIATION ANNOUNCEMENTS

PROGRAM

FORTY-SECOND ANNUAL MEETING

OF THE

AMERICAN DAIRY SCIENCE ASSOCIATION

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO, CANADA
JUNE 24–26, 1947

PROGRAM COMMITTEE

GENERAL:
J. A. NELSON, *Chairman*
Montana State College
G. E. RAITHBY
Ontario Agricultural College

MANUFACTURING:
B. E. HORRALL, *Chairman*
Purdue University
C. L. HANKINSON
North American Creameries, Inc.
Minnesota
F. J. BABEL
Iowa State College
W. C. LOY
Wilson and Co.
Illinois

EXTENSION:
W. T. CRANDALL, *Chairman*
Cornell University
E. H. LOVELAND
University of Vermont
A. R. PORTER
Iowa State College

PRODUCTION:
D. M. SEATH, *Chairman*
Louisiana State University
G. H. WISE
Iowa State College
G. W. SALISBURY
Cornell University

REGISTRATION

ADMINISTRATION BUILDING
ONTARIO AGRICULTURAL COLLEGE

Meetings will be held in the buildings on the campus of Ontario Agricultural College. Headquarters will be in the Administration Building.

PROJECTION EQUIPMENT

Lanterns will be available in all lecture rooms for projection of standard and $2'' \times 2''$ slides. Projectors for 16 mm. movies will be available by arrangement. Request for projection equipment should be made at the time abstracts of papers are submitted to the respective section Chairman. For the benefit of anyone bringing special electrical equipment, the available current is all 25 cycle.

COMMITTEE MEETINGS

Those wishing rooms for Extension and Production Section Committee meetings should write or contact G. E. Raithby and those in the Manufacturing Section wishing the use of rooms for Committee meetings should write or contact W. H. Sproule.

SPECIAL MEETINGS

Groups wishing rooms and equipment for special meetings before, during, or after the regular session will please contact G. E. Raithby. Provision also can be made for a limited number of breakfasts, luncheons, or dinners for special groups.

SCHEDULE OF PROGRAMS

Date and Time	General	Manufacturing	Production	Extension
Monday				
June 23, 1947	Registration			
Tuesday				
June 24, 1947				
8:00	Registration			
9:30–12:00	Opening Session			
1:00– 4:00		Papers	Papers	Papers
4:00– 5:00	Committees	Committees	Committees	Committees
8:00	Reception (Informal)			
Wednesday				
June 25, 1947				
9:00–12:00		Papers	Papers, A & B	Session
1:00– 1:30	Group Picture			
1:30– 5:30			Joint Meeting and Symposium	
1:30– 3:30		Papers		
3:30– 4:30		Business		
4:30– 5:30		Committees		
8:00	Mixer			
Thursday				
June 26, 1947				
9:00–11:00		Papers	Papers	Papers
11:00–12:00		Business	Business	Business
1:00– 3:00		Invitational Papers	Papers, A & B	
1:00– 2:00				Papers
2:00– 3:00				Business
3:00– 5:00	Business			
6:30	Annual Banquet			

GENERAL PROGRAM

Tuesday, June 24, 1947

Eastern Daylight Saving Time

9:30–12:00 OPENING SESSIONS, *War Memorial Hall*
G. E. RAITHBY, *Department of Animal Husbandry,* presiding
Introduction of Officers and Guests
Address of Welcome
W. R. REEK, *Acting President of Ontario Agricultural College*
Presidential Address
FORDYCE ELY, *President, American Dairy Science Association*
Guest Speaker
HON. GEORGE A. DREW, *K. C., Premier of the Province of Ontario*
Announcements

1:00– 4:00 SECTIONAL MEETINGS
Joint Meeting Production Sections A & B
Field Husbandry Building
Manufacturing Section
Dairy Building
Extension Section
Animal Husbandry Building

4:00– 5:00 COMMITTEE MEETINGS

8:00 RECEPTION (INFORMAL)

Wednesday, June 25, 1947

9:00–12:00 SECTIONAL MEETINGS
Production Section A
Field Husbandry Building
Production Section B
Field Husbandry Building
Manufacturing Section
Dairy Building
Extension Section
War Memorial Hall

1:00– 1:30 GROUP PICTURE, *Administration Building*

1:30– 5:30 SECTIONAL MEETINGS
Joint Meeting of Production Sections A & B and Extension Section
War Memorial Hall
Manufacturing Section
Dairy Building

3:30– 4:30 BUSINESS MEETING
Manufacturing Section
4:30– 5:30 COMMITTEE MEETINGS
Manufacturing Section
8:00 MIXER

Thursday, June 26, 1947

9:00–11:00 SECTIONAL MEETINGS
Joint Session Production Sections A & B
War Memorial Hall
Manufacturing Section
Dairy Building
Extension Section
Animal Husbandry Building
11:00–12:00 BUSINESS MEETING OF SECTIONS
Production Section
War Memorial Hall
Manufacturing Section
Dairy Building
Extension Section
Animal Husbandry Building
1:00– 3:00 SECTIONAL MEETINGS
Production Section A
Field Husbandry Building
Production Section B
Field Husbandry Building
Manufacturing Section
Dairy Building
Extension Section
Animal Husbandry Building
3:00– 5:00 GENERAL BUSINESS SESSION
War Memorial Hall
6:30 ANNUAL BANQUET
Creelman Hall
INSTALLATION OF OFFICERS AND PRESENTATION OF AMERICAN DAIRY SCIENCE ASSOCIATION AND BORDEN AWARDS

MANUFACTURING PROGRAM

Tuesday, June 24

Afternoon Session

Dairy Building

C. L. HANKINSON, *Chairman*

1:00– 4:00 **Bacteriology**

M1 Application of the Phosphatase Test to Various Dairy Products. GEORGE P. SANDERS AND OSCAR S. SAGER, *Bureau of Dairy Industry, U.S.D.A.*

M2 Time-Temperature Conditions Required to Inactivate Phosphatase in Different Dairy Products. GEORGE P. SANDERS AND OSCAR S. SAGER, *Bureau of Dairy Industry, U.S.D.A.*

M3 Determining the Germicidal Potency of Quaternary Ammonium Compounds and Their Use in Dairy Sanitation. W. S. MUELLER, D. B. SEELEY, AND E. P. LARKIN, *Massachusetts State College.*

M4 Effectiveness of Hypochlorite and Quaternary Ammonium Germicides in Destroying *Streptococcus agalactiae* in a Mastitis Sanitation Procedure. K. R. SPURGEON, P. R. ELLIKER, W. J. HARPER, AND J. R. FROEDGE, *Purdue University.*

M5 The Resazurin Reductase Test Using Prepared Sterile Dry Vials. N. S. GOLDING, *State College of Washington.*

M6 Some Observations on the Inversion of Sucrose by Invertase. L. E. MULL AND L. R. ARRINGTON, *University of Florida.*

M7 Observations on the Microscopic Analysis of Raw and Pasteurized Milk. G. H. WATROUS, JR., *Pennsylvania State College.*

M8 An Activity Test for Cheddar and Cottage Cheese Starters. B. E. HORRALL AND P. R. ELLIKER, *Purdue University.*

M9 Special Cultures for Manufacture of Blue Cheese from Pasteurized Milk. C. E. PARMELEE AND F. E. NELSON, *Iowa State College.*

M10 Lipase Production by *Mycotorula lipolytica.* I. I. PETERS AND F. E. NELSON, *Iowa State College.*

4:00– 5:00 **Committee Meetings**

Wednesday, June 25

Morning Session

Dairy Building

C. L. HANKINSON, *Chairman*

9:00–12:00 **Dry Milk Powders and Cheese**

M11 The Vapor Pressure–Moisture Relationships in Dry Milk Products. R. W. KUNKEL AND S. T. COULTER, *University of Minnesota.*

M12 Some Factors Influencing the Design of Spray Driers. ARNOLD KITZER AND S. T. COULTER, *University of Minnesota.*

M13 Changes Produced in Milk on Heating. H. A. HARLAND, R. JENNESS, AND S. T. COULTER, *University of Minnesota.*

M14 Some Changes in Dry Whole Milk during Storage. R. JENNESS, S. T. COULTER, H. A. HARLAND, AND L. K. CROWE, *University of Minnesota.*

M15 The Relationship of Ascorbic Acid to the Keeping Quality of Dry Whole Milk. S. T. COULTER AND R. JENNESS, *University of Minnesota.*

M16 Factors Affecting the Ease of Reconstitution of Milk Powders. U. S. ASHWORTH AND H. A. BENDIXEN, *State College of Washington.*

M17 The Use of Non-fat Dry Milk Solids for Mother and Batch Starters. B. E. HORRALL AND P. R. ELLIKER, *Purdue University.*

M18 Influence of Per Cent Oxygen in the Headspace Gas of Container on the Quality of Dry Whole Milk during Storage for One Year. G. H. WILSTER, *Oregon State College.*

M19 A Comparison of the Yields of Cheddar Cheese Obtained from Raw, Holder Pasteurized and High Short-Time Pasteurized Milk. O. W. IRVINE, L. R. BRYANT, D. C. HILL, AND W. H. SPROULE, *Ontario Agricultural College.*

Wednesday, June 25

Afternoon Session

Dairy Building

B. E. HORRALL, *Chairman*

1:30– 3:30 **Chemistry**

M20 A Study of the Volatile Acidity in Milk. P. G. MILLER, P. L. ZIMMERMAN, AND E. B. OBERG, *Carnation Company, Milwaukee, Wisconsin.*

M21 Some Unique Properties of Lactose as a Dietary Carbohydrate. LLOYD K. RIGGS, *Kraft Foods Company, Chicago, Illinois.*

M22 The Relationship between the Oxidation of Ascorbic Acid and the Development of the Oxidized Flavor in Milk. GEORGE R. GREENBANK AND PHILIP A. WRIGHT, *Bureau of Dairy Industry, U.S.D.A.*

M23 The Use of Carotene for Coloring Butter. G. A. RICHARDSON AND M. L. LONG, *University of California.*

M24 Graphic Procedure for Determining Quantitative Results of Volumetric Analysis. W. I. TRETSVEN, *Advisory Service, Chicago, Illinois.*

M25 Some Chemical Reactions Involved in the Production of the Sunlight Flavor in Milk. D. G. KEENEY AND D. V. JOSEPHSON, *Ohio State University.*

M26 A New Method for Determining Concentration of Quaternary Ammonium Germicide Solutions. W. J. HARPER AND P. R. ELLIKER, *Purdue University,* AND W. K. MOSELEY, *Indianapolis, Indiana.*

M27 Ionic Exchangers in the Dairy Industry. O. F. GARRETT, *M and R Dietetic Laboratories, Columbus, Ohio.*

3:30– 4:30 **Business Session**

4:30– 5:30 **Committee Meetings**

Thursday, June 26

Morning Session

Dairy Building

C. L. HANKINSON, *Chairman*

9:00–11:00 **Ice Cream, Evaporated Milk, and Sanitation**

M28 A Microscopic Study of the Texture of Ice Cream, W. S. ARBUCKLE, *University of North Carolina.*

M29 The Place of the Private Quality Control Laboratory in the Dairy Industry. M. A. COLLINS, *Dryden, New York.*

M30 Newly Developed Cleaning Aids for the Dairy Industry. JOHN R. PERRY, *Sealtest, Inc., New York, N. Y.*

M31 Some Observations on the Role of Sulphydryls in Heated Milk. STUART PATTON AND D. V. JOSEPHSON, *Ohio State University.*

M32 The Utilization of the Mineral-Ion Exchange Principle in the Manufacture of Evaporated Milk. D. V. JOSEPHSON AND C. B. REEVES, *Ohio State University.*

M33 The Manufacture of High-Solids Evaporated Milk. MARK KEENEY AND D. V. JOSEPHSON, *Ohio State University.*

M34 Condensing Whole Milk for Ice Cream Mix with the Vacreator. G. H. WILSTER, *Oregon State College.*

M35 A Study of the Use of Nordihydroguairaitic Acid in the Storage of Frozen Sweet Cream. J. W. STOLL, E. O. HERREID, AND P. H. TRACY, *University of Illinois.*

11:00–12:00 **Business Session**

Thursday, June 26

Afternoon Session

Dairy Building

C. L. HANKINSON, *Chairman*

1:00– 3:00 **Special Invitational Papers**

Utilization of Whey. B. H. WEBB, *Bureau of Dairy Industry, U.S.D.A.*

Milk Lipase. I. A. GOULD, *Dairy Department, University of Maryland.*

Continuous Methods for the Manufacture of Butter. A. W. FARRALL, *Agricultural Engineering, Michigan State College.*

Physical Chemistry as Applied to Ice Cream Manufacture. H. H. SOMMER, *University of Wisconsin.*

3:00– 5:00 **General Business Session**

War Memorial Hall

6:30 **Annual Banquet**

Creelman Hall

PRODUCTION PROGRAM

Tuesday, June 24

Afternoon Session

Field Husbandry Building

DWIGHT M. SEATH, *Chairman*

1:00– 4:00 SECTIONS A & B, **Artificial Breeding, Heredity Studies, Cross Breeding**

P1 The Influence of Streptomycin upon the Livability and Bacterial Content of Bull Semen. J. O. ALMQUIST, W. T. S. THORP, AND P. J. GLANTZ, *Pennsylvania State College.*

P2 Some Effects of Adding Thyroxine to Bull Semen. A. B. SCHULTZE AND H. P. DAVIS, *University of Nebraska.*

P3 Total Digestible Nutrients and Protein Levels for Dairy Bulls Used in Artificial Insemination. CECIL BRANTON, R. W. BRATTON, AND G. W. SALISBURY, *Cornell University.*

P4 A Study of Factors Affecting the Length of Gestation in Dairy Cattle. H. A. HERMAN AND R. W. SPALDING, *University of Missouri.*

P5 The Relationships of Frequency of Ejaculation, Age and the Ratio of Plasma Calcium and Phosphorus Levels to the Plasma Phosphatases of Dairy Bulls. J. T. REID, G. M. WARD, R. L. SALSBURY, AND C. E. SHUART, *New Jersey Agricultural Experiment Station.*

P6 Light Variation Associated with Conception Rate in Artificial Breeding. ERNEST MERCIER AND G. W. SALISBURY, *Animal Industry Service, Department of Agriculture of Quebec, Canada, and Cornell University.*

P7 Studies of Oxidative Mechanisms in Bull Semen. J. T. REID, R. L. SALSBURY, AND G. M. WARD, *New Jersey Agricultural Experiment Station.*

P8 Collecting Genetic Data through Cooperating Dairymen. N. P. RALSTON, S. W. MEAD, AND W. M. REGAN, *University of California.*

P9 Variation in the Type Ratings of Individual Ayrshire Cows. GEORGE HYATT, JR., AND W. J. TYLER, *West Virginia University.*

P10 Heritability of Type Ratings, and the Correlation between Type and Butterfat Production of Ayrshire Cows. W. J. TYLER AND GEORGE HYATT, JR., *West Virginia University.*

P11 Analysis of the Production Records of Cross-Bred Dairy Cattle. R. A. HILDER AND M. H. FOHRMAN, *Bureau of Dairy Industry, U.S.D.A.*

P12 Progress Report on Cross-Breeding of Dairy Cattle at Beltsville. M. H. FOHRMAN, *Bureau of Dairy Industry, U.S.D.A.*

P13 A Case of Intersex in Dairy Cattle. W. W. YAPP, *University of Illinois.*

4:00– 5:00 **Committee Meetings**

Wednesday, June 25

Morning Session

Field Husbandry Building

DWIGHT M. SEATH, *Chairman*

9:00–12:00 SECTION A, **Feeding and Management**

P14 Dairy Cattle Improvement Work of the Imperial Agricultural Research Institute—India. J. D. S. KUMARAN, *University of Missouri.*

P15 The Use of the Pen Barn as a Means of Mastitis Control. P. L. KELLY, D. F. BREAZEALE, G. S. HARSHFIELD, AND A. B. HOERLEIN, *South Dakota State College.*

P16 Report on Attempts to Prevent Mid-Summer Slump in Milk Production by Hay Feeding. D. M. SEATH AND G. D. MILLER, *Louisiana State University.*

P17 The Influence of Cracked Soybeans and Soybean Hay on the Flavor and Quality of Milk. ERLE E. BARTLEY AND C. Y. CANNON, *Iowa State College.*

P18 The Value of Adding Ground Alfalfa Hay to the Concentrate Mixture Fed with Prairie Hay in Rations for Dairy Cows. A. H. KUHLMAN AND H. W. CAVE, *Oklahoma A. & M. College.*

P19 The Effects of Calcium and Other Mineral Elements on the Lipid Partition in the Feces of Milking Cows. G. M. WARD AND J. T. REID, *New Jersey Agricultural Experiment Station.*

P20 Cobalt Tolerance in Young Dairy Cattle. H. A. KEENER, G. P. PERCIVAL, AND K. S. MORROW, *University of New Hampshire,* AND G. H. ELLIS, *U. S. Plant, Soil and Nutrition Laboratory, Ithaca, N. Y.*

P21 Phosphorus Metabolism Studies. I. Secretion of Phosphorus in Milk as Determined with the Radioactive Isotope. C. L. COMAR, W. A. KRIENKE, P. T. DIX ARNOLD, R. B. BECKER, AND GEORGE K. DAVIS, *University of Florida.*

P22 Feeding Value and Digestibility of Dehydrated Sweet Potatoes. L. L. RUSOFF, D. M. SEATH, AND G. D. MILLER, *Louisiana State University.*

GEORGE WISE, *Chairman*

9:00–12:00 SECTION B, **Colostrum, Mastitis, Milk Secretion**

P23 Studies on the Globulins of Bovine Colostrum. I. Isolation and Properties of a Water Soluble Globulin. R. G. HANSEN AND P. H. PHILLIPS, *University of Wisconsin.*

P24 Studies on the Globulins of Bovine Colostrum. II. The Absorption of Globulins by the Young Calf. R. G. HANSEN AND P. H. PHILLIPS, *University of Wisconsin.*

P25 Tocopherol Levels in the Colostrum and in the Early Milk of the Dairy Cow. D. B. PARRISH, G. H. WISE, AND J. S. HUGHES, *Kansas State College.*

P26 Action of Bacterial Filtrates Infused in the Mammary Gland. MAX L. DAWDY AND W. E. PETERSEN, *University of Minnesota.*

P27 The Effect of Intramammary Treatment for Mastitis upon Milk Production. ERIC W. SWANSON AND H. A. HERMAN, *University of Missouri.*

P28 The Use of Penicillin vs. Natural Recovery as a Means of Treatment of Mastitis. D. F. BREAZEALE, P. L. KELLY, G. S. HARSHFIELD, AND A. B. HOERLEIN, *South Dakota State College.*

P29 The Use of Non-Chlorine Disinfectants for the Washing of Cows' Udders. ROBERT H. KEITH AND PAUL M. REAVES, *Virginia Polytechnic Institute.*

P30 The Effect of Reduced Feed Intake on Mammary Growth and Lactation. J. F. SYKES, T. R. WRENN, AND S. R. HALL, *Bureau of Dairy Industry, Agricultural Research Administration, U.S.D.A.*

P31 Further Studies on the Effect of Vitamin D on Some of the Blood Changes in Normal and Milk Fever Cows at Parturition. J. W. HIBBS, W. D. POUNDEN, AND W. E. KRAUSS, *Ohio State University.*

P32 The Effect of the Quality and Quantity of Feed Prepartum and Post-partum upon Blood Glucose and Blood Acetone Bodies. J. C. SHAW AND G. M. CAIRNS, *University of Maryland.*

P33 Vitamin A Deficiency in Dairy Cattle on Rations Containing Ground Raw Soybeans. J. C. SHAW, *University of Maryland,* AND L. A. MOORE AND J. F. SYKES, *Bureau of Dairy Industry, Agricultural Research Administration, U.S.D.A.*

Wednesday, June 25

Afternoon Session

War Memorial Hall

W. T. CRANDALL AND D. M. SEATH, *Co-chairmen*

1:30– 5:30 **Joint Meeting with Extension Section**

Report of Dairy Cattle Health Committee, C. G. BRADT, *Chairman.*

Symposium—Brucellosis in Cattle.

3:00– 3:30 **Recess**

Report of Dairy Cattle Breeding Committee. E. J. PERRY, *Chairman.*

Report of Breeds Relations Committee. H. A. HERMAN, *Chairman.*

Symposium with PUREBRED DAIRY CATTLE ASSOCIATION participating, Getting the Most Out of Our Nation-Wide Testing Program.

Thursday, June 26

Morning Session

War Memorial Hall

DWIGHT M. SEATH, *Chairman*

9:00–11:00 SECTIONS A & B, **Roughage and Pasture**

P34 Values of Regular Corn Silage, Grainless Corn Silage and Ear Corn Silage in the Dairy Ration. KENNETH M. DUNN, RAY E. ELY, AND CARL F. HUFFMAN, *Michigan State College.*

P35 Carotene Losses from Artificially Dehydrated Alfalfa and from Artificially Dehydrated Alfalfa Silage. R. G. WASHBURN, W. E. KRAUSS, AND C. F. MONROE, *Ohio State University.*

P36 Silage Density: Effect of Pressure, Time and Crop Condition. A. E. PERKINS AND R. G. WASHBURN, *Ohio State University.*

P37 The Comparative Feeding Value of Corn Silage and Corn-Treated Meadow Crop Silage, with and without the Addition of Dilute Acetic Acid. C. F. MONROE, A. E. PERKINS, C. E. KNOOP, AND R. C. THOMAS, *Ohio State University.*

P38 The Digestibility of Coarsely Ground and Finely Ground Alfalfa for Dairy Heifers. ERIC W. SWANSON AND A. C. RAGSDALE, *University of Missouri.*

P39 Drying Requirements, Losses Due to Drying and Quality of Forage Obtained in Mow Hay Drying Experiments at Beltsville. J. B. SHEPHERD, L. G. SCHOENLEBER, H. G. WISEMAN, AND C. G. MELIN, *Bureau of Dairy Industry, Agricultural Research Administration, U.S.D.A.*

P40 Grazing Management Studies of Orchard Grass-Ladino Clover. P. S. WILLIAMS, V. G. SPRAGUE, C. B. KNODT, AND K. M. AUTREY, *Pennsylvania State College, and U. S. Regional Pasture Laboratory, State College, Pa.*

P41 The Evaluation of Several Grass-Legume Mixtures for Grass Silage and Aftermath Grazing. C. B. KNODT, V. G. SPRAGUE, P. S. WILLIAMS, AND K. M. AUTREY, *Pennsylvania State College, and the U. S. Regional Pasture Laboratory, State College, Pa.*

11:00–12:00 **Business Meeting**

Thursday, June 26

Afternoon Session

Field Husbandry Building

DWIGHT M. SEATH, *Chairman*

1:00– 3:00 SECTION A, **Milk Secretion**

P42 The Influence of Thyroprotein in the Ration of Dairy Cattle. RALPH P. REECE, *New Jersey Agricultural Experiment Station.*

P43 Some Effects of Feeding Thyroprotein to Dairy Cows. J. W. THOMAS AND L. A. MOORE, *Bureau of Dairy Industry, U.S.D.A.*

P44 The Effect of Thyroprotein and Feed Intake on the Heart Rate of Dairy Steers. J. F. SYKES, T. R. WRENN, L. A. MOORE, AND J. W. THOMAS, *Bureau of Dairy Industry, Agricultural Research Administration, U.S.D.A.*

P45 Further Observations on the Effects of Feeding Thyroprotein to Dairy Cows. A. H. VAN LANDINGHAM, GEORGE HYATT, CHARLES E. WEAKLEY, JR., AND H. O. HENDERSON, *West Virginia University.*

P46 Absorption and Elimination of Thiouracil in Ruminants. RAY E. ELY, KENNETH J. OLSON, AND E. P. REINEKE, *Michigan State College.*

P47 The Influence of Thiouracil on Mammary Lobule-Alveolar Growth in Mice. JOHN P. MIXNER, *New Jersey Agricultural Experiment Station.*

P48 Factors Influencing the Male Hormone Content of Cow Manure. C. W. TURNER, *University of Missouri.*

P49 Progress Report in Study of Certain Goitrogens. G. W. PIPES AND C. W. TURNER, *University of Missouri.*

P50 The Effect of the Interval between Washing of the Udder and Attachment of Milking Machines upon the Bacterial Flora and Milk Production of Dairy Cows. C. B. KNODT, J. J. REID, P. S. WILLIAMS, AND E. M. KESLER, *Pennsylvania State College.*

GEORGE WISE, *Chairman*

1:00– 3:00 SECTION B, **Calf Feeding**

P51 The Riboflavin Content of Cow's Colostrum. T. S. SUTTON AND HAROLD E. KAESER, *Ohio State University.*

P52 Some Possible Relationships between Management, Fore-Stomach Contents, and Diarrhea in the Young Dairy Calf. W. D. POUNDEN AND J. W. HIBBS, *Ohio State University.*

P53 The Effect of Feeding Various Levels of Vitamin A on the Depletion Time of Dairy Calves. W. C. JACOBSON, H. T. CONVERSE, AND L. A. MOORE, *Bureau of Dairy Industry, U.S.D.A.*

P54 The Antirachitic Properties for Calves of Hay Harvested by Field Curing, Barn Drying and Making Wilted Silage. L. A. MOORE, *Bureau of Dairy Industry, U.S.D.A.*

P55 Changes in the Cell Volume and in the Concentration of Several Inorganic Constituents in the Blood of the Dairy Calf during Its Early Post-Natal Development. G. H. WISE, M. J. CALDWELL, D. B. PARRISH, AND J. S. HUGHES, *Kansas State College.*

P56 Distillers' Dried Solubles and Grains with Solubles as a Supplement in Dairy Calf Rations. J. R. SCHABINGER AND C. B. KNODT, *Pennsylvania State College.*

P57 The Utilization of β-Carotene, Vitamin A Alcohol, and the Natural Ester of Vitamin A by Holstein Heifers. R. H. ROSS, C. B. KNODT, AND N. B. GUERRANT, *Pennsylvania State College.*

P58 Soybean Oil Filled Milks for Feeding Young Dairy Calves. NORMAN JACOBSON AND C. Y. CANNON, Iowa *State College.*

P59 The Placental Transfer and Colostral Storage of Vitamin D in the Bovine. H. D. EATON, A. A. SPIELMAN, AND J. K. LOOSLI, *Cornell University.*

P60 The Effect of Protein Level on the Nitrogen Metabolism and Gains in Weight of Growing Holstein Calves. G. P. LOFGREEN AND J. K. LOOSLI, *Cornell University.*

3:00– 5:00 **General Business Session**
War Memorial Hall

6:30 **Annual Banquet**
Creelman Hall

EXTENSION PROGRAM

Tuesday, June 24

Afternoon Session

Animal Husbandry Building

W. T. CRANDALL, *Chairman*

1:00– 1:15 **Opening Business Session**

1:15– 4:00 **Dairy Record Keeping**

Report of Dairy Records Committee. J. F. KENDRICK, *Bureau of Dairy Industry, U.S.D.A.*

Canadian Registration and Production Policies. G. E. Raithby, *Ontario Agricultural College.*

The Ohio Dairy Service Plan. R. R. STARBUCK, *Ohio State University.*

Estimating the Yield of Pasturage on Farms (a) The Method; (b) Use in Dairy Herd Improvement. R. E. HODGSON, F. J. ARNOLD, J. B. SHEPHERD, AND R. E. SHEAFFER, *Bureau of Dairy Industry, U.S.D.A. and the University of Maryland, cooperating.*

4:00– 5:00 **Committee Meetings**

Wednesday, June 25

Morning Session

War Memorial Hall

W. T. CRANDALL, *Chairman*

9:00–12:00 **Teaching Methods and Exhibits**

Technicolor, sound Extension Teaching Movie, "The Challenge to New York Dairymen".

Inspection of Exhibits and Explanation of Each Exhibit by Person in Charge.

Report of the Exhibit Committee. L. A. JOHNSON, *Michigan State College.*

Wednesday, June 25

Afternoon Session

Animal Husbandry Building

W. T. CRANDALL AND D. M. SEATH, *Co-chairmen*

1:30– 5:30 **Joint Meeting with the Production Sections**

War Memorial Hall

Report of Dairy Cattle Health Committee. C. G. BRADT, *Cornell University.*

Symposium—Brucellosis in Dairy Cattle.

3:00– 3:30 **Recess**

Report of Dairy Cattle Breeding Committee. E. J. PERRY, *Rutgers University.*

Report of Breeds Relations Committee. H. A. HERMAN, *University of Missouri.*

Symposium with PUREBRED DAIRY CATTLE ASSOCIATION participating, Getting the Most Out of Our Nation-Wide Testing Program.

Thursday, June 26

Morning Session

Animal Husbandry Building

W. T. CRANDALL, *Chairman*

9:00–11:00 **Artificial Insemination and Pen Stabling**

Selection and Repeatability of Sires Used in Artificial Insemination. RAY ALBRECTSEN, *Cornell University.*

The Montana Elevated Cow Stall. J. O. TRETSVEN, *Montana State College.*

The Uninsulated Pen Barn in Wisconsin. G. R. BARRETT, *University of Wisconsin.*

11:00–12:00 **Business Meeting**

Thursday, June 26

Afternoon Session

Animal Husbandry Building

W. T. CRANDALL, *Chairman*

1:00– 2:00 **4-H Club Programs**

Report of 4-H Club Committee. G. W. VERGERONT, *University of Wisconsin.*

A 4-H Dairy Extension Program and Plan of Work. H. A. WILLMAN, *Cornell University.*

2:00– 3:00 **Business Meeting**

3:00– 5:00 **General Business Session**

War Memorial Hall

6:30 **Annual Banquet**

Creelman Hall

VOLUME XXX MAY, 1947 NUMBER 5

JOURNAL OF DAIRY SCIENCE

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

ABSTRACTS OF LITERATURE

F. E. NELSON, Editor
Ames, Iowa

MILK AND MILK PRODUCTS

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

MILK INDUSTRY FOUNDATION
COL. B. F. CASTLE, Executive Director
1001 Fifteenth Street, N.W., Washington 5, D. C.

CONTENTS

THE SCIENCE PRESS PRINTING COMPANY LANCASTER, PA.

PUBLICATIONS AND ABSTRACTS

EDITORS

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

ABSTRACTORS

Archibald, J. G.
Babcock, C. J.
Bennett, F. W.
Berggren, Ruth E.
Burgwald, L. H.
Burkey, L. A.
Bushnell, L. D.

Call, A. O.
Caulfield, W. J.
Cole, W. C.
Coulter, S. T.

Doan, F. J.
Dorsey, L. M.
Downs, P. A.

Ely, Fordyce
Erb, J. H.

Frazier, W. C.
Fuller, S. A.

Glick, D. P.
Goss, E. F.

Henderson, J. L.
Huffman, C. F.

Irvine, O. R.

Josephson, D. V.
Kristoffersen, T.
Lucas, P. S.

Martin, W. H.
Marquardt, J. C.
Mueller, W. S.

Price, W. V.
Pyenson, Harry

Reece, Ralph P.

Salisbury, G. W.

Thomsen, L. C.
Trout, G. M.

Waugh, R. K.
Webb, B. H.
Weckel, K. G.
Weiser, H. H.

Yale, M. W.

JOURNALS

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

Biochemical Journal

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

Dairy Industries
Dairy World

Endocrinology

Food in Canada
Food Industries
Food Manufacture
Food Research

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

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

Lancet
Le Lait

Milk Dealer
Milk Industry
Milk Plant Monthly
Molkeritidende

National Butter and Cheese Journal
New Zealand Journal of Science and Technology

Nordisk Mejeri-Tidsskrift

Pacific Dairy Review
Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture
Southern Dairy Products Journal

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
Milk Industry Foundation

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

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

BOOK REVIEWS

138. Ice Cream Industry. Second Edition. G. D. TURNBOW, P. H. TRACY, AND L. A. RAFFETO. 654 pages. $6.00. John Wiley & Sons, New York. 1947.

This textbook on the manufacture of ice cream is entirely new and replaces an earlier book by Turnbow and Raffeto. The text covers the ice cream industry from its early history up to and including the war years. The book is well illustrated, contains 25 chapters of worthwhile information, and is understandable to the plant man who has had no technical training.

There are chapters dealing with history, classification, and recipes. The recipes (15 pages) are largely for various flavors used and for ice cream of different flavors, sherbets, ices, and fancy ice creams. Adequate directions also are supplied. Other chapters cover composition of mix, selection of milk products, and sweetening agents with their relative sweetness values.

A chapter of considerable size deals with stabilizers in which gelatins, gums of the kinds used in ice cream, and emulsifying agents are discussed. A short chapter is devoted to eggs in ice cream, and another to standardization of the mix. "Mix Preparation" is the title of a long chapter covering equipment use, standardizing of acidity, pasteurization, homogenizing, cooling, restandardization of off batches, making mixes in the vacuum pan, and coloring. Two chapters are devoted to freezing the mix by batch and both kinds of continuous freezers, overrun control, and factors affecting overrun. Flavoring ice cream is covered in Chapter 12, while other chapters deal with hardening ice cream and with packaging and delivery. Ice cream novelties, sherbets and ices, specialties, and the manufacture of fancy ice cream forms are well handled. Several excellent illustrations show how fancy forms are made.

Sanitary control, bacterial content, washing and sterilizing, food value, defects, and physical and chemical properties are discussed in detail in chapters devoted to these subjects. The business phases of ice cream manufacturing are covered in chapters devoted to merchandizing, plant costs, and records. The final chapters deal with mechanic phases such as refrigeration, steam and equipment, the testing of dairy products used in ice cream, and the testing of ice cream for fat and total solids. C.D.D.

139. Prices of Dairy Products and Other Livestock Products. FRANK A. PEARSON AND EDMUND E. VIAL. 154 pages. $3.00. Cornell University Press, Ithaca, New York. 1946.

This book contains the results of a study to determine the effect of monthly production, stocks, supply, price level, demand, and competitive

products on the monthly prices from 1920 to 1941 for each of twelve livestock products: butter, cheese, evaporated milk, nonfat dry milk solids, casein, eggs, poultry, lamb, veal, beef, pork, and lard. Oleomargarine and cottonsed oil also are discussed because of their close relationship to butter and lard, respectively. Most of the variations in prices of livestock products are explained on the basis of the general price level and the production, stocks, or supply of the different products. These factors accounted for 45 to 94% of the variation in the monthly prices. The importance of price level varied from month to month. For some products large production and low prices were associated, while in others high prices and high production were related. Stocks generally were related inversely to prices, but the effects varied widely from season to season and from product to product. Butter prices, for example, were more closely related to supply than to production. The commonly used measures of demand—national income, earnings of factory workers, and business activity—did not explain much of the variation in the prices after the effects of the price level and production, stocks or supply had been eliminated.

The book is well written, with most of the data presented in simple tabular and graphical form. A 14-page abstract and summary contains conclusions based on the principal findings for each product and a statement of the economic principles involved. This book should be a welcome addition to the library of any person interested in the factors affecting the prices of dairy and closely related farm products. W.L.S.

140. Bacterial Chemistry and Physiology. JOHN R. PORTER. pp. 1073 + x. $12.00. John Wiley & Sons, Inc., New York, N. Y. 1946.

This book is a needed addition to the literature of fundamental bacteriology, as it summarizes material from very diverse sources and provides an excellent bibliography for further study of special points. Much of the material is such as to have considerable technological application. Of the ten chapters, those on growth and death of bacteria, effects of physical agents on bacteria, effects of chemical agents on bacteria, bacterial enzymes and bacterial respiration, bacterial nutrition, and microbial fermentations should be of special interest to people in the dairy industry. F.E.N.

141. Concise Chemical and Technical Dictionary. H. BENNETT, Editor. pp. 1055 + xxxix. $10.00. Chemical Publishing Co., Inc., Brooklyn, N. Y. 1947.

More than 50,000 items, compounds, or names are described or defined. For many chemical compounds the chemical name, synonymous names, semistructural formula, molecular weight, color, form, specific gravity, melting point, and solubilities are given. The biological terms in general are incom-

pletely listed, and many of those listed are not defined as well as one might wish. The coverage of trade names and common trade terms appears to be unusually good and is one of the most desirable features of the book. The rules of nomenclature of organic chemistry adopted by the Council of the International Union of Chemistry in 1930 are summarized in some detail, and an extensive list of names and formulae of radicals occurring in organic compounds is presented. The 1934 report of the Nomenclature, Spelling and Pronunciation Committee of the American Chemical Society is reproduced by permission. Tables of Greek, mathematical, apothecary and miscellaneous symbols are given, as are weights and measures and temperature conversion scales. The list of indicators unfortunately lists those for pH, oxidation-reduction potential, and specific compounds all in one group. The diagraming of many of the important organic ring systems provides a useful summary.

While this is not a handbook in the usual sense of the word, it fulfills many of the functions of a handbook and provides considerable information, especially in the fields of chemistry and related topics, which is not included in the usual handbook. F.E.N.

BACTERIOLOGY

142. **A Review of Micrococcus Enterotoxin Food Poisoning.** W. C. HAYNES AND G. J. HUCKER, N. Y. State Agr. Expt. Sta., Geneva, N. Y. Food Res., *11*, 4: 281. July–Aug., 1946.

A rather complete summary of the available information relative to the rôle of certain varieties of micrococci in causing outbreaks of food poisoning or gastroenteritis in humans is presented. Milk and other dairy products frequently have been involved as sources of the organisms. Much of the presentation deals with the characteristics and properties of the bacterial enterotoxin, which is the real cause of the symptoms found in those suffering attacks. An extensive bibliography is presented. F.J.D.

CHEESE

143. **Building of Store Rooms for Cheese.** FRANK LAMBERTSEN. Nordisk Mejeri-Tidsskrift, *12*, 11: 221–230. 1946.

The modern store room for cheese must have a capacity large enough that it can hold 3–4 months' production; thus the cheese does not need to be sold in a period of low prices. A one-story building is the ideal, because cheese can be trucked easily from room to room. A one-story store room may be built in the basement and extended out under the area around the factory. The racks should be low enough that a man easily can reach the cheese

placed on the upper shelf. A sufficient space between the shelves and between the shelves, ceiling, and floor is of great importance for good working conditions, as are wide passages between the racks. No rack should ever touch the wall. The walls, ceilings, and floors should be smooth and without irregularities. For sanitary reasons, the walls should be faced with brick.

If a one-story store room cannot be built, the staircases and elevators should be placed conveniently. Likewise, the different rooms—the salting room, curing room, the cold cooler, and the sales room—should be located conveniently.

Much is dependent on the temperature and the humidity in the store room. Good insulation and a good heating and cooling system are of great importance. Heating is best done by circulation of warm water. Radiators are best placed on the walls. The cooling system can work with an evaporation temperature of 32° F. or a little above, and the humidity easily can be held at 80–85° F. without artificial humidification. A cooling system in which the air is circulated by a fan is best. It prevents water condensate on walls and ceilings and renews the air.

In store rooms for Blue cheese and Emmenthaler cheese the fan system cannot be used because of the high humidity wanted. Pipes in which a cooling medium is circulated can be placed under the ceiling and cold air will circulate over the cheese and keep it cold.

Both building and equipment must be of good quality. T.K.

144. Process for Making Material for Use in the Manufacture of Process Cheese. HIGBEE WAYNE BRYANT (to Kraft Cheese Co.). U.S. 2,392,362. Jan. 8, 1947. (5 claims).

In the manufacture of the class of cheese including Limburger, brick and Camembert varieties, after the curd is matted, it is subdivided into chunks not materially more than 1 inch in thickness and then washed promptly to prevent re-matting. The surfaces are subjected to action of appropriate aerobic ripening organisms in an atmosphere suitable for proper development and the ripened chunks then consolidated by heat to form the finished cheese. Increased rate of ripening under conditions which "substantially prevent" formation of undesirable rind is claimed. F.E.N.

145. Process for Making Cheese. ALAN E. FLOWERS AND ANDREW E. MERGET (to The De Laval Separator Co.). U.S. 2,415,239, Feb. 4, 1947. (4 claims).

A process for removing gas from cheese curd dispersed in whey and centrifuging out the curd as the heavier component by a continuous process is described. F.E.N.

CHEMISTRY

146. The Component Fatty Acids of Buffalo Colostrum Fat. C. P. ANANTAKRISHNAN, V. R. BHALE RAO, T. M. PAUL, AND M. C. RANGASWAMY, Imperial Dairy Research Institute, Bangalore, India. Jour. Biol. Chem., *166:* 31–33. 1946.

Composite mixtures of colostrum fat from four Murrah buffaloes taken the first five days, the tenth and fifteenth days of lactation were analyzed for the usual physical and chemical fat constants. The refractive index and the iodine value gradually decreased, with a corresponding increase in the Reichert and saponification values. Fat from the first, second, third, and tenth days of lactation was subjected to detailed chemical analysis by ester fractionation. "The chief changes to be found were the gradual increase in the amount of butyric, myristic, and palmitic acids and a decrease in the amount of stearic and oleic acids, the decrease in the latter being more pronounced." The analytical data are summarized in two tables. A.O.C.

147. The Immune Proteins of Bovine Colostrum and Plasma. EMIL L. SMITH, E. R. Squibb and Sons, New Brunswick, N. J. Jour. Biol. Chem., *164:* 345–358. 1946.

Colostrum and the protein fractions derived from it were studied electrophoretically. A lactoglobulin possessing all the immune properties of colostrum could be isolated, and data are given to show that this globulin easily is distinguished from β-lactoglobulin. In two different trials this immune globulin comprised 55% of the total protein of colostrum drawn 1 hour post partum. "Immune activity has not been found in fractions free from this protein, and conversely the isolated protein accounts completely for the immune properties of colostrum . . . by the second day the composition of the colostrum begins to approach that of milk and the immune lactoglobulin fraction can no longer be obtained free of other proteins by the simple method described."

Some discussion is devoted to the relationship of the various immune proteins. While the colostrum globulin is similar to the globulin found in bovine blood serum, the two are not identical. A.O.C.

148. Isolation and Properties of Immune Lactoglobulins from Bovine Whey. EMIL L. SMITH, E. R. Squibb and Sons, New Brunswick, N. J. Jour. Biol. Chem., *165:* 665–676. 1946.

"The high levels of immunity generally present in colostrum have served to obscure the fact that immunity is also present in the later milk. Though present in small amount, the immune proteins occur regularly in the whey of normal animals.

"Electrophoretic analysis has shown that the immune lactoglobulins constitute about 10 per cent of the protein in normal bovine whey. During hyperimmunization the immune components may increase considerably, although this does not occur regularly.

"A method has been described for the isolation from whey of the euglobulin and pseudoglobulin in electrophoretically homogeneous form. Immune activity is associated with both of these proteins.

"The isolated proteins have been studied in the Tiselius apparatus at different pH values, and the proteins have been characterized by their isoelectric points, diffusion constants, absorption spectra, and other properties.

"Studies in the ultracentrifuge reveal that all of the isolated bovine immune proteins contain more than one component. The principal component (76 to 92%) has a molecular weight of about 180,000." A.O.C.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

149. Plastic Cream, Its Production and Uses. R. J. SPIERS, Abbotts Dairies, Inc., Philadelphia, Pa. Dairy Ind. Found. Assoc. Bul., *39*, 7: 189–192. Feb. 14, 1947.

The present methods of producing plastic cream were perfected and patented by Abbotts Dairies, Inc., and a suitable bowl assembly designed by the De Laval Separator Co. A number of factors must be controlled carefully if the quality of the product is to be right. Included are: (1) good quality raw material, (2) freedom from copper or iron contamination, (3) temperature control (170° F. for 15 min. after the first separation and the second separation carried out at 145° F.), (4) product cooled enough to be like ice cream as it is packaged—never so much that paddles are necessary for handling, (5) use of a cylindrical cardboard container similar to 5-gallon ice cream can, (6) cooling as soon as packaging begins, using 10–20° F. air blast, (7) storing at 0 to −10° F., (8) shipping in brine-refrigerated cars, (9) keeping the fat content between 79.5–80.5% (all testing must be done at time of packing and not on frozen cream).

A thorough study of the psychrophylic type of bacteria in this product is needed. Plastic cream may be used for any purposes for which 50% cream is used and for some additional purposes. Largest use is in ice cream, with cream cheese a close second. If more attention is not paid to quality, plastic cream will lose much of the trade advantage it recently has earned. E.F.G.

150. Manufacture of Casein by Means of Gyratory Motion Applied to an Inclined Screen. EDWARD J. WENDT (to Hercules Powder Co.). U.S. 2,415,268, Feb. 4, 1947. (4 claims).

This patent describes a device consisting of a means for causing gyratory

motion to which is attached a closed pan provided with an inlet, a fine-mesh screen on the bottom but tilted from the horizontal, and an outlet in the pan from the highest point on the screen. A catch basin is placed under the pan to collect the liquid after the very fine particles have been separated from it. F.E.N.

151. **Dairy Process.** GERALD C. NORTH AND ALVIN J. ALTON (to Beatrice Creamery Co.). U.S. 2,392,401, Jan. 8, 1947. (6 claims).

Powdered whole milk is made by first separating the whole milk to fluid cream and skim milk. The resultant skim milk is condensed and heated to 170–180° F. for 15–30 min. The cream is heated separately to 170–180° F. for 15–30 min., then combined with the treated skim milk portion and the resultant mixture dried to a powder. F.E.N.

FEEDS AND FEEDING

152. **Factors Affecting the Enzymic Destruction of Carotene in Alfalfa.** H. L. MITCHELL AND S. M. HAUGE, Purdue University Agr. Expt. Sta., Lafayette, Ind. Jour. Biol. Chem., *164:* 543–549. 1946.

"Enzymic destruction of carotene in alfalfa leaves was retarded as long as the tissues remained turgid, but increased rapidly with wilting. Since the loss of carotene was very rapid when the cells had been ruptured or otherwise modified by freezing, it appears that cell permeability limits carotene destruction. Under field conditions, little loss of carotene occurs until wilting takes place.

"Soil fertility had no significant effect on the carotene-destroying activity of alfalfa leaves.

"As the plants approached maturity, there was a slight decrease in carotene-destroying activity.

"There were no consistent differences in the carotene-destroying activity of the four varieties of alfalfa studied.

"Enzymic destruction of carotene during field curing appeared to be greater than destruction by light." A.O.C.

ICE CREAM

153. **Retension of Ascorbic Acid in Strawberries during Processing, Frozen Storage and Manufacture of Velva Fruit.** H. J. LOEFFLER, Western Regional Research Laboratory, Albany, Calif. Food Res., *11,* 1: 69. Jan.–Feb., 1946.

Prime, mature strawberries averaged 66 mg. of ascorbic acid per 100 g. on a sirup-free basis 3 months after freezing. Immature fruit averaged 91 mg. and over-ripe fruit 55 mg. on the same basis. Whole or sliced berries

frozen without sugar lost no ascorbic acid during freezing. With sugar the losses amounted to about 10–15%. Whole berries packed in water lost about 20%, while pureeing or flash pasteurizing of the puree prior to freezing reduced the ascorbic acid not more than 5%.

On short storage (2–3 months), the berries frozen without sugar lost about 12–15% of their ascorbic acid; those with sugar, less than 5%; purees with sugar, 12%; and purees without sugar, about 16%. On extended storage up to 15 months, the sugared and unsugared berries lost only an additional 5% of ascorbic acid. The sugared and unsugared purees lost about 10 and 15%, respectively.

Losses during defrosting were found to be greater than in freezing and holding, particularly if the defrosting was slow or if the products were held some time after defrosting. When sugared puree was made into velva fruit, the loss of ascorbic acid was less than 5%. Unsugared purees, however, lost 12% during the mixing and refreezing. F.J.D.

154. Retension of Ascorbic Acid in Raspberries during Freezing, Frozen Storage, Pureeing and Manufacture into Velva Fruit. H. J. LOEFFLER, Glacier Packing Co., Sanger, Calif. Food Res., *11*, 6: 509. Nov.–Dec., 1946.

Essentially all the ascorbic acid was retained in raspberries during freezing and storage up to 4 months, and not over 25% was lost up to 28 months. Sugar was found of definite value in reducing even this small loss. In frozen raspberry purees, lack of sugar more than doubled the loss of ascorbic acid during 16 months of storage. F.J.D.

155. Ice-Cream Freezer. LEROY H. KNIBB. U.S. 2,416,326, Feb. 25, 1947. (15 claims).

The motor-driven freezer is intended for insertion into the ice compartment of a refrigerator. Provisions are made for discharge to the atmosphere of the air heated by the driving motor. F.E.N.

MILK

156. When Electricity Is Used for Pasteurization Does It Fit in with Other Plant Operations. ISRAEL ADAMS, St. Lawrence Dairy, Reading, Pa. Dairy Ind. Found. Assoc. Bul., *39*, 7: 177–179. Feb. 14, 1947.

The installation of an electrical pasteurizer presents no problems that cannot be corrected as readily as when installing any other system of pasteurization. The possibility of two or three small units to get the desired total capacity is suggested. E.F.G.

157. Pros and Cons of Short-Time High-Temperature Pasteurization. R. J. WINNING, Sheffield Farms Co., Inc., New York, N. Y. Dairy Ind. Found. Assoc. Bul., *39*, 7: 180–188. Feb. 14, 1947.

The advantages include: (1) a double safety factor from automatic control and the flow diversion valves, (2) lower equipment cost for large plants, (3) less floor space, (4) regeneration savings, (5) less labor in cleaning, (6) easier to operate, (7) more uniform product, (8) elimination of trouble from thermophilic bacteria, (9) expansion at small cost, (10) less milk held too long in case of shut down, (11) lower milk losses, (12) fact that thermoduric bacteria may survive encourages cleaning up milk supply, and (13) equipment more easily sterilized.

Disadvantages are: (1) gasket trouble, (2) some products as buttermilk, sour cream, etc., do not process well, (3) possibility of freezing when a low temperature cooling medium is used, (4) flow diversion valve should be improved and body made of stainless steel.

Some suggestions for use include checking flow in both forward and diverted position, keeping the unit completely airtight for ease of cleaning, and checking the flow with both homogenized and regular milk when putting out homogenized milk. E.F.G.

158. Experiences Using the S.T.H.T. on Milk, Cream, Buttermilk, Cocoa and Cottage Cheese. MARTIN KLOSSER, Bowman Dairy Co., Chicago, Ill. Milk Ind. Found. Assoc. Bul., *39*, 7: 167–179. Feb. 14, 1947.

Results from STHT as compared with a long flow method are as good from the standpoint of thermodurics, thermophilics, phosphatase test and cream volume, and better for the flavor of the milk. Seven units are operated in four plants of the writer's organization, with a total capacity of 105,000 lbs. of milk per hour. Both the Chicago Board of Health and the plant engineer frequently check the operation of the units in various ways. Sixteen hours with 75% regeneration seems to be the maximum length of run before loss in heat transfer rate requires disassembling and cleaning up the unit. Milk is heated to 161.5° F. for 16 sec. with clarification between regenerator and heater. Homogenized milk is heated to 170° F. for 16–18 sec., going from regenerator to homogenizer to clarifier to heater at 70° F. Cream is cooled in the cooling section. Thirty-six per cent cream takes about 20 sec. rather than 16 to pass through the holder. Skim milk for culture is heated with a second regenerator and heater to 185–190° F. When processing chocolate drink made from cocoa, a meandering retarder gives a 10 min. holding period at 180° F. Cocoa has a grinding effect on pumps, which need to be checked frequently. For cottage cheese 161.5° F. for 16 sec. is high enough; higher temperatures give curds which are too

fine. For cleaning, the alternate acid and alkali methods are used, followed by assembly and a sterilizing water rinse. STHT is used for all fluid milk, specialty products, and by-products, except sour cream and ice cream mix.

E.F.G.

159. **Some Cooking Qualities of Homogenized Milk. II. White Sauces.** ALICE M. TOWSON AND G. M. TROUT, Michigan State College, East Lansing, Mich. Food Res., *11,* 3: 261. May–June, 1946.

White sauces made with homogenized milk failed to incorporate added fats as well as when made with unhomogenized milk. As the amount of fat was increased, the difference became more pronounced. The viscosity of the sauces increased as the pressure used in homogenizing the milk was raised. Beaten sauces made with a rotary beater were smoother in texture and superior in flavor when homogenized milk rather than unhomogenized milk was incorporated into them. F.J.D.

160. **Improving Milk Quality from Cow to Plant.** C. B. A. BRYANT, Johnson and Johnson, Chicago, Ill. Milk Dealer, *36,* 4: 49–54. Jan., 1947.

See Abs. 72, Jour. Dairy Sci., *30,* 3: A33. Mar., 1947.

161. **Bottle Capping Head.** CARL W. GOODWIN (to American Seal-Kap Corp.). U.S. 2,416,001, Feb. 18, 1947. (4 claims).

A capping head for use with a hood cap having a central diaphragm, a top wall, and a fluid marginal skirt to be folded around the outer surface of the bottle neck is described. F.E.N.

162. **Method and Apparatus for Pasteurizing Liquids.** RAYMOND E. OLSON (to Taylor Instrument Co.). U.S. 2,415,304, Feb. 4, 1947. (10 claims).

The basic change involved in the usual high temperature–short time pasteurization process is the provision for raising the temperature of the heating fluid to a value above the predetermined level in response to diversion of the product when it fails to maintain the prescribed temperature.

F.E.N.

MISCELLANEOUS

163. **Federal and State Standards for the Composition of Milk Products.** ANONYMOUS. U. S. Dept. Agr., Bureau of Dairy Industry, Leaflet BDIM—Inf—45. 4 pp. Feb., 1947.

Federal, State and Territorial standards in force Jan. 1, 1947, are pre-

sented in tabular form, with explanatory footnotes in many instances. Data on minor products are not included. F.E.N.

164. Manufacture of Cream Products. LLOYD K. RIGGS (to Kraft Foods Co.). U.S. 2,414,837, Jan. 28, 1947. (6 claims).

A material containing 80 to 95% milk fat is produced by adjusting cream to pH 3.8 to 4.8, heating to at least about 180° F., and then centrifuging the heated acid cream to break the original emulsion. F.E.N.

165. Sediment Testing Device. BERNARD L. KINYON. U.S. 2,414,044, Jan. 7, 1947. (11 claims).

A portable sendiment tester using vacuum and compressed air for actuating the reciprocal plunger within the barrel is described. A measured quantity of milk is drawn into the barrel on the suction stroke and discharged through the filter on the pressure stroke. F.E.N.

166. Method of Removing and Concentrating Residue from Containers. E. ROY ALLING AND HENNING A. TREBLER (to Rice & Adams Corp.). U.S. 2,418,063, Mar. 25, 1947. (11 claims).

A pre-rinse for a continuous can washer, in which two lots of detergent-free water are used consecutively and repeatedly until a "marketable concentration" of material such as milk is built up in the first of the two rinses, is described. The rinsed cans then are washed with water containing a detergent. F.E.N.

167. Can Dumping Mechanism. CLAUDE H. ABBOTT. U.S. 2,413,900, Jan. 7, 1947. (5 claims).

A power-driven can dumping device for use with milk cans is described. F.E.N.

168. Defrosting Frozen Foods by High Frequency Heat. W. H. CATHCART AND J. J. PARKER, National Bakery Division, The A & P Tea Co., New York, N. Y. Food Res., *11*, 4: 341. July–Aug., 1946.

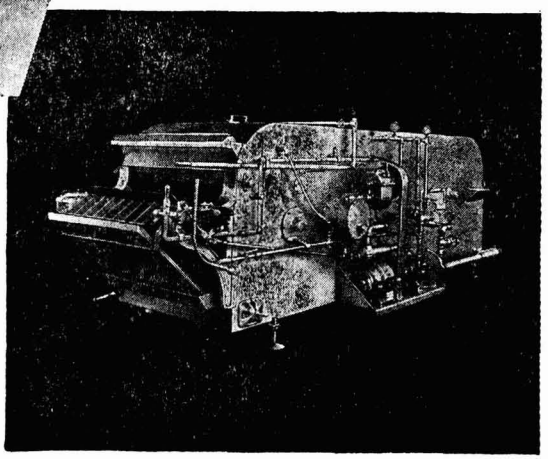
Utilizing a 3-kilowatt high frequency unit made by the Federal Telephone and Radio Corporation, the authors were able to defrost frozen eggs, fruit, vegetables, and fish in cardboard containers in from 2 to 15 min., depending on the size of the package. This was accomplished without loss of quality, such as discoloration and flavor deterioration. F.J.D.

Copies of the 20-Year Index covering Volumes I to XX, inclusive are available at the following prices:

MEMBERS	
Cloth Bound	**$2.35**
Paper Bound	**2.00**
NON–MEMBERS	
Cloth Bound	**$5.50**
Paper Bound	**5.00**

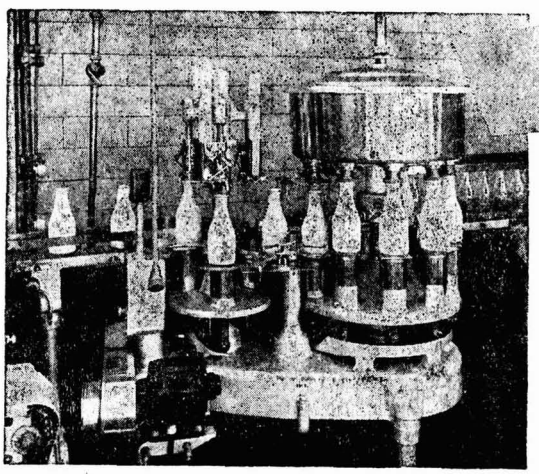
A WINNING TEAM

CP 8-WIDE BOTTLE WASHER



This rugged, efficient Style C soaker washer, equipped with automatic feed and discharge, delivers clean, sparkling bottles at the rate of 54 to 66 bottles a minute. Handles round or square bottles in sizes from half-pint to quart. Efficient use of water and washing powder. Holds bottle washing costs to a minimum. Write for Bulletin J-422.

CP 26 ROTO-MATIC BOTTLER



Equipped with ten diamond-bored Equa-Fill Valves. Handles all size bottles from ½-pt. up to 2-qt.—round or square. Capacity, when filling quarts, is 48 bottles per minute. Maximum speed, 70 bottles per minute. Speed is readily adjustable to synchronize with washer, pasteurizer or to handle heavy-bodied products. Write for Bulletin F-734.

Creamery Package

THE CREAMERY PACKAGE MFG. COMPANY

General and Export Offices: 1243 W. Washington Blvd., Chicago 7, Illinois

Branches in 21 Principal Cities

CREAMERY PACKAGE CO. OF CANADA, LTD. · TORONTO, ONT.

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