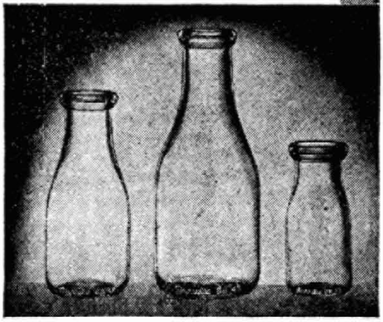
JOURNAL OF DAIRY SCIENCE

Contents

Vol. XXX, No. 1, January, 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.

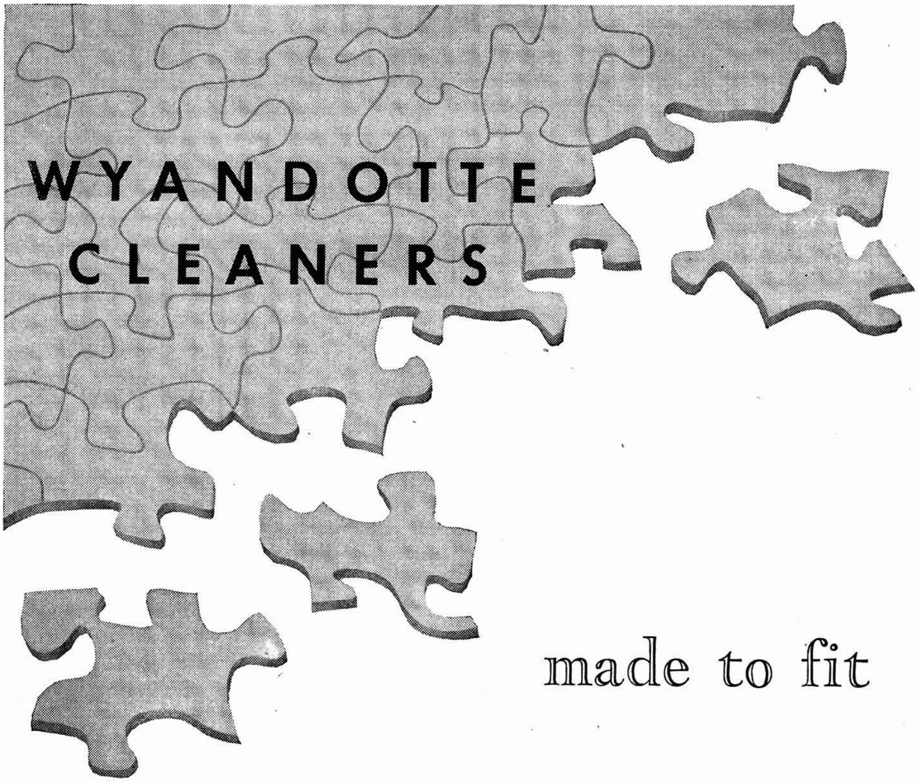
Whichever line you choose, you will profit by these Owens-Illinois features:

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



In the complete Wyandotte line there's a product especially made to fit every cleaning need.

For washing cans by machine, there's Wyandotte C.W., efficient, non-corroding. Wyandotte G.L.X.* assures removal of deposits from monel, steel and glass. Wyandotte S.R.-10 makes quick work of milkstone removal.

Four tested Wyandotte bottle-washing compounds are available—Alkali Special, 721 Special,* Seneca Flakes,* Chippewa Flakes.* Where difficult washing conditions prevail use Wyandotte B.W.C. (Bottle Water Conditioner) with any of these.

For equipment cleaning, under any water conditions, there's a Wyandotte Product. Wyandotte G.L.X. is for all kinds of water. Wyandotte Cleaner and Cleanser* is for soft water—Wyandotte Poma Cleaner* for water of medium hardness—Wyandotte Keego* for very hard water. Wyandotte Detergent keeps cans bright and clean. An efficient acid neutralizer, Wyandotte C-A-S* is readily soluble, pure and uniform.

Walls, floors and washrooms respond to Wyandotte treatment, too! Wyandotte Detergent is preferred in many modern plants. Or, if you want an *all-soluble* cleaner, Wyandotte F-100* is unexcelled. A good paste cleaner for metal and porcelain is Wyandotte Paydet.

For the germicidal rinse or spray, after washing, use Wyandotte Steri-Chlor.* For further information about Wyandotte Products call in the Wyandotte Representative.

**Registered trade-mark*

WYANDOTTE CHEMICALS CORPORATION

WYANDOTTE, MICHIGAN • SERVICE REPRESENTATIVES IN 88 CITIES

Wyandotte
REG. U. S. PAT. OFF.

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION

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

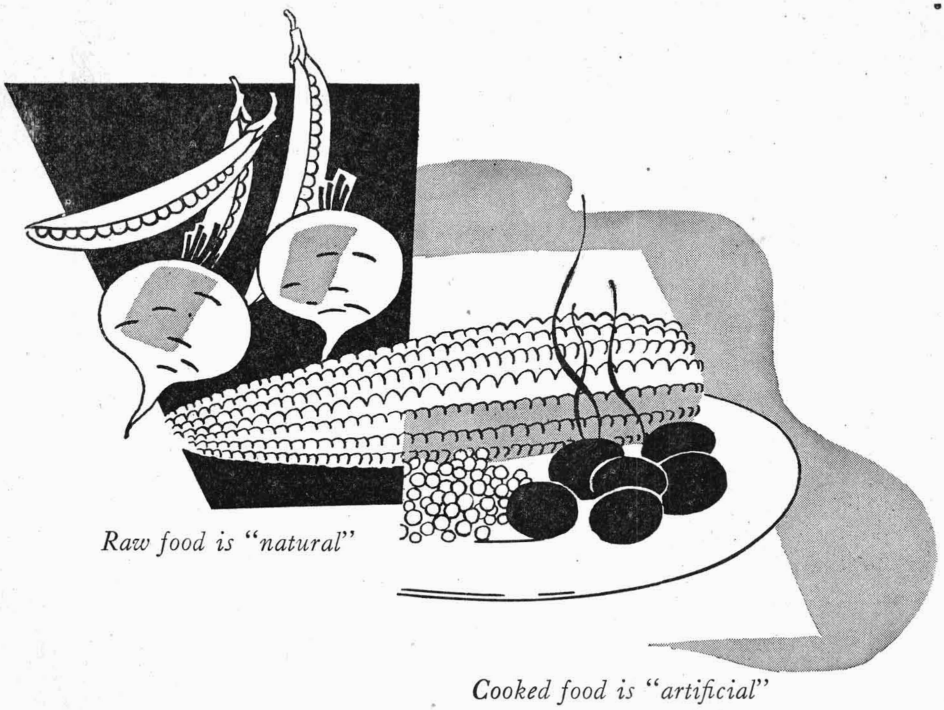
Subscriptions. Price; $6.00 per volume in North and South America; $6.50 in all other countries. Prices are net, postpaid. New subscriptions and renewals are entered to begin with the first issue of the current volume. Renewals should be made promptly to avoid a break in the series. Subscriptions should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



TASTE *is the test in* FOODS

Primitive man ate raw food for mere survival. Then he discovered that fire can be friend as well as foe; began eating for survival *and* pleasure. Science discovered that vanillin synthesized from tropical spices heightens the flavor of "natural" vanilla. The combination is at its flavor-peak in Michael's Mixevan. You're cooking with sagacity when you use Mixevan to bring *Controlled Flavor* to every batch of vanilla ice cream. Start the new year right with Mixevan.

Mixevan—"America's Flavorite"
and other powdered vanilla products
DAVID MICHAEL & CO.
half a century in the flavoring field
3743-63 D St., Philadelphia 24, Pa.

JOURNAL OF DAIRY SCIENCE

VOLUME XXX | JANUARY, 1947 | NUMBER 1

THE MALE HORMONE CONTENT OF RUMINANT MANURE[1]

C. W. TURNER

Department of Dairy Husbandry, University of Missouri, Columbia

While the bull testis served as the source of the first extract of male hormone (8, 9) and bull urine was found to be one of the paths of excretion of slight amounts of this hormone (7), it was not until 1942 that Riley and Hammond presented evidence indicating that dairy cattle during certain physiological states excrete considerable amounts of male hormone by way of the digestive tract in the manure. They noted the precocious development of the comb and wattles of chicks fed dried cow manure as part of the starter ration without stimulation of the gonads. This observation not only indicated the presence of some androgenic hormone in the manure but its oral availability to the chick as well.

The largest content of androgens was observed to be present in the manure of dairy cows in lactation in various stages of pregnancy. Manure from heifers not pregnant produced slight comb development, whereas that from bulls was reported to be without effect.

The secretion of considerable amounts of male hormone by the lactating cow and its elimination in the feces adds significance to the observations of many investigators that androgens stimulate the growth of the mammary glands and may play a rôle in stimulating the lactation process. It seemed of interest, therefore, to study further the extent of elimination of the male hormone by various ruminants preliminary to a detailed study of the excretion rate of this hormone during various physiologic periods.

EXPERIMENTAL[2]

The method of assay of the androgenic hormone in the manure of various species of ruminants has been essentially the same as that described by Riley and Hammond (11). White Plymouth Rock chicks were substituted for Rhode Island Reds. The basal chick starter is the same as used in our

Received for publication August 19, 1946.

[1] Contribution from the Department of Dairy Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 1009.

[2] I am indebted to Mr. A. J. Olsan for his aid in the collection and drying of the samples and for the care of the chicks during the period of assay of the male hormone.

previous studies (14) except that the alfalfa meal was eliminated in proportion to the addition of manure up to 10 per cent of the diet. At the end of 4 weeks, the combs were removed even with the surface of the head and weighed. The average comb weight and the comb weight per 100 gm. body weight indicates the extent of androgen stimulation. When the chicks were sexed, the sum of the average weight of the combs of the males and females was divided by two.

Since David (2) showed that the sensitivity of the capon comb to androgen stimulation showed a seasonal variation of as much as 100 per cent from the peak response in winter to the minimum in the summer, the date of each assay is reported. It might be expected that a similar seasonal variation would occur in our assay method since a seasonal rhythm in thyroid secretion rate of chicks has been observed (10) under the same environmental conditions.

The urine-free manure was collected daily, placed in a thin layer in an electric drying oven, and heated to dryness at a temperature of 45° C. or slightly less, except where especially indicated. Usually about 48 hours were required to dry this material. The manure was then ground in a mill to the consistency of alfalfa meal. The starter ration containing the dried cow manure in amounts up to 20 per cent was eaten without apparent discrimination by the chicks.

Unless otherwise indicated, the manure was collected from the same group of lactating cows is free of urine, straw and extraneous material as possible.

EXPERIMENTAL RESULTS

I. *Effect of the temperature of drying on male hormone in cow manure.* In the original study of Riley and Hammond (11) and in later publications (4) it was reported that drying cow manure at a temperature of 80° C. caused the total destruction of the male hormone. To determine the effect of the temperature of drying of cow manure upon the male hormone content under our conditions, samples of cow manure were dried at 45°, 55°, 65°, 75°, and 85° C. in a Freas electric oven. At the lower temperatures about 48 hours were required. At the higher temperatures drying was faster, requiring only 24 hours.

The manure was then ground and fed to groups of about 20 chicks as 10 per cent of the chick starter ration. It will be seen in table 1 that as the temperature of drying manure increased there was a gradual inactivation of the male hormone present. At temperatures above 75° C. all hormone was destroyed since the comb weights were down to control levels.

From these data it appears that the slow drying of cow manure at temperatures above 45° C. for 24 hours or more inactivates increasing amounts of the male hormone present up to about 75° C. It is possible that even a lower temperature of drying would preserve even larger amounts of the hormone, although the drying time would be increased. These data do not answer the question whether higher drying temperatures might not be employed successfully if the time of drying could be reduced to a minimum.

II. *The androgen content of manure of cattle, goats, and sheep.* The following comparisons are based upon the inclusion of 10 per cent of the manure in the chick starter ration. In each case the manure was dried at 45° C. The average weight of the combs of the control White Plymouth Rock chicks at 4 weeks of age varied from 47.8 mg. to a high of 91.0 mg., with an average of 61.3 mg. for 51 chicks. When chicks were fed manure from lactating cows, the combs were much enlarged and bright red in color. The combs of 40 chicks averaged 225.2 mg. in weight—almost a 4-fold increase over the control chicks' combs. This average comb weight is quite similar to that reported by Riley and Hammond (11) for chicks fed manure from lactating cows (237.1 mg.).

TABLE 1

Effect of drying temperature upon male hormone content of cow manure fed at 10% level
(Experiment started, Feb. 14, 1946)

Temperature of drying for 24 to 48 hours	No. of chicks	Average body weight at 28 days	Average comb weight	Comb weight / 100 gm. body weight
°C.		*gm.*	*mg.*	
45	20	259.0	249.2	96.2
55	20	227.6	178.9	78.6
65	21	231.5	76.3	32.9
75	21	232.6	31.2	13.4
85	21	233.5	35.0	14.6

In a preliminary test of mixed bull manure, the average comb weight of the chicks indicated the presence of about one-fourth as much male hormone as did the manure from lactating cows. In a further test of the manure of three Holstein-Friesian bulls varying in age from 2 to 16 years, only slight stimulation was observed.

From the data presented, it would appear that lactating goats are not similar to lactating cows in excreting large amounts of male hormone in their feces. At least, if it is excreted, it is not orally available to chicks. The sample from the pregnant, not lactating, group showed the greatest effect upon the comb. Some male hormone is excreted by the buck since the response of the comb was about double that of the controls and was greater than that shown by the bulls.

Samples from a single, non-pregnant ewe at two periods showed slight responses comparable to that of the non-pregnant goats.

From these observations, it would appear that the lactating cow eliminates a considerable amount of an androgen or androgens which are orally available to the chick. Lactating goats and other ruminant animals both male and female appear to excrete only slight amounts by this route.

III. *Androgen in manure from lactating cows compared with methyl testosterone administered orally.* Riley and Hammond (11) fed 18 mg. of testosterone acetate per kg. of feed in one lot and 18 mg. testosterone acetate + 3.6 mg. of estrone to a second lot of chicks. The comb weights of the two groups were essentially the same. On the basis of equal numbers of the two sexes, the average comb weight of 48 chicks was 649.7 mg. Since the average comb weight of these chicks was far above the comb weight of

TABLE 2

The androgen content of dry manure of cattle, goats and sheep
(Fed as 10% of the chick ration)

Type of manure	No. of chicks	Average body weight at 28 days	Average comb weight	Comb weight / 100 gm. body wt.	Date of start of experiment
		gm.	*mg.*		
Control feed	10	305.1	56.3	18.4	Nov.
"	10	227.7	60.8	26.7	Dec.
"	11	307.4	91.0	29.6	Dec.
"	20	223.1	47.8	21.5	May
Cow, lactating	10	257.1	172.6	67.1	Oct.
"	10	296.6	229.8	77.4	Dec.
"	20	259.0	249.2	96.2	Feb.
Bull, mixed	8	230.6	119.5	51.8	Dec.
H-Bull—16 years	20	261.2	62.7	23.9	May
H-Bull— 2 years	19	219.4	59.3	26.7	May
H-Bull— 6 years	20	247.1	73.6	29.5	May
Goat, not pregnant	21	272.0	77.4	29.3	May
Goat, pregnant non-lactating	10	248.1	134.9	54.3	Oct.
Goat, lactating	21	256.9	76.5	29.2	May
Buck	19	223.0	95.2	41.1	May
Sheep, not pregnant	10	307.0	97.5	31.7	Oct.
"	20	221.3	62.9	28.4	May

chicks fed 10 per cent manure, it seemed desirable to determine the amount of synthetic male hormone administered orally equivalent to the amount of male hormone present in the manure of lactating cows.

In a preliminary experiment, groups of about 20 chicks each were fed from 0.75 mg. to 6.0 mg. of methyl testosterone[3] per kg. of feed. As will be observed in table 3, this dosage range was too low to compare with varying amounts of cow manure added to the ration, so in a second experiment the amount of hormone was increased progressively from 10.0 mg. to 40.0 mg. per kg. of feed. There was a regular increase in average comb weight of the chicks up to 30.0 mg. per kg. of feed. When this latter amount was fed dissolved in soybean oil, the comb response was slightly reduced.

[3] Kindly supplied by Dr. E. Schwenk of Schering Corp., Bloomfield, N. J.

For comparison with these data, graded amounts of cow manure were added to the chick ration to cover the same range of average comb response. It will be seen that over the range of 50 gm. to 200 gm. cow manure per kg. feed, the average comb weight compares with the effect of 10 to 30 mg. of methyl testosterone per kg. of feed. In other words, 100 gm. of dry cow manure contains the oral equivalent (in chicks) of 20 mg. of methyl testosterone or 5 kg. of cow manure contains the oral equivalent of 1 gm. of methyl testosterone.

Since 18 mg. of testosterone acetate per kg. feed produced combs weighing 649.7 mg. (11) whereas 20 mg. methyl testosterone per kg. of feed increased combs to an average of 225.2 mg., it would appear that the methyl derivative of testosterone is less effective orally in fowls than the acetate.

TABLE 3

Comparison of comb-stimulating properties of dried cow manure and methyl testosterone administered orally

Material per kg. feed	No. of chicks	Average body weight at 28 days	Average comb weight	Comb weight / 100 gm. body wt.	Date of experiment
		gm.	*mg.*		
Methyl testosterone					
0.75 mg.	21	250.7	51.0	20.3	Jan.
1.50 mg.	19	268.2	88.0	32.8	Jan.
1.50 mg. (in oil)	16	253.4	56.5	22.2	Jan.
3.00 mg.	22	264.0	98.1	37.1	Jan.
6.00 mg.	17	261.5	84.6	32.3	Jan.
10.00 mg.	20	239.3	161.4	67.4	Feb.
20.00 mg.	19	208.2	233.8	112.3	Feb.
30.00 mg.	21	234.8	348.2	148.3	Feb.
30.00 mg. (in oil)	21	234.6	321.3	136.9	Feb.
40.00 mg.	21	226.9	196.7	86.6	Feb.
Cow manure					
25.0 gm. (2.5%)	10	319.5	113.1	35.3	Dec.
50.0 gm. (5.0%)	9	298.6	155.0	51.9	Dec.
100.0 gm. (10.0%)	40	....	225.2	....	(see table 2)
200.0 gm. (20.0%)	20	264.5	386.4	146.0	Oct.–Dec.

IV. *Source of the androgen in cow manure.* In the fowl, part if not all of the male hormone produced by laying hens which stimulates the growth of the comb is believed to be secreted by the medullary part of the ovary (3). In the mouse, the secretion of male hormone by the ovaries is stimulated when ovarian grafts are made into the ear (5). Burrill and Greene (1) present evidence indicating the secretion of male hormone in the pregnant and lactating rat. In man, both normal male and female urine contains considerable amounts of both estrogens and androgens.

In cattle, the male hormone was observed to be excreted in small amounts in the urine of the bull (7). Little has been reported on androgn content of cow urine. The observations presented in this paper indicating the presence of considerable amounts of androgens in the feces of lactating cattle raise the question as to the source of the male hormone and the part of the digestive tract where the androgen is passed into the contents of the tract. In addition to the ovaries, it is well established that the adrenal glands may under certain conditions secrete male hormone.

As might be expected, it has been reported that androgens are not present in dried rumen contents (4). From our knowledge of the metabolism of other hormones, the liver might be expected to play a rôle in the elimination of androgen by way of the bile from either the ovaries or adrenals, although it is possible that it might be excreted directly by the cells lining the digestive tract.

Since milking cows were not available, the entire digestive tracts of two Shorthorn type cows were obtained from a local packing house for our preliminary study. The livers and bile were also retained. The rumen contents were each sampled and dried. The contents of the omasum, small intestine and large intestine of each cow were combined and dried. The livers were dried and ground and the bile mixed with the chick feed and dried. The average weight of the combs of the chicks indicated insufficient androgen present to indicate the point in the digestive tract where the products of androgen metabolism were discharged into the digestive tract.

While the combs of the chicks fed graded amounts of liver were almost

TABLE 4

Source of androgen
(20 chicks in each lot)

Material	Amount fed	Average body wt. chicks at 28 days	Average comb weight	Comb weight / 100 gm. body wt.	Date of experiment
		gm.	*mg.*		
Cattle					
Rumen content					
Cow I	10%	234.7	72.8	31.0	April
Cow II	10%	217.7	48.0	22.0	April
Omasum content, mixed	10%	233.8	40.9	17.4	April
Small intestine, mixed	355 gm. in 10 kg.	220.5	49.3	22.3	April
Large intestine, mixed	10%	225.2	38.6	17.1	April
Dried liver	5%	275.1	63.5	23.0	April
" "	10%	295.6	74.3	25.1	April
" "	15%	298.0	75.9	25.4	April
Bile	470 ml.*	276.7	55.2	19.9	April
Goat rumen	10%	202.1	45.0	22.2	Dec.
" urine	5876 cc. dried in 10 kg. feed	233.3	52.3	22.4	April

* Since no more cattle bile could be obtained, 735 ml. of hog bile was added.

double the control comb weight, the fact that their size was not closely graded in proportion to liver dosage raises a question as to the significance of the greater comb weight.

This preliminary work clearly indicates the necessity of using lactating cows in such a study and to have evidence that the cows being used are discharging normal amounts of androgens in their manure.

DISCUSSION

The discovery of the excretion of considerable amounts of androgenic hormone in the feces of the lactating dairy cow is of considerable interest from several points of view. The use of dried cow manure in the ration of chickens and swine as a rich source of B-vitamins with nutritive value comparable to an equivalent amount of alfalfa meal raises the question of the desirability of utilizing this by-product of dairy farming as a feeding stuff rather than as a fertilizer.

In addition to its nutritive value, dried cow manure is an economical source of an orally available androgenic hormone. It has been shown in rats that the injection of androgens in suitable amounts stimulates the rate of growth (12–13). It is also recognized that this hormone favorably influences nitrogen metabolism (6). Work in this laboratory indicates that the feeding of dried cow manure at suitable levels to chicks from hatching time until sexual maturity stimulates the growth of the pullets especially, and the age of the onset of egg production was reduced.

The rôle of the male hormone in lactating dairy cows is especially intriguing. Evidence is constantly increasing indicating that both male and female sex hormones are being produced by the endocrine glands of both males and females in considerable amounts. It has been demonstrated that certain androgenic hormones stimulate the growth of the mammary glands experimentally. However, up to the present time the male hormone has not been suggested as playing a dynamic rôle in either the normal growth of the cow's udder or in the initiation or maintenance of milk secretion. This problem deserves serious consideration in the light of the observations reported.

SUMMARY

The male hormone (androgen) content of ruminant manure was assayed biologically by feeding it as part of the starter ration to groups of White Plymouth Rock chicks during a period of 28 days. The average comb weight of 40 chicks fed 10 per cent dried manure from lactating cows was 225.2 mg. in comparison to the comb weight of normal chicks of 61.3 mg.

Lactating cow manure dried at temperatures ranging from 45° C. to 85° C. by 10 degree intervals gradually declined in androgen potency. At temperatures of 75° C. and above all biological activity was lost.

The androgen content of the manure of other ruminants including goats

and sheep of both sexes and conditions was either low or absent. The manure of dairy bulls showed indications of only small androgen excretion by that route.

Chicks fed methyl testosterone at the rate of 20 mg. per kg. of feed had combs averaging 233.8 mg. This is comparable to the effect of lactating-cow manure fed at the 10 per cent level or 100 gm. per kg. of feed.

The point of entrance of the androgenic hormone into the digestive tract of the cow has not yet been determined.

REFERENCES

(1) Burrill, M. W., and Greene, R. R. Androgen Production During Pregnancy and Lactation in the Rat. Anat. Rec., 83: 209. 1942.

(2) David, K. Über den Einfluss der Saison auf die Empfindlichkeit des Hahnenkammes. Acta Brevia Neerl., 8: 133. 1938.

(3) Domm, L. V. Precocious Development of Sexual Characters in the Fowl by Homeoplastic Hypophyseal Implants. II. The Female. Soc. Expt. Biol. and Med. Proc., 29: 310. 1931.

(4) Hammond, J. C. Dried Cow Manure and Dried Rumen Contents as a Partial Substitute for Alfalfa Leaf Meal. Poultry Sci., 23: 471. 1944.

(5) Hill, R. T. Ovaries Secrete Male Hormone. Endocrinol., 21: 495–633. 1937.

(6) Kenyon, A. T., Sandiford, I., Bryan, A. H., Knowlton, K., and Koch, F. C. The Effect of Testosterone Propionate on Nitrogen, Electrolyte, Water and Energy Metabolism in Eunuchoidism. Endocrinol., 23: 135. 1938.

(7) Koch, F. C. The Male Sex Hormone. Physiol. Rev., 17: 153. 1937.

(8) McGee, L. C. The Effect of the Injection of a Lipoid Fraction of Bull Testicle in Capons. Inst. Med. of Chicago Proc., 6: 242. 1927.

(9) McGee, L. C., Juhn, M., and Domm, L. The Development of Secondary Sex Characters in Capons by Injections of Extracts of Bull Testes. Amer. Jour. Physiol., 87: 406. 1928.

(10) Reineke, E. P., and Turner, C. W. Seasonal Rhythm in the Thyroid Hormone Secretion of the Chick. Poultry Sci., 24: 499. 1945.

(11) Riley, G. M., and Hammond, J. C. An Androgenic Substance in Feces from Cattle as Demonstrated by Tests on the Chick. Endocrinol., 31: 653. 1942.

(12) Rubinstein, H. S., and Solomon, M. L. Growth-stimulating Effect of Testosterone Propionate. Soc. Expt. Biol. and Med. Proc., 44: 442. 1940.

(13) Rubinstein, H. S., and Solomon, M. L. Effect on Body Growth of Small Doses of Testosterone Propionate Administered at Different Seasons. Soc. Expt. Biol. and Med. Proc., 45: 745. 1940.

(14) Schultze, A. B., and Turner, C. W. The Determination of the Rate of Thyroxine Secretion by Certain Domestic Animals. Mo. Agr. Expt. Sta. Res. Bul. 392. 1945.

SOME OBSERVATIONS ON NERVE REGENERATION IN THE UDDER[1]

DWIGHT ESPE[2]

Iowa State College, Ames, Iowa

The theory has been generally accepted that cows "let down" their milk as a result of afferent stimuli which originate in the udder. The most common of these stimuli are nursing by the calf or milking by hand or machine. Ingelbrecht (1), working with rats, claimed that the "letting down" of the milk in the mammary gland was dependent upon an intact nerve supply. When he destroyed the nerves to the posterior mammary glands and covered the anterior glands the rats failed to lactate normally and the young soon died. But when he permitted the young rats to nurse the glands with an intact nerve supply, every gland secreted milk and the rats grew normally.

Ely and Petersen (2) consider this phenomenon due to a nerve-endocrine mechanism rather than to a nervous reflex. They suggest that the afferent impulses produced by milking cause the posterior lobe of the pituitary to release oxytocin. The oxytocin acts upon the smooth muscle fibers surrounding the alveoli in the mammary gland and forces the milk in the cells and lumina of the alveoli into the larger collecting ducts and udder cisterns. It is at this particular moment that a cow is said to have "let down" her milk.

If their theory is correct only the milk in the udder cisterns could be obtained from a cow in the absence of this nerve-endocrine stimulus. Although a cow may be so conditioned to milking that various afferent stimuli cause her to "let down" her milk, the nursing of the calf or the massaging of the udder in milking should be the primary stimuli. Ely and Petersen (2) found that cutting the inguinal nerve on three dry cows had no effect on milk secretion when the cows freshened about two months later. This procedure should have eliminated any direct effect of the nerves on the musculature of the udder, unless nerve-regeneration occurred. But cutting of the inguinal nerve does not interfere with the sensory nerve supply to the skin of the udder.

EXPERIMENTAL

In order to destroy all nerve pathways to the mammary gland, an udder transplant was made on a Holstein calf when she was about six weeks of age. The mammary glands were dissected free of the body except for one exter-

Received for publication September 7, 1946.

[1] Journal Paper No. J–1391 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 814.

[2] Present address: North Dakota State College, Fargo, North Dakota.

nal pudic artery which was left intact. The dissected glands were turned around so that the rear teats faced anteriorly, and the udder was then sewed back into place. After the skin lesions had healed a second incision was made on the right side of the glandular area and the external pudic artery which had previously been left intact, was ligated.

The heifer was bred at as early an age as possible. She freshened when less than 22 months of age. This may help to explain why she failed to clean normally and why she was rather slow in coming to her milk. However, she was able to provide sufficient milk for her calf and another calf which nursed her. Although the udder presented a most unusual appear-

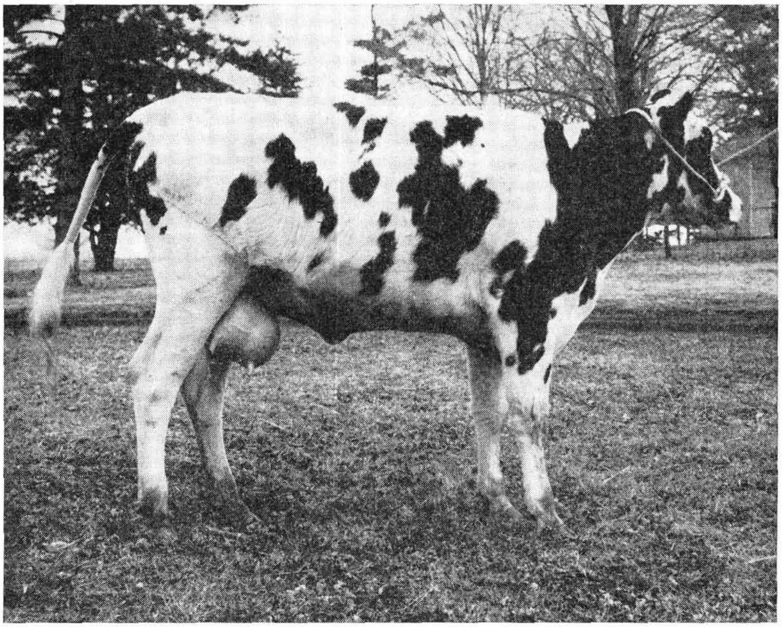


FIG. 1. Cow whose udder was reversed and all nerves and blood vessels ligated.

ance the day after parturition (fig. 1), its development during pregnancy seemed quite normal. One month after freshening the calves were weighed before and after nursing (twice a day) for three days. By this method of calculation it was found that she was producing 23½ pounds of milk per day, in spite of the fact that the right rear gland (as now attached) gave almost no milk. Bacteriological examination showed that the gland was badly infected with mastitis. Except for this quarter the mammary glands produced an apparently normal secretion. Treatment with penicillin failed to return the diseased gland to the same production as the left rear quarter.

An electrical current from a secondary coil was used to determine the sensitivity of the udder to external stimuli. Although the left side of the udder did not seem quite as sensitive as the skin above the incision there was no point on the left half of the udder when the electrical current did not cause the cow to jump. The entire right half of the udder was devoid of a sensory nerve supply. The only explanation the author has for this discrepancy in nerve supply between the two halves of the udder is that the regenerating nerves were destroyed on the right side of the udder when the second incision was made. However, if this explanation were valid, it seems strange that the anterior and posterior surfaces of the right half of the udder (where only the one incision was made) would be as devoid of a sensory nerve supply as the area immediately below the second incision. Every effort was made to ligate all of the mammary tissue during the two operations, yet it is conceivable that this was not done. Failure to completely sever all of the nerves seems a more probable explanation, especially since

TABLE 1

Milk obtained from transplanted udder

Quarter	Amount of milk obtained in first 4 minutes of milking	Amount of milk obtained in last 2 minutes of milking
	pounds	*pounds*
Right front	1.5*	0.7†
Right rear	Not used because of mastitis	......
Left front	3.2	0.4
Left rear	2.8	0.5

* Before any known afferent stimuli had caused the cow to "let down" her milk.

† After the calves have nursed for 2 minutes the glands with an afferent nerve supply (left front and left rear).

electrical stimuli when applied to the left side of the udder caused the cow to kick with her right foot.

Since this cow had never been milked by hand there should have been a minimum amount of interfering conditioned reflexes established. A milking machine with one teat cup was used for these experiments. The cow was locked in her stanchion in a box stall at the time when the calves regularly nursed. Instead of allowing the calves to nurse, the experimenter would curry the cow for a couple of minutes to secure her confidence. The milking machine was then attached as quietly as possible. After four minutes, the milking machine was removed and the calves allowed to nurse all but the gland under observation. When the calves had nursed for approximately two minutes, the milking machine was again attached to the gland under observation and milking was continued for another two minutes. The results are given in table 1.

The results presented in table 1 are too meager to offer conclusive evidence. Certainly the glands which have an intact nerve supply were emptied much more quickly than the one "normal" gland without an afferent nerve supply. The reader may wonder why approximately 1½ pounds of milk were secured from the right front gland before the nursing of the calves provided the essential nerve-endocrine stimulus suggested by Ely and Petersen. Certainly this amount of milk was not already present in the gland and teat cistern. Although no definite readings were made, the milker is positive that a goodly proportion of this milk was obtained during the last half of the four-minute milking period. The only explanation the author can suggest is that the emptying of the udder provided a certain indirect stimulus. Although a half-inch spark to the end of the right front teat elicited no response from the cow, before the four-minute milking interval was completed she manifested a certain awareness to the action of the machine. This was especially noticeable when the milking machine was removed.

SUMMARY

The mammary tissue of a calf was transplanted so as to sever all of the original nerve and vascular supply between the body and mammary glands. Normal development of the udder occurred during pregnancy with the exception of the right half of the udder which had no sensory nerve supply. A simple experiment on the nerve-free gland has helped to confirm the theory of Ely and Petersen in regard to the functioning of a nerve-endocrine mechanism in the "letting down" of the milk.

REFERENCES

(1) INGELBRECHT, P. L'influence du Systeme Nerveux Central sur la Mamelle Lactante Chez le Rat Blanc. Compt. Rend. Soc. de Biol., **120**: 1369–1371. 1935.

(2) ELY, FORDYCE, AND PETERSEN, W. E. Factors Involved in the Ejection of Milk. JOUR. DAIRY SCI., **24**: 211–223. 1946.

PEPTIC–TRYPTIC DIGESTION OF RENNET–CUSTARDS IN VITRO

BERNHARD SPUR AND IRVING J. WOLMAN
Milk Research Laboratory, The Children's Hospital of Philadelphia, Philadelphia, Pa.

The present paper describes further studies in which plain and rennin-treated milks (rennet-custards) were first digested artificially by pepsin-hydrochloric acid mixtures, and then exposed to additional digestion by synthetic mixtures of pancreatin and bile.

The possibility that cow's milk can be made more easily digestible by exposure to enzymes, such as the rennet enzyme, prior to ingestion, has not been adequately explored. Both Doan and Dizikes (2) and Turner (5) have observed that milk previously exposed to tryptic (pancreatin) digestion in vitro for a short period became broken down more quickly than ordinary milk. Actual feeding of infants with enzyme-treated milks has been carried out by Blatt (1), who stated that such treated milk proved easily digestible, well tolerated and well utilized, even by premature infants.

The influence of added rennin upon curd-forming properties and peptic digestion of milk has already been discussed in a previous publication (4). This study showed that when rennet-custards were exposed to conditions of hydrochloric acid and pepsin resembling those in the normal stomach, they underwent proteolysis more rapidly than untreated milks used as controls. However, the degree of proteolysis as measured by the amount of casein made soluble in the whey filtrate was relatively small. Evidently, gastric digestion of milk is only preparatory to the major digestive activity of the small intestine.

PROCEDURE

In the experiments here reported, the artificial coagulation device (3) and the artificial digestion procedures (4) were the same as already described. The rennet-custards were prepared as follows: Lukewarm pasteurized milk was mixed with the rennet preparation undergoing test, and 100-ml. portions of the mixture poured promptly into the rubber bags in the coagulation device. These stood motionless in the water bath at a temperature of 37° C. for 5 minutes, during which time the coagulation into rennet-custards took place. Lukewarm control milks, without rennet, were added to similar bags at this time.

The apparatus was next set in motion. One ml. of a 0.6 per cent pepsin solution containing sufficient N/1 hydrochloric acid to lower the pH to 5.5 was then added to each bag. (The pH of 5.5 reproduces the approximate hydrogen ion concentration at which milk normally coagulates in the child's stomach (6).) After the control milks had coagulated, the apparatus was then agitated for one-half hour. Two ml. of the pepsin solution and sufficient

Received for publication September 10, 1946.

additional hydrochloric acid to bring the mixture to the desired pH were next mixed in each bag and the agitation permitted to continue for 2½ hours longer.

The rennet-custards and the control milks were handled in the same way. When rennet tablets[1] were used, the controls had the same amount of water added as did the rennet-custards, omitting the dissolved tablet; when rennet powder[1] was used, all ingredients of the powder, except the rennin itself, were added to the control milks.

The next step was digestion by pancreatin-bile solutions of varying strengths. After exposure of the milk to the pepsin-hydrochloric acid activity for 3 hours, the pH was raised to 7.5 by a strong sodium hydroxide solution, a solution of pancreatin-bile was mixed in, and the digestion continued for 2 hours more. During this period representative samples were removed at 20, 60, and 120 minutes. The digestion experiments were grouped into three series, according to the concentrations of pepsin-hydrochloric acid and pancreatin-bile used (table 1). In the first series, 3 ml. of 0.6 per cent pepsin solution, together with sufficient hydrochloric acid to produce a pH of 2.5, were mixed with 100 ml. milk. In the second series, 1 ml. of 0.6 per cent pepsin solution, together with sufficient hydrochloric acid to produce a pH of 3.5, were added. In the third series, 0.5 ml. of 0.6 per cent pepsin solution, together with sufficient hydrochloric acid to produce a pH of 5.5, were added. Thus, the concentration of pepsin in the second series was one-third, and in the third series, one-sixth of that in the first series.

The pancreatin-bile consisted of a solution of 3 gm. pancreatin powder (U.S.P. XII) plus 3 gm. bile powder (Bacto lactose peptone bile, dehydrated) in 100 ml. water. Of this solution 3 ml. were added to each experimental specimen in the first series, 1.5 ml. to each in the second series, and 0.5 ml. to each in the third series. Enough sodium hydroxide was introduced along with the pancreatin-bile mixture to keep the pH constantly at 7.5, corresponding to the hydrogen ion status of the upper part of the resting small intestine. For purposes of convenience, the three procedures have been designated as "stronger," "intermediate," and "weaker" peptic-tryptic digestion.

The amount of soluble nitrogen in the filtered whey was measured by the macro Kjeldahl method. The amount of soluble nitrogen in the blank test, *i.e.*, in the milk itself prior to any of the digestive manipulations, was sub-

[1] The rennet preparations used to make rennet-custard were: Household rennet tablets, composed of powdered rennet—2.84% and table salt—97.17% (one 0.55 gm. tablet per 500 ml. milk). Rennet powder, containing salt with added sugar and vanilla flavor, and composed of sugar 98.59%, salt—1.37% and rennin—0.04% (45 gm. of powder per 500 ml. milk). Each preparation contained sufficient rennin to coagulate 500 ml. milk in 2½ minutes at 110° F.

The tablets and powder were secured from Chr. Hansen's Laboratory, Inc., Little Falls, N. Y.

TABLE 1

	Pepsin-HCl mixture	pH	Pancreatin-bile mixture	pH
	cc.		*cc.*	
1. "Stronger" peptic-tryptic digestion	3.0	2.5	3.0	7.5
2. "Intermediate" " "	1.0	3.5	1.5	7.5
3. "Weaker" " "	0.5	5.5	0.5	7.5

tracted, and the difference taken as indicative of the rate of digestion at the end of the subsequent pancreatin-bile digestion. To measure the extent of trypsin digestion of casein, the method of the U. S. Pharmacopoeia (XII) was used. A few ml. of a specially prepared acetic acid-alcohol solution were added to the samples just before filtering. This solution precipitates that fraction of the casein which has become soluble but not yet fully broken down.

RESULTS

The mixtures of pepsin-hydrochloric acid and pancreatin-bile used in these experiments are believed to simulate the conditions prevailing in the stomach and small intestine of children at successive stages of growth. The exact amounts of the several components which would enter into the actual digestion of 100 ml. of milk are not precisely known, of course. The results of this study are to be viewed as comparative rather than absolute; they

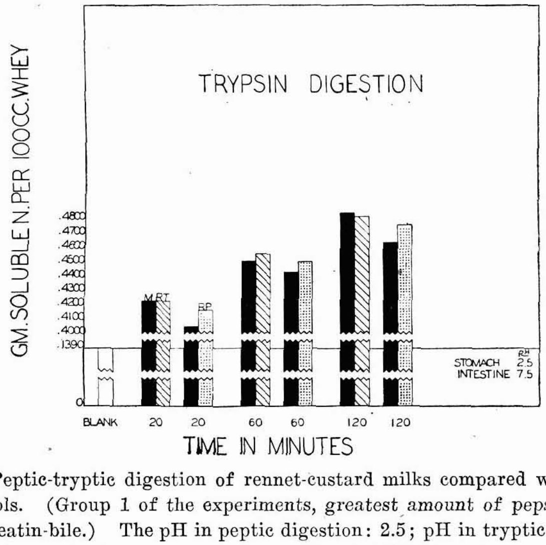


FIG. 1. Peptic-tryptic digestion of rennet-custard milks compared with pasteurized milks as controls. (Group 1 of the experiments, greatest amount of pepsin-hydrochloric acid and pancreatin-bile.) The pH in peptic digestion: 2.5; pH in tryptic digestion: 7.5; amount of pepsin used: 3 ml. 0.6% pepsin solution to 100 ml. milk; amount of trypsin (pancreatin-bile) used: 3 ml. of 3% solution of pancreatin-bile. (Average of 4-experiment series.) M = milk controls; RT = rennet-custard made with tablets; RP = rennet-custard made with powder.

serve for contrasting the breakdown rates of rennet-custards versus controls of untreated milk under a certain set of conditions, even though these conditions may not simulate exactly the conditions in the living body.

In the pepsin-hydrochloric acid digestion phase the rennet-custards produce curds which are smaller than those of the controls. These curd size differences may influence the digestion rates (4). In the later pancreatin-bile digestion, the coagula liquefy quickly and disappear. Only when the pepsin-hydrochloric acid and the pancreatin-bile preparations were both of low potency did curds of considerable size persist to the end of the process.

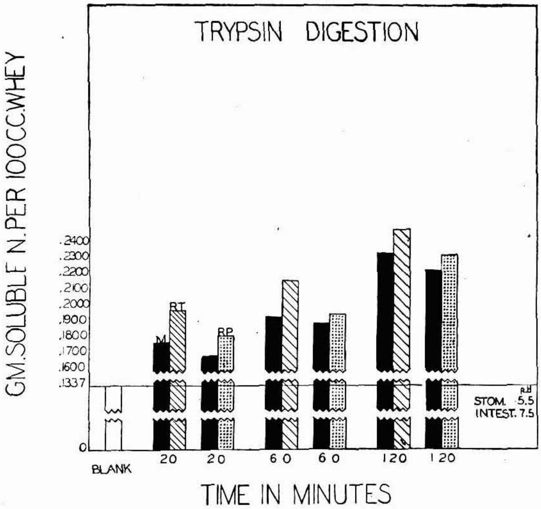


FIG. 2. Peptic-tryptic digestion of rennet-custards compared with pasteurized market milks as controls. (Group 3 of the experiments, smallest amount of pepsin-hydrochloric acid and pancreatin-bile.) The pH in peptic digestion: 5.5. Amount of pepsin $\frac{1}{8}$, and of hydrochloric acid, $\frac{1}{3}$ of amount used in group 1. Amount of (trypsin) pancreatin-bile: $\frac{1}{8}$ of amount used in group 1. (Average values from 6-experiment series.) M = milk controls; RT = rennet-custard made with tablets; RP = renent-custard made with powder.

Here, as with the pepsin-hydrochloric acid digestions, the curds from rennet-custards were smaller than those from the control milks.

With the "stronger" peptic-tryptic procedure, the difference between the rennet-custards and their controls was negligible (fig. 1, table 2).

With the "weaker" peptic-tryptic procedure, the rennet-custards as made with the two preparations of enzyme lead with a slight margin over the controls (fig. 2, table 3). The pepsin-hydrochloric acid phase of the digestion presented approximately the same relative picture, but of course with less total digestion, since the hydrogen ion concentration (pH 5.5) practically excluded any peptic activity.

With the "intermediate" peptic-tryptic procedure, the rennet-custards

TABLE 2

Pepsin-trypsin digestion in vitro

Group 1

Gastric digestion: 3 ml. pepsin solution (0.6%) pH: 2.5
Tryptic " : 3 ml. (trypsin) pancreatin-bile solution (3%) pH: 7.5

Average from 4-experiment series

Milk	Digestion time	Sol. N in whey from 100 ml. of milk	Increase of sol. N in whey from 100 ml. of milk	Difference	% Casein made sol.	Diff.
	min.					
Blank test	....	0.1390	....	....	......	......
Control 1	20	0.4231	0.2841	....	73	......
#1	20	0.4231	0.2841	0.0000	73	0
Control 3	20	0.4054	0.2664	....	68	......
#3	20	0.4165	0.2775	0.0111	71	3
Control 1	60	0.4512	0.3122	....	80	......
#1	60	0.4563	0.3173	0.0051	81	1
Control 3	60	0.4435	0.3045	....	79	......
#3	60	0.4512	0.3122	0.0077	80	1
Control 1	120	0.4850	0.3460	....	89	......
#1	120	0.4824	0.3434	0.0026	88	1
Control 3	120	0.4645	0.3255	....	84	......
#3	120	0.4768	0.3378	0.0123	87	3
Genuine milk ...	....	0.5289	....	....	......	......

TABLE 3

Pepsin-trypsin digestion in vitro

Group 3

Gastric digestion: 0.5 ml. pepsin solution (0.6%) pH: 5.5
Tryptic " : 0.5 ml. (trypsin) pancreatin-bile solution (3%) pH: 7.5

Average from 6-experiment series

Milk	Digestion time	Sol. N in whey from 100 ml. of milk	Increase of sol. N in whey from 100 ml. of milk	Difference	% Casein made sol.	Diff.
	min.					
Blank test	....	0.1337	....	....	......	......
Control 1	20	0.1771	0.0434	....	11	......
#1	20	0.1979	0.0642	0.0208	17	6
Control 3	20	0.1685	0.0348	....	9	......
#3	20	0.1815	0.0478	0.0130	13	4
Control 1	60	0.1936	0.0599	....	16	......
#1	60	0.2160	0.0823	0.0224	22	6
Control 3	60	0.1887	0.0550	....	15	......
#3	60	0.1946	0.0609	0.0059	16	1
Control 1	120	0.2338	0.1001	....	26	......
#1	120	0.2483	0.1146	0.0145	30	4
Control 3	120	0.2226	0.0889	....	24	......
#3	120	0.2324	0.0987	0.0098	26	2
Genuine milk ...	....	0.5126	....	....	......	......

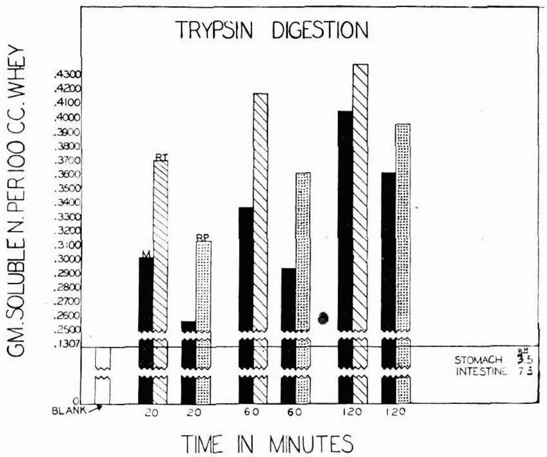


FIG. 3. Peptic-tryptic digestion of rennet-custard milks compared with pasteurized market milks as controls. (Group 2 of the experiments, intermediate conditions.) The pH in peptic digestion: 3.5. Amount of pepsin: $\frac{1}{3}$, and of hydrochloric acid: $\frac{2}{3}$ of amount used in group 1. Amount of pancreatin-bile (trypsin): $\frac{1}{2}$ of amount used in group 1. (Average values from 30-experiment series.) M = milk controls; RT = rennet-custard made with tablets; RP = rennet-custard made with powder.

showed more casein digestion than the controls; this was appreciable at 20 and 60 minutes, but less striking at 120 minutes (fig. 3, table 4).

TABLE 4

Pepsin-trypsin digestion in vitro

Group 2

Gastric digestion: 1 ml. pepsin solution (0.6%) pH: 3.5
Tryptic " : 1.5 ml. (trypsin) pancreatin-bile solution (3%) pH: 7.5

Average from 30-experiment series

Milk	Digestion time	Sol. N in whey from 100 ml. of milk	Increase of sol. N in whey from 100 ml. of milk	Difference	% Casein made sol.	Diff.
	min.					
Blank test	......	0.1307	......	......	......	......
Control 1	20	0.3030	0.1723	......	45	......
#1	20	0.3717	0.2410	0.0687	63	18
Control 3	20	0.2580	0.1273	......	33	......
#3	20	0.3145	0.1838	0.0565	48	15
Control 1	60	0.3382	0.2075	......	54	......
#1	60	0.4188	0.2881	0.0806	76	22
Control 3	60	0.2954	0.1643	......	43	......
#3	60	0.3633	0.2326	0.0683	61	18
Control 1	120	0.4061	0.2754	......	72	......
#1	120	0.4398	0.3091	0.0337	81	9
Control 3	120	0.3633	0.2326	......	61	......
#3	120	0.3971	0.2664	0.0338	70	9
Genuine milk	......	0.5117	......	......	......	......

The greater relative degree of breakdown of rennet-custards in contrast to their controls of untreated milk in some of these experiments suggests that rennin facilitates in one way or another—perhaps by opening up some peptide bindings—the peptic-hydrochloric acid activity. The greatest differences between rennet-custards and controls did not appear when the peptic and tryptic activities were strongest, as in group #1 (although this group of course showed the largest total breakdown of casein for both), or when peptic and tryptic activities were weak, as in group #3, but when the peptic and tryptic activities were moderate, as in group #2. If it is permissible to draw a clinical parallel, then this enhanced rate of digestion of rennet-custards seemingly would take place under corresponding conditions in the human body also.

SUMMARY AND CONCLUSIONS

Rennet-custards and ordinary untreated milks were subjected to experimental study in vitro to investigate the possible influence of rennin upon digestibility. The degree of digestibility was measured by the amount of soluble nitrogen which appeared in the whey after the milks had been exposed to pepsin-hydrochloric acid (peptic) digestion followed by pancreatin-bile (tryptic) digestion.

Different combinations were investigated. When strong peptic digestion was followed by strong tryptic digestion, practically no differences between the two types of milk were detectable. The same result was obtained when both peptic and tryptic activity were markedly reduced. Under intermediate digestive conditions, however, faster digestion of the rennet-custards was noticeable. For example, after the first 60 minutes of tryptic digestion, an average of 18 per cent more casein was digested in the rennet-custards than in the controls. This difference became less marked after 2 hours of digestion.

It may be concluded, therefore, that under certain experimental conditions, rennin treatment of milk speeds up digestion. It seems likely that a similar effect would take place in vivo under corresponding conditions.

REFERENCES

(1) Blatt, W. L., and Harris, Ellis. Enzylac, a Simplified Infant Food. Amer. Jour. Dis. Child., 56: 1388. 1938.

(2) Doan, F. J., and Dizikes, J. L. Digestion Characteristics of Various Types of Milk Compared with Human Milk. Pa. Agr. Expt. Sta. Bul. 428. 1942.

(3) Spur, B., and Wolman, I. J. The Curd Number Test, a Method of Testing the Curdling Quality of Milk. Jour. Dairy Sci., 25: 409. 1942.

(4) Spur, B., and Wolman, I. J. Influence of Added Rennin Upon Curd-Forming Properties and Peptic Digestion of Milk. Jour. Dairy Sci., 28: 129. 1945.

(5) Turner, A. W. Digestibility of Milk as Affected by Various Types of Treatment. Food Res., 10: 52. 1945.

(6) Wolman, I. J. The Gastric Phase of Milk Digestion in Childhood. Amer. Jour. Dis. Child., 71: 394. 1946.

BEST RECORDS VS. THE AVERAGE OF ALL RECORDS FOR THE EVALUATION OF A SIRE'S INHERITANCE FOR LEVEL OF PRODUCTION

R. R. GRAVES[1]

Most of the published data on which sires are proved is on the basis of averages of all records made by daughters and their dams. The sires proved in the dairy herd improvement associations, and probably in the herd tests of the breed associations, are on the basis of the averages of all the records made by the daughters and by their dams. Probably this use of the average of all records stems from the belief that a cow that has made several records has given better proof of her producing ability than the cow that has made only one record; that an average of a number of records is a better indication of the cow's real producing ability than one record; that some cows are primed for one big record and that such a record is far above her ability to produce year in and year out. The publicity that has been given to the cows making big lifetime records has probably added to the belief that the average of all records is the best medium to use for evaluating the inheritance of a sire. Most of the proof for sires is on young sires and consequently the averages usually represent a far greater number of records for the dams than for the daughters. Not infrequently the daughters may average only one record apiece while the average number for the dams may be for from 1 to 6 or more records.

In studying the proof on a large number of sires being considered for use in the Bureau of Dairy Industry's experimental breeding herds, we have been impressed with the number of sires that show up very favorably when their proof is based on the averages of several records for the dams and only one or two records for the daughters, and that show up very poorly when the proof is based on the best record made by the daughter and the best record made by the dam.

This is illustrated by the proof obtained on 16 sires loaned to cooperators by the Huntley Experiment Station. The data for these 16 sires are shown in table 1 and so arranged that a comparison is available of the average butterfat yields of the daughters, and their dams, for each sire, on the basis of both the averages of their best records and the averages of all their records. The number of daughter-dam pairs for each sire; the number of daughters that made records that were better than those of their dams, in the comparison of the best records; the number of records made by the

Received for publication September 21, 1946.

[1] Formerly Chief, Division of Dairy Cattle Breeding, Feeding and Management Investigations, Bureau of Dairy Industry, U.S.D.A.; now President, Wood-Jon Farms, Inc., Valparaiso, Ind.

TABLE 1

Comparison of the best records and the average of all records of the daughter-dam pairs of 16 bulls from the Huntley Experiment Station

Sire number	Best records				All records average			
	Number of pairs	Drs. ave. fat.	Dams ave. fat.	Number better	Number of records	Drs. ave. fat	Dams ave. fat	Number better
191	29	654	620	18	49–52	631	596	17
193	16	416	357	13	24–18	395	355	11
194	5	413	459	2	5–18	413	406	3
195	14	744	675	8	19–26	734	650	11
199	6	407	416	4	6–16	407	377	4
505	10	350	398	1	10–32	350	353	4
503	16	487	451	8	25–63	465	422	8
506	13	446	507	4	24–66	424	418	7
508	11	511	530	4	18–50	484	450	7
510	7	404	408	5	7–8	404	406	5
517	6	421	432	3	8–17	415	392	4
520	7	386	384	5	7–25	386	324	5
521	6	376	454	0	6–20	376	385	3
523	5	288	347	1	5–20	288	286	2
528	7	717	579	5	8–8	704	578	5
531	6	452	470	3	6–32	452	419	4

daughters and by the dams in the comparison of the averages of all records; and the number of daughters whose average of all their records was greater than the average for all the dams' records, is also shown in table 1. For instance, sire 191 has 29 daughter-dam pairs but in the comparison of averages of all records the daughters have 49 records and the dams have 52 records, the number of records by daughters and dams being approximately equal. Sire 503 has 16 daughter-dam pairs, and in the comparison based

TABLE 2

The per cent increases and the sire indexes, calculated from the best record, and also from the average of all records, as given in table 1

Sire	Per cent increase on best records	Bull index best records	Per cent increase all records	Bull index on all records
191	+ 3.5	684	+ 5.9	666
193	+16.5	475	+11.2	435
194	−10.0	367	+ 1.7	420
195	+10.2	813	+12.9	818
199	− 2.1	398	+ 7.9	437
505	−12.1	302	− 0.8	347
503	+ 8.0	523	+10.2	508
506	−12.0	385	+ 1.4	430
508	− 3.6	492	+ 7.6	518
510	− 0.9	400	− 0.5	402
517	− 2.4	410	+ 5.9	438
520	+ 0.5	388	+19.1	448
521	−17.2	298	− 2.2	367
523	−17.0	229	+ 0.7	290
528	+23.8	855	+21.8	830
531	− 3.8	434	+ 3.8	485
Average 16	− 1.22	465.7	+ 6.66	490.0

on averages of all records the daughters have a little less than two records per daughter, while the dams have almost four records per dam. In the case of sire 506 the dams average five records per dam. In the comparison for sire 531 the daughters average one record apiece and the dams average a little better than five records per dam.

The first 11 sires in table 1 are all sons of one sire; the last five are all sons of another sire.

In table 2, the data in table 1 are used to show the per cent increase in butterfat yield when the best records of daughters and dams are compared, and an equal parent sire index is calculated from the same data. The per cent increase in butterfat yield and an equal parent sire index is also shown for the data based on the average of all records made by daughters and dams. In general the data in table 2 indicate that where the number of records of the dams greatly exceeds the number of records of the daughters, in the comparison based on averages of all records, the per cent increase of the daughters over the dams and also the sire index will be much greater than the per cent increase, and the sire index, for these same animals when the comparison is based on the best records of the daughters and the dams. Note the occurrence of these increases in sires 194, 199, 505, 506, 508, 517, 520, 521, 523 and 531. There are two exceptions, namely, sire 195, where the dams have 26 records and the daughters 19 and the per cent increase is only 2.7 and the sire index is raised only 5 pounds; and 503, where the 16 dams have 63 records and the 16 daughters 25 records, and the per cent increase is 2.2 and the sire index is decreased 15 pounds. The case of 503 is most unusual.

The reverse of this trend would be expected where the daughters have a greater number of records than the dams. Only one sire, 193, illustrates this. He has 16 daughters with 24 records and the 16 dams have only 18 records, and table 2 shows that the per cent increase and the sire index based on the average of all records is smaller than the per cent increase and the sire index that is based on the comparison of the best records of the daughters and the dams.

If there is no great difference in the number of records of the daughters and dams, and if all the records are made under the same conditions there will be no great difference in the per cent increase and the sire index secured by the two methods of comparison.

This trend is probably the result of the fact that where a cow is tested year after year she is almost certain to have some bad years when her production will be below her best, and these poor years will reduce her average yield. These poor years are not necessarily due to a poor inheritance. They may be due to her having been bred too soon after calving; to an attack of mastitis; to bloat or poor hay or failure to clean properly after calving, or any one of a dozen different things that may result in her failure to produce up to her inherent capacity. On the other hand the two-year-old daughters are more likely to be sound in their first lactation periods than at any other time in their lives, and barring lack of development or the possession of an inheritance for slow maturity, they are likely to produce at as high a level in their first lactation period—age considered—as in any subsequent lactation. Therefore, if the proof of a bull is based on the average production of his daughters in their first lactation periods as compared to an average for all the records made by their dams, that comparison is likely to be unduly favorable to the sire. It is a much more stringent test for the sire to base his proof on the best records made by his daughters as compared to the best records made by their dams.

SUMMARY AND CONCLUSIONS

Daughter-dam comparisons for 16 sires are made, one comparison on the basis of the best records made by the daughters and the best records made by the dams, and a second comparison on the basis of the average for all records made by the daughters and all records made by their dams.

The per cent increase in butterfat yield and an equal parent sire index is shown for each sire and for each of the two comparisons.

When the number of records averaged for the dams is larger than the number of records averaged for the daughters the comparison based on averages is more likely to be unduly favorable to the sire than is the comparison based on the best record made by the daughters and the dams. This is due to the fact that any cow that has a number of records is likely to have some lactations when her production is below her best level and these low years reduce her average yield. The comparison is likely to be particularly favorable to the sire if his daughters' first records, made under favorable conditions, are compared to an average of several records made by the dams.

The comparison of the best records of the daughters and the best records of the dams is a much more rigorous test for the evaluation of the sire's inheritance for level of production. There will be fewer disappointments where sires are being selected for the improvement of germ plasm for high levels of production if they are selected on the basis of the best records rather than on the basis of the average of all records.

THE RELATION OF INCLINATION OF RUMP TO INCLINATION OF UDDER, PRODUCTION ABILITY AND BREEDING EFFICIENCY[1]

R. E. LEIGHTON[2]

Superintendent of the United States Dairy Experiment Station at Woodward, Oklahoma[3]

AND R. R. GRAVES

Formerly Head, Division Dairy Cattle Breeding, Feeding and Management; now President, Wood-Jon Farms, Inc., Vaparaiso, Indiana

In many cows the pin bones are lower than the hip bones, resulting in what is commonly called a "sloping rump". Perhaps the frequency of the sloping rump is decreasing somewhat. Certainly most breeders have discriminated against the sloping rump in their selection of breeding animals. Man's idea of beauty in the bovine long ago insisted that the rump should be level, in spite of the fact that most species of animals possess sloping rumps. Note the rarity of the level rump in the animals in the zoo or in the wild. Probably because the level rump was associated in man's mind with beauty, there have been developed over a period of years opinions that there are certain associated defects that are likely to accompany the undesirable sloping rump, some of them of economic importance. One such defect that received emphasis was that if the rump slopes the floor of the udder will be tilted because the floor of the udder parallels the rump, with a likelihood of the fore quarters being undeveloped. The following quotation from Van Pelt's Cow Demonstration emphasizes this idea.

> Many cows, though long in the rump, droop from the hip bones to the pin bones and are described by the expression "Drooping rumped." This conformation not only detracts from the beauty of the cow but as a rule those cows which droop at the rump, also have tilted or slanting udders a portion of which seems to have been cut away and this naturally detracts from the ability of the cow.
>
> On the other hand those cows which carry out straight from the hip bones to the pin bones have udders that are straight on the bottom, symmetrical and carry well forward with each quarter large and uniform in size. The fact that the length of udder can be determined by the length from hip bones to the pin bone, and the shape of the udder by the manner in which the rump is carried out, is likely due to the law of correlation of parts which enables the anatomist when he finds a bone to determine from its dimensions the dimensions of every other bone in the animal's body from which it came.

Few, if any, of these opinions have been checked by recorded observations and statistical analysis. There existed in the files of the United States

Received for publication September 21, 1946.

[1] The original data used in this paper were in a thesis submitted to the Graduate School of the Oklahoma Agricultural and Mechanical College in partial fulfillment for the degree of Master of Science by R. E. Leighton. This paper presents a new analysis of the original data and some new material.

[2] The work at this station is in cooperation with the Oklahoma A. & M. College.

[3] Now Superintendent, Hatch Expt. Sta., Hannibal, Mo.

Dairy Experiment Stations, where breeding experiments have been carried on over a period of years, carefully made photographic records of the types of the animals that have constituted several generations of planned breeding that could be analyzed for the purpose of determining the relation of the angle of the rump to other body characteristics and functions. The material for this study has been confined to the records that were available at the Woodward, Oklahoma, Station.

PROCEDURE

A series of more than 500 photographs of 155 Holstein-Friesian females in the herd of the U. S. Dairy Experiment Station at Woodward were made in connection with the inheritance investigations in progress at that station over a period of some 15 years. All females except those that die or become non-breeders are kept in the herd until they have completed at least one 365-day lactation record on official test. The size of the herd that can be maintained at the station is limited by both facilities for handling and funds. These factors have made it necessary to dispose of many of the animals by the time they are 5 years of age. Consequently the animals studied in this project were largely young cows, and they constitute an unselected cow population.

Each cow was photographed each year by a method that made all photographs comparable in scale and detail. The animals were posed on a level track, squarely in front of the camera which was mounted on a fixed post at a distance of 28 feet. No attempt was made to pose the animals so as to cover up defects; but a standardized position was used that was designed to show the actual conformation to the greatest possible extent. The same experienced photographer made and developed all of the pictures and the same camera and lens were used for the entire period. The prints were 5 by 7 inches in size and clear in detail. Legends were placed on the pictures when made. As the photographs were all made in the fall of the year it was not possible to get pictures of all of the animals when at the same stage of lactation.

In order to measure the angle of inclination or slope of the rump and udder a base line was established by drawing a line through the extreme upper attachment of the dew-claws on the front and rear legs nearest the camera. Since the cows were standing directly in front of the camera and on a level track, this proved a satisfactory line from which to measure the angles. To obtain the angle for the rump slope, a line was drawn through points at the dorsal extremity of the hip bone (tuber coxae) and the dorsal extremity of the pinbone (tuber ischii). The angle formed by the intersection of this line with the base line, or a line parallel to the base line, was measured with a protractor. To measure the udder slope, a line was drawn through the points where the front portion of the front teat and the front portion of the rear teat join the udder. The line was extended until it intersected the base line and the angle formed was measured with a protractor. If it was evident that the pose of an animal was unnatural the measurements for that animal were discarded. If the udder was not lactating or if it appeared to be abnormal, the udder measurements were not used. The photographs were measured during the winter of 1940 by R. E. Leighton and, as a check, a number were measured again a year later. In all cases the rump slope readings were the same, but in a few cases there was as much as one degree variation in the udder slope readings.

The last animal photographs were made in 1938. In 1941 and 1942 measurements were made with a clinometer of the angle of the rump of 17 living

TABLE 1

A comparison of the degree of inclination of rump as taken from photographs and as secured from living animals

Cow number	Age of animal—years							
	1	2	3	4	5	6	7	8
	Degree of inclination							
W-212	7	11	12	15	10	......	(10)	(11)
W-223	12	11	12	12	......	......	(12)	(11)
W-235	11	11	13	......	......	(13)	(14)	......
W-245	9	11	14	......	(13)	(12)	......	......
W-246	9	10	......	......	(10)	(10)	......	......
W-247	11	10	......	......	(9)	(8)	......	......
W-251	10	7	......	(8)	......	......	......	......
W-256	10	......	......	(11)	(10)	......	......	......
W-258	13	......	(13)	(11)	......	......	......	......
W-259	10	......	(7)	(12)	......	......	......	......
W-260	12	......	(11)	(13)	......	......	......	......
W-261	10	......	(12)	(10)	......	......	......	......
W-262	15	......	(15)	(16)	......	......	......	......
W-263	12	......	(12)	(10)	......	......	......	......
W-264	8	......	(11)	(12)	......	......	......	......
W-265	10	......	(12)	(12)	......	......	......	......
W-266	9	......	(9)	(13)	......	......	......	......

The figures enclosed in parentheses are those taken on live animals in February, 1941 and 1942.

animals in the herd. The slope of the rump for these same animals had been calculated from their pictures, though the pictures were made at an earlier age. The measurements on the living animal offer a check on the accuracy of the slopes calculated from the photographs. The results are shown in table 1, the readings made on the living animals appearing in parentheses. In view of the difference in age of the animals when photographs were taken and when the readings on the living animals were made, the results arrived at by the two methods appear quite consistent.

Only two cows had both picture measurements and clinometer readings of udder slope and these were taken 3 years apart. The photographs taken when the two cows were 3 years old showed 11° and 32° slope, respectively.

The clinometer readings made 3 years later were 23° and 32°, respectively. The increase in udder slope of the first cow was probably due to the effect of advancing age and does not indicate a lack of consistency in the slope calculated from the picture and the direct reading on the living animal.

RESULTS AND DISCUSSION

Effect of age. To determine the effect of age on the slope of rump and the slope of the udder, averages were computed for the readings for all animals for each year, starting at 1 to 6 months for slope of rump, and at 19 to 30 months for slope of udder. Since the animals were photographed each year as long as they were in the herd, many of the animals are represented in each age-year group, but the younger groups are represented by larger numbers. In order to obtain data that would bear more specifically on the effect of advance in age on the slope of rump and of udder, an additional calculation was made on 20 cows on which there were data for each age year up to 5 years, with the exception that some of these animals were not represented by pictures for study in the youngest age groups. These two groups of data are shown in table 2, A and B.

TABLE 2

Effect of age upon inclination of rump and udder

Age in months	Rump		Udder	
	Animals	Inclination	Animals	Inclination
A—Average of all animals				
	number	*degrees*	*number*	*degrees*
1–6	76	10.8	......	....
7–18	124	11.4	......	....
19–30	115	12.2	50	10.1
31–42	98	13.2	82	14.1
43–54	64	13.1	59	14.7
55–66	36	14.1	33	18.3
67–78	20	13.4	18	18.0
79–90	12	13.4	12	19.0
B—Average of 20 animals with complete data from 1 to 5 years of age				
1–6	8	9.4	......	....
7–18	20	10.7	......	....
19–30	20	12.0	12	9.7
31–42	20	12.7	20	14.2
43–54	20	13.0	20	16.3
55–66	20	13.3	20	18.3

In general the two groups show the same trend but there is some difference in magnitude of the increase in degree of slope of the rump with age. In the group shown in table 2, A, the maximum slope in the rump is attained in the age group 55–66 months, with a per cent increase in the degree of slope from the age group 1–6 months, of 30.6. The maximum degree slope for the 20-cow group is also reached at 55–66 months and the total per cent increase from the 1–6 months is 41.5. There is a fairly consistent increase in the slope of the rump with each age group, with the most rapid increases in the A group occurring between 7–18 months and 19–30 months, with a 7 per cent increase; and from 19–30 months to 31–42 months, with an 8.2 per cent increase. In the B group the most rapid rate of increase came earlier. From 1–6 to 7–18 months the increase in degree of slope was 13.8 per cent; from 7–18 to 19–30 months, it was 12.1 per cent; and from 19–30 to 31–42 it was 5.8 per cent. Thereafter the per cent increase in slope of rump for each age group was 2.3 per cent.

The increase in degree of udder slope was much more pronounced. For the A group the maximum degree of slope was at 79–90 months and the total increase in degree of slope at this age from the slope at 19–30 months was 88.1 per cent. For the B group the maximum degree of slope for the 20 cows was reached at 55–66 months and the total increase in degree of slope at this age was 88.6 per cent over that at 19–30 months. In both groups the greatest increase in degree of slope came from 19–30 to 31–42 months with 39.6 and 46.4 per cent, respectively. For succeeding age groups the rate of increase was very irregular, being 4.2, 24.5, –1.6, and 5.5 per cent for the animals in table 2, A; and 14.8 and 24.5 per cent for those in table 2, B.

Thus it appears that in this herd there was an increase in slope of rump up to 5 years of age, with the most rapid increases in slope falling between 1 and 3 years of age. There was an increase in slope of udder up to 7 years, with the most rapid increases taking place between 2 and 3 years of age. The maximum degree of slope of the udder attained at mature age was approximately 40 per cent greater than the maximum degree of slope of the rump at mature age.

The above observations have applied to the averages secured from all animals in each age group. There were many individual animals that varied from this trend. It was observed that in some cases there appeared to be an improvement in the levelness of the rump, even when the measurements showed an actual increase in the degree of slope. The apparent improvement was probably due to a raised tail setting.

The relation of rump inclination to udder inclination. It has been pointed out that there is a common belief that the sloping rump is associated with the tilted udder. To determine whether there was any relationship between sloping rumps and tilted udders in the animals in the Woodward Station herd, correlation coefficients were run on 87 pairs, using the readings for animals in the 31–42 months age-group. This group has the largest population for udder inclination and the third largest population for rump inclination (see table 2, A). The coefficient secured was $+0.021 \pm 0.11$, indicating that there is no relationship between the sloping rump in the animals in this study and the tilted udder. Correlation coefficients were run on these same 87 pairs to determine if there was any relation between the sloping rump and producing ability; or between the tilted udder and producing ability. The coefficient for sloping rump and producing ability was -0.013 ± 0.107, indicating that the relationship was not significant. The coefficient for tilted udder and producing ability was -0.196 ± 0.103, indicating that this relationship was not significant.

Thus it appears that in this group one is as likely to find a tilted udder on a cow with a level rump as on a cow with a sloping rump; or a cow with a sloping rump is no more likely to possess a tilted udder than is the cow with a level rump. Furthermore, producing ability, at least within the levels of production possessed by the cows in this study, is not effected by the degree of slope of either the rump or the udder.

Some observers believe that cows that have sloping rumps are more likely to have difficulty delivering calves than are cows with level rumps. Our records were not complete enough to permit a study of the relationship of degree of slope of rump to difficult calving, but we did run a correlation coefficient on the relationship of degree of slope of the rump to breeding efficiency, as measured by the number of services per conception. It is recognized that there are many factors that may cause a lowered breeding efficiency and it was hardly expected that the correlation coefficient for sloping rump and breeding efficiency would be significant. The coefficient was $+0.220 \pm 0.088$. While not high enough to be considered significant, it indicated a more pronounced trend than the other three coefficients that have been discussed.

The inheritance of the degree of rump and udder inclination. It appears from the data presented that neither the sloping rump nor the tilted udder has any influence on the producing ability of an animal. Also the levelness of the rump, or the degree of its slope, is not associated with either the levelness or the degree of tilt of the udder. Nevertheless animals with level rumps and/or level udders have much greater sales value than do animals that have sloping rumps and/or tilted udders, other points being equal. This will be true even though it is fully understood that these features do not have a bearing on producing ability, because of the fact that the level rump and the level udder are commonly associated with the correct type or beauty of an animal.

So far as is known there are no environmental conditions that will cause a level rump to become sloping. Photographic records in the Bureau of Dairy Industry, portraying the development of experimental breeding animals from calfhood to maturity, do show, however, that many animals undergo startling changes in the conformation of the rump. Some that are level become sloping and some that are sloping become level. The reasons for these changes are not known.

There are a number of known causes for changes in the shape of the udder. Injury or infection in one or more quarters may cause atrophy of the tissues that may result in an unbalanced udder. Investigations have shown that the average cow secretes in the rear quarters approximately 60 per cent of the total amount of milk produced. The greater weight of the milk in the rear quarters may result in a more pronounced sagging in these quarters. Then there is the not inconsiderable weight of the udder that may cause a relaxation of the supporting tissues. The average weight of 17 empty udders from cows at the Beltsville station that had been in milk 3 months or less at the time of slaughter was 72.98 pounds.

An investigation of the "Arrangement of the tissues by which the cow's udder is suspended,"[4] by W. W. Swett, P. C. Underwood, C. A. Matthews, and R. R. Graves, showed that probably the main supporting tissue of the udder was the fan-shaped septum between the two halves of the udder that attaches directly to the abdominal wall. If this main supporting tissue, or the lesser supporting tissues, becomes lax and stretches, because of hereditary tendencies, old age, or ill health, the shape and the balance of the udder may change quickly. The illustrations of these tissues in the publication cited show more clearly than can words how this may occur.

There was a greater probability of error in measuring the inclination of the udder than in measuring the inclination of the rump. This was because of the short distance between the base points—the base of the front and rear teats—from which the angle of the inclination of the udder was projected; the difficulty in accurately locating the teat base with some types of teats, especially those that are inclined to balloon or funnel out; and the differences that existed in the stage of lactation of different animals when photographed. The greater possibility of environmental factors influencing the shape of the udder and the greater probability of error in obtaining the correct angle of the inclination of the udder result in greater variations and more indefinite trends in the following study of the inheritance of the udder inclination than is the case in the study of rump inclination.

The data obtained in this study have been analyzed for indications of the part that inheritance plays in determining the extent of the inclination of the rump and the udder.

Table 3 shows the average inclination of the rump and of the udder of the daughters and of their dams, of the five sires used in the station herd. The data for the outbred and inbred daughters are shown separately. The program of taking photographs of each animal in the breeding herd each year had to be discontinued a few years ago, so that data are not available for all the daughter-dam pairs for sires 4 and 5. In reading the per cent increase or decrease in inclination in this table it should be kept in mind that a plus per cent indicates that the degree of slope of the daughters has

[4] Journal of Agricultural Research, Vol. 65, No. 1.

increased over that of their dams, and the minus per cent indicates the degree of slope of the daughters has decreased or the rump or udder of the daughters has become more level as compared to that of the dams.

The inbred daughters of sire 1 and the outbred daughters of sire 2 had the most sloping rumped daughters, each with an average of 13.5°; but the degree of slope of sire 1's inbred daughters was 10.6 per cent greater than the slope of their dams, while the degree of slope of sire 2's daughters was only 3.9 per cent greater than that of their dams. Sire 5's daughters had the least slope of any sire's daughters and they had 27.6 per cent less slope than did their dams. This was the greatest change from the average inclination of the rump of the dams shown by any group of daughters. Sires 3 and 4 were mated to dams that had the highest average rump inclination and sire 3's outbred daughters average 6.6 per cent less inclination than their dams and sire 4's daughters averaged 12.6 per cent less than their dams.

The per cent changes in udder inclination were much greater than those for the rump. Perhaps this is because the changes in udder inclination were due to some extent to environmental factors.

The greatest increase in udder inclination was in the daughters of sire 1. The dams of his outbred daughters had more level udders than did any other group of dams. The inbred daughters of sire 1 had udders with a greater inclination than did his outbred daughters, but the per cent increase in inclination was less.

Coefficients of correlation indicated that there was no relationship between the sloping rump and the tilted udder. The results shown in table 3 show why a correlation coefficient for these characters would be without significance. Sire 2's outbred daughters ranked with sire 1's inbred daughters in possessing the most sloping rumps but sire 2's daughters also had the most level udders. He increased the degree of inclination of rump of his daughters over that of their dams by 3.9 per cent and he decreased the udder inclination of his daughters 23.8 per cent. On the other hand, sires 3 and 4 decreased the rump inclination of their daughters and greatly increased their udder inclination.

From the data in table 3 equal parent indexes have been calculated for each sire for inclination of rump and for inclination of udder, on the assumption that the average inclination of the rump or udder of the daughters represents the average of the degree for that character transmitted by the parents. These indexes for sires 1, 2, and 3 are used in table 4, along with the measurements of certain cows that they were mated to, to show the expected inheritance for inclination of rump and udder as compared to that actually secured in full sisters. Thus the index for inclination of rump calculated from the outbred daughters of sire 1 and their dams is 12.8°, and the index for inclination of udder is 27.2°. Sire 1 was mated to cow W–14, whose inclination of rump was 9.0°, and of udder 1.0°. The average of sire

TABLE 3

Comparison of degree of rump and of udder inclinations of daughters–dams of five sires

Sires	Number pairs	Rump inclination			Udder inclination		
		Daughters	Dams	Increase or decrease of daughters	Daughters	Dams	Increase or decrease
		degrees	*degrees*	*per cent*	*degrees*	*degrees*	*per cent*
No. 1, outbred	5	11.8	10.8	+ 9.2	17.6	8.0	+ 120.0
No. 1, inbred 75%*	9	13.5	12.2	+ 10.6	22.0	14.3	+ 53.8
No. 1, inbred 87.5%†	1	16.0	17.0	− 5.9	20.0	22.0	− 9.0
No. 2, outbred	20	13.5	13.0	+ 3.9	9.3	12.2	− 23.8
No. 2, inbred 62.5%‡	1	12.0	10.5	+ 14.3	12.0	20.0	− 40.0
No. 3, outbred	18	12.7	13.6	− 6.6	16.1	11.0	+ 46.3
No. 3, inbred 75%	3	13.0	14.6	− 10.9	13.3	14.0	− 5.0
No. 4, outbred	4	11.8	13.5	− 12.6	19.7	13.0	+ 51.5
No. 5, outbred	8	7.6	10.5	− 27.6	11.0	...... §	......

* 75% inbreds, result of mating daughter to sire.
† 87.5% inbreds, result of mating 75% inbred daughter to sire—3 crosses of sire.
‡ 62.5% inbreds, result of mating granddaughter to sire.
§ Pictures on dams of daughters as 3-year-olds not available for measuring inclination of udder.

TABLE 4

Comparison of degree of rump and of udder inclinations of full sisters with parent index

Sire and dam	Rump inclination (degrees)		Udder inclination (degrees)	
	Parents	Daughters	Parents	Daughters
Sire No. 1	12.8		27.2	
Dam W–14	9.0		1.0	
Equal parent index	10.9	W–36, 14; W–41, 8	14.1	W–36, 10; W–41, 19
Sire No. 2	14.0		6.4	
Dam W–14	9.0		1.0	
Equal parent index	11.5	W–77, 13; W–63, 12; W–88, 8	3.7	W–77, 8; W–63, 18; W–88, 11
Sire No. 1	12.8		27.2	
Dam W–16	10.0		10.0	
Equal parent index	11.4	W–39, 12; W–47, 8	18.6	W–39, 23; W–47, 25
Sire No. 2	14.0		6.4	
Dam W–18	14.0		11.0	
Equal parent index	14.0	W–68, 11; W–81, 17	8.7	W–68, 0; W–81, 12
Sire No. 2	14.0		6.4	
Dam W–23	9.0		13.0	
Equal parent index	11.5	W–69, 13; W–79, 11	9.7	W–69, 8; W–79, 0
Sire No. 1 (inbred)	14.8		29.7	
Dam W–25	15.0		11.0	
Equal parent index	14.9	W–42, 16; W–33, 10	20.3	W–42, 22; W–33, 14
Sire No. 2	14.0		6.4	
Dam W–25	15.0		11.0	
Equal parent index	14.5	W–80, 13; W–86, 11; W–98, 16	8.7	W–80, 12; W–86, 2; W–98, 15
Sire No. 2	14.0		6.0	
Dam W–38	17.0		11.0	
Equal parent index	15.5	W–93, 13; W–54, 17	8.7	W–93, 13; W–54, 22
Sire No. 2	14.0		6.4	
Dam W–44	18.0		18.0	
Equal parent index	16.0	W–94, 14; W–223, 12	12.2	W–94, 2; W–223, 0
Sire No. 3	11.8		21.0	
Dam W–55	12.0		9.0	
Equal parent index	11.9	W–226, 9; W–95, 14	15.0	W–226, 17; W–95, 12
Sire No. 3	11.8		21.0	
Dam W–77	13.0		8.0	
Equal parent index	12.4	W–213, 14; W–99, 14; W–233, 10	14.5	W–213, 19; W–99, 12; W–233, 19
Sire No. 3	11.8		21.0	
Dam W–79	11.0		0.0	
Equal parent index	11.4	W–219, 10; W–203, 11	10.5	W–219, 10; W–203, 14

1's index for inclination of rump, and of cow W–14's actual inclination of rump, was 10.9°, the average inheritance for inclination of rump from these two parents. Inclination of the rump of the two full sisters resulting from the mating of these two parents, W–36 and W–41, is 14° and 8°, respectively. Likewise, the average index for these two parents for inclination of udder is 14.1 and the inclination for udder of W–36 and W–41 is 10° and 19°, respectively.

Such comparisons can only be of value in showing trends for the reasons that both parents were undoubtedly heterozygous for the factors determining degree of slope and consequently no one index figure can represent the range that they will transmit at different matings; and also because the

TABLE 5

The "expected" inheritance from the parents and the "actual" phenotypic inheritance received, as shown by the average inclinations of full sisters

Parents	Inclination of rump		Inclination of the udder	
	Expected index	Actual average of daughters	Expected index	Actual average of daughters
	degrees	*degrees*	*degrees*	*degrees*
1 × 14	10.9	11.0	14.1	14.5
2 × 14	11.5	11.0	3.7	12.4
1 × 16	11.4	10.0	18.6	24.0
2 × 18	14.0	14.0	8.7	6.0
2 × 23	11.5	12.0	9.7	4.0
1 × 25	14.9	13.0	20.3	18.0
2 × 25	14.5	13.3	8.7	9.7
2 × 38	15.5	15.0	8.7	17.5
2 × 44	16.0	13.0	12.2	1.0
3 × 55	11.9	11.5	15.0	14.5
3 × 77	12.4	12.7	14.5	16.7
3 × 79	11.4	10.5	10.5	12.0
Average	12.9	12.2	12.0	12.5

index as calculated for the sire is a genotypic expression of his inheritance for these characters, while the measurement of the dam and of each daughter for degree of inclination is a phenotypic expression. Nevertheless the data in this table do show trends that appear to indicate that the inclination of the rump, and to a less extent the udder, is controlled largely by inheritance.

The data in table 4 give some idea of the variability of full sisters for these two variables. The daughters of W–14 and W–25 are especially interesting because each of these dams has daughters by sires 1 and 2. The daughters of cow W–25 by sire 1 are inbred and the index for sire 1 in this case is calculated from the averages of his 9 inbred daughters and their dams. Note the variability in the udder inclination of the three daughters of sire 2 and W–14, though the index of the parents was only 3.7. Also note the low range of variability of udder inclination in the two daughters of sire 2 and cow W–44, though the parent index was 12.2.

In order to show the trend more clearly the data in table 4 are condensed and given in table 5 as the "expected" and the "actual" inclinations occurring in the daughters.

The expected inheritance for inclination of rump for the 12 parental combinations shown in table 5 varies from 10.9 to 16.0°. As is to be expected in the matings of heterozygous parents, there is considerable variation among the full sisters resulting from each parental combination. When, however, the readings for the full sisters are averaged, the results fit quite closely to the expected inheritance for inclination of rump. Thus the "expected" for the first 2 parents is 10.9° and the average of their 2 daughters is 11.0°; and for each of the other parental combinations the results are: 11.5 to 11.0, 11.4 to 10.0, 14.0 to 14.0, 11.5 to 12.0, 14.9 to 13.0, 14.5 to 13.3, 15.5 to 15.0, 16.0 to 13.0, 19.9 to 11.5, 12.4 to 12.7, and 11.4 to 10.5°. The average for the expected for the 12 parental combinations is 12.9° and the average of the full sisters of the different parental combinations is 12.2°. Thus it appears that inclination of rump is clearly an inherited character; and of a multiple factor type.

The "expected" inheritance for inclination of udder covers a much wider range than the "expected" inheritance for inclination of rump, ranging from 3.7 to 20.3°. There is also a greater departure from the "expected" in both the individual daughter and in the average of the full sisters. This is to be expected in view of the greater part that environment may play, as well as the possibility of greater error in measurement. Though there is not as close a fit of the "actual" to the "expected" as in rump inclination, the trends of the "actual" and "expected" are in sufficient agreement to indicate that inheritance plays a major part in determining the extent of the inclination of the udder.

The comparison of the "expected" to the "actual" as expressed by the average of the degree of udder inclination of the full sisters from each parental combination, reading from top to bottom, is as follows (table 5): 14.1 to 14.5, 3.7 to 12.4, 18.6 to 24.0, 8.7 to 6.0, 9.7 to 4.0, 20.3 to 18.0, 8.7 to 9.7, 8.7 to 17.5, 12.2 to 1.0, 15.0 to 14.5, 14.5 to 16.7, and 10.5 to 12.0°. The average for the "expected" is 12.0° and for the actual 12.5°. The daughters of sire 2 and W–14 greatly exceed the parental index; also the daughters of sire 2 and W–38. The 2 daughters of sire 2 and W–44 and the daughters of sire 2 and W–23 have much more level udders than was to be expected from the parental index. On the whole, however, where the parental index is high the average of the daughters is high, and where the parental index is low the average of the daughters is low. It appears that the degree of slope of the udder is also a blended inheritance but that the inheritance picture is far more likely to be distorted by environmental factors than is the degree of slope of the rump.

TABLE 6

Variation in rump and udder slope and milk and butterfat production by groups according to sire of the groups

Group	Average rump slope, age 3 years			Average udder slope, age 3 years			Average production, mature equivalent				
	Animals	Degrees	Coefficient of variation	Animals	Degrees	Coefficient of variation	Animals	Milk	Coefficient of variation	Butter fat	Coefficient of variation
	number						*number*	*pounds*		*pounds*	
Daughters of sire 1	14	11.3	28.3	14	12.8	50.0	14	18,735	11.9	595	12.0
75 per cent inbred daughters of sire 1	9	13.6	19.2	9	22.0	25.4	9	16,321	22.0	509	23.0
Daughters of sire 2	20	13.9	25.2	20	11.0	55.0	20	20,819	12.7	685	11.0
Daughters of sire 3	22	12.8	18.7	22	15.0	36.0	22	17,458	20.2	624	19.9
75 per cent inbred daughters of sire 3	4	12.0	6.7	4	14.0	18.0	3	16,418	5.3	607	12.2
Daughters of sire 4	6	13.0	25.3	6	18.0	45.0	6	18,896	9.4	678	12.1
Daughters of sire 5	6	8.6	39.5	6	11.0	17.3	3	17,718	7.2	706	6.6

Most of the records were made between 2 and 3 years of age.

VARIABILITY

Coefficients of variability were calculated for the daughters of the five sires, on which data were secured on the inclination of the rump and the udder, for milk yield, butterfat yield, inclination of the rump, and inclination of the floor of the udder. Coefficients for these characters were calculated separately for the inbred daughters of sires 1 and 3. These coefficients are shown in table 6 along with average inclination of the rump and of the floor of the udder, and the average milk yields and the average butterfat yields of the daughters of the five sires.

The outbred daughters of sire 1 were less sloping on the average than his inbred daughters, but the variation in degree of slope was far greater in the outbred daughters. His inbred daughters also had less variability in slope of the udder floor. In this case inbreeding brought about a more uniformly sloping rump and a more uniformly sloping udder floor, but when it came to milk yield and butterfat yield the inbred daughters had lower yields, and the variability of the yields was far greater than that of the outbred daughters. The greater variability in milk and butterfat yields in the inbred daughters is in accordance with findings in an experiment with inbred dairy cattle at the Beltsville Station of the Bureau of Dairy Industry, the results of which will be published in a technical bulletin of the United States Department of Agriculture. On the other hand, the variability was lower in the inbred daughters of sire 3 than in his outbred daughters for all four variables. However, there were milk and butterfat yields on only three daughters.

The daughters of sire 5 had the lowest average slope of rump of the daughters of the five sires, but the coefficient of variation was the greatest. The daughters of sire 5 and the daughters of sire 2 had the lowest average inclination for udder floor, but the daughters of sire 5 had the lowest coefficient of variation and the daughters of sire 2 had the highest coefficient of variability for this character. Perhaps these are additional indications that the slope of rump and slope of udder floor are inherited independently of each other.

In view of the history of the daughters of sire 3 at the Woodward Station, it is surprising that his daughters do not show a greater slope of the udder floor, and an even greater coefficient of variability for this character and for milk yield and butterfat yield. The daughters of this sire suffered rather uniformly at calving time from a severe inflammation of the udder and an edematous condition that persisted long after calving. It was thought that the severity of this condition resulted in some breaking down of the udder and interference with the expression of their normal inherent producing ability.

SUMMARY AND CONCLUSIONS

1. Man's ideas of beauty in the bovine long ago insisted that the rump should be level, though most species of animals have sloping rumps. Breeders for many years have selected for level rumps. But the inheritance for the sloping rump still persists, and is continually occurring in all breeds of dairy cattle, though with decreasing frequency. Along with the selection of breeding animals for level rumps, there have been developed over a period of years opinions that there are certain associated defects that are likely to be inherited along with the sloping rump. Of these opinions the most common and the most important were: (a) that the floor of the udder would parallel the rump—that with a sloping rump there would be a tilted udder; (b) the tilted or sloping udder would be deficient in the front quarters and would, therefore, have less capacity; (c) that difficult calving and lower breeding efficiency occurs in cows with sloping rumps.

2. In the experimental breeding herds of the Bureau of Dairy Industry animals were photographed once a year under carefully controlled conditions as to posing on a level track with camera on a fixed post at a uniform distance from animal and at uniform height from ground, and with the same camera used for all the pictures. It was found that these pictures could be satisfactorily used in obtaining the degree of slope of the rump; they can also be used for determining the degree of slope of the udder, though with somewhat less accuracy than that of the rump. The degree of accuracy of the slope obtained from the photographs was checked with a clinometer on the living animal and found to be satisfactory.

3. The material for this paper was obtained from a series of more than 500 photographs of 155 females in the experimental breeding herd of Holstein-Friesian cattle at the United States Experiment Station at Woodward, Okla.

4. The animals with the straightest rumps were in the age group of 1 to 6 months. From that age the slope of the rump became progressively greater up to the age of 5 years. The most rapid change in the slope of rump came at the younger ages. In one group the per cent increase in degree of inclination of the rump from the age group of 1–6 months to the age group of 7–18 months was 13.8; from 7–18 months to 19–30 months the degree of inclination was 12.1 per cent greater, and from 19–30 to 31–42 months, the increase was 5.8 per cent.

5. The increase in degree of udder slope with advance in age was more pronounced than the change in rump slope. The maximum slope of udder was at 79–90 months of age, and the per cent increase in the degree of slope at this age was 88.1 per cent greater than the degree of slope in the 19–30 month age group. As with the rump, the greatest increase in the slope of

the udder came in the younger age groups with decreasing increments with advance in age.

6. The correlation coefficient for the relationship of the degree of inclination of the rump to the degree of inclination of the udder for 87 animals was $+0.021 \pm 0.11$; the correlation coefficient for relation of degree of sloping rump to producing ability was -0.013 ± 0.107; the correlation coefficient for relation of degree of inclination of the udder to producing ability was -0.196 ± 0.103. None of these coefficients was significant.

7. Herd records were not sufficiently complete to determine the relationship of the sloping rump to difficult calving. A correlation coefficient on the relation of the degree of inclination of the rump to the number of services per conception was $+0.220 \pm 0.088$. While hardly significant, this coefficient does show a more pronounced trend than the other three coefficients.

8. Study of the data on the daughters of the different sires used in the experiment indicates that the sloping rump and the tilted udder are inherited characters, probably of a multiple factor or blending type, and that the slope of the rump and the tilt of the udder are inherited independently of each other. The average of the actual slope of either the rump or the udder of several full sisters fits quite closely the expected slope calculated from the equal parent index of all the daughter-dam pairs for the sire and the actual slope of the dam.

9. Variability was decreased in the slope of rump and in the slope of the udders of the inbred daughters of one sire while the variability in milk and butterfat yields was increased. In a second sire the inbred daughters had a lower variability than the outbred daughters in slope of rump, slope of udder, milk yield, and butterfat yield, though the number of inbred daughters was rather small. The degree of variability was not associated with the degree of the slope of either the rump or the udder.

CAN GOOD PRODUCING COWS BE FED IN SUCH MANNER AS TO MAINTAIN THEIR WEIGHT?

R. R. GRAVES[1]

Students of dairy cattle nutrition often say that dairy cows should be so fed that they will not lose weight; that if a good producing cow is losing weight she is not receiving enough nutrients. If she is producing well and is not gaining or losing in weight she is correctly fed. In other words the weight of the cow during the lactation period is one of the best guides to good feeding.

A few years ago we conducted feeding experiments at field stations to determine the relative production of cows when on limited grain rations and on rations of roughage alone and when they were receiving what we termed a full grain ration, that is when they were fed grain at the rate of 1 pound to each 3 pounds of milk produced. It was noted that the cows on roughage alone lost weight quite rapidly early in the lactation period and then gained slowly during the remainder of the period. This indicated, apparently, that the cows were unable to eat enough of the bulky roughage ration to meet their requirements for production and maintenance in the early months of lactation. This is probably the reason why these cows did not approach more closely, when on a good quality of alfalfa hay, their level of production when receiving the full grain ration, rather than because of any deficiencies in the hay.

In one experiment 11 cows were fed throughout a 12-month lactation period on a ration consisting entirely of alfalfa hay, and 8 of these cows were fed through a second successive lactation period on alfalfa hay alone.[2] In the first lactation period these 11 cows lost in the first month an average of 107 pounds, in the second month 43 pounds and in the third month 7 pounds; in the fourth month they gained 4 pounds, in the fifth month they lost 8 pounds, and thereafter they gained in weight each month. Their total average loss, from their "after-calving" weight, during 4 of the first 5 months of the lactation period was 165 pounds, and their total average gains during the remaining 8 months was 122 pounds; therefore, in the twelfth month they had failed to regain their after-calving weight by 43 pounds.

The 8 cows that completed a second successive lactation period on alfalfa hay alone lost weight only in the first 2 months of lactation—an average of 91 pounds for the 8, and during the remainder of the lactation period gained

Received for publication September 21, 1946.

[1] Formerly Chief, Division of Dairy Cattle Breeding, Feeding and Management Investigations, Bureau of Dairy Industry, U.S.D.A., now President, Wood-Jon Farms, Inc., Valparaiso, Ind.

[2] Feeding Dairy Cows on Alfalfa Hay Alone. U.S.D.A. Tech. Bul. 610, March, 1938.

123 pounds, so that they weighed an average of 33 pounds more in the twelfth month than their after-calving weight.

In an experiment at the Utah Station[3] 12 cows were fed through three successive 10-month lactation periods, in one of which they were fed only alfalfa hay and pasturage in season; in a second alfalfa hay, and ground barley fed at the rate of 1 pound to each 5.7 pounds of milk produced, plus pasturage in season; and in a third alfalfa hay and corn silage and pasturage in season. The weights of these 12 cows followed a very similar pattern during the three lactation periods. In the first they lost 104 pounds the first month and 17 pounds the second month—a total average loss of 121 pounds in 60 days. They gained it all back in the next 8 months and were 10 pounds over the after-calving weight in the tenth month. In the second lactation period, the one in which they received ground barley in addition to alfalfa hay, they lost an average of 105 pounds the first month, 14 pounds the second, and 4 pounds the third month, a total shrinkage of 123 pounds in the first 3 months of lactation. In the next 7 months their total average gain was 104 pounds so that in the tenth month of lactation they lacked 19 pounds of regaining their after-calving weight. In the third lactation period, when they received alfalfa hay and corn silage, the average loss of the 12 cows was 105 pounds the first month and 15 pounds the second month —a total loss of 120 pounds. Starting with the third month they made some gain each month, making a total average gain at the end of the tenth month of 154 pounds and putting them 34 pounds over their after-calving weight. Such uniformity of losses and gains for 12 cows over three lactation periods is quite remarkable.

So far as we could determine these severe losses in weight caused no physical injury to these cows, but it was no doubt associated with a lower level of production than would have been the case had they been fed in such manner as to enable them to maintain a more uniform weight. But can good dairy cows be fed so that there will be little change in their weights during the lactation period? A study was made of the changes in weight through a 12-month lactation period of 20 2-year-old Jerseys on Register of Merit test at the Lewisburg, Tenn., Field Station, of 20 2-year-old Holstein heifers on Advanced Registry test at the Huntley, Mont., Field Station, of 9 2-year-old Holsteins and 9 mature Holsteins on Advanced Registry test at the Beltsville Station, and of 9 2-year-old Jerseys and 9 mature Jerseys on Register of Merit test at the same station.

At the Lewisburg Station cows on Register of Merit test are fed legume hay *ad lib,* and a grain mixture fed at the rate of 1 pound to each 3 pounds of milk produced. They are also on pasture during the pasture season. At the Huntley Station cows are fed alfalfa hay *ad lib,* corn silage, and a grain mixture at the rate of 1 to 3. They are not pastured. At the Beltsville

[3] U.S.D.A. Tech. Bul. 724, April, 1940.

Station the method of feeding is somewhat different. The requirements of the cows for maintenance and production are calculated every 10 days. After allowing for the alfalfa hay and corn silage consumed, enough of a grain mixture is fed to provide total digestible nutrients 10 per cent in excess of the requirements. Some heavy-producing cows will not consume enough feed early in their lactation periods to provide the 10 per cent over requirements, but they were fed as closely to that level as their consumption permits. This no doubt results in somewhat more liberal feeding than is the case at the Lewisburg and Huntley Stations.

THE JERSEYS

The Beltsville 2-year-old Jerseys had an average weight of 868 pounds 13 days before calving, the individual weights ranging from 749 to 1,010 pounds. Their average weight 11 days after calving was 803 pounds, ranging from 695 to 900 pounds. The loss in weight from the before-calving to the after-calving was approximately 8 per cent of the latter weight. In the tenth month of lactation all but one of the 9 2-year-olds had reached a weight that exceeded her pre-calving weight. The one exception had the heaviest before-calving weight.

In the twelfth month of lactation they had reached an average weight of 951 pounds, a gain of 148 pounds over the after-calving weight, or 18.4 per cent. The lowest gain was 109 pounds and the highest gain was 214 pounds.

These 9 2-year-old Jerseys were evidently able to get on full feed quickly for four of them had no monthly weight that was below their after-calving weights and two more had monthly weights that were only 2 pounds and 7 pounds below their respective after-calving weights. The remaining 2 reached low weights that were 19 pounds and 42 pounds below their respective after-calving weights. They were one pound below the average after-calving weight in the first month of lactation but thereafter they made a gain each month.

Three of these heifers did not conceive during the lactation period, but they did not affect the result since their average gain from the after-calving weight to the twelfth month weight was 140 pounds, while the gain for the other 6 heifers was 153 pounds and they carried their calves an average of 188 days during the lactation period.

Feeding nutrients at the rate of 10 per cent in excess of requirements enabled them to gain consistently through the lactation period, to exceed their after-calving weights by an average of 148 pounds and to produce at the average rate of 8,994 pounds of milk, 479 pounds butterfat, starting at the age of 2 years, 1 month.

The 20 2-year-old Jersey heifers at the Lewisburg, Tenn., Station had an average before-calving weight of 769 pounds—99 pounds lighter than the before-calving weights of the 9 2-year-old Jersey heifers at Beltsville.

They ranged from 630 to 890 pounds. Their average after-calving weight was 729 pounds, with a range from 560 to 830 pounds. Thus the Lewisburg 2-year-olds were 12.8 per cent lighter than the Beltsville Jerseys before calving, and 10 per cent lighter after calving. The Lewisburg 2-year-olds lost only 40 pounds from the before-calving weight to the after-calving weight—equivalent to 5.5 per cent of the latter. The Beltsville Jersey shrinkage was 8 per cent. Only 12 of the 20 reached their before-calving weights in the tenth month of lactation.

In the twelfth month their average weight was 836 pounds and the average gain over the after-calving weight was 118.7 pounds or 16 per cent.

They lost very slightly in the first, second, fourth and sixth months—the total average loss was only 21 pounds. Actually they just about held their weight during the first 6 months, the total average gains of 20 pounds balancing the total average loss of 21 pounds, but starting with the seventh month they gained consistently during the remainder of the lactation period. This in contrast with the Beltsville 2-year-old Jerseys that gained from the first month to the twelfth.

The Lewisburg heifers were experiencing breeding trouble. Only half of them conceived during the lactation period, but this does not appear to have materially affected the results so far as gains are concerned. The 10 heifers that did not conceive made an average gain from after calving to the twelfth month of 118 pounds, while the 10 heifers that carried calves an average of 176 days during the lactation period made average gains of 122 pounds. The average butterfat yield was not materially affected by pregnancy; the 10 that carried calves an average of 176 days had an average yield of butterfat of 393.6 pounds and those that did not conceive had an average yield of 385.2 pounds.

The weights of the mature Beltsville Jerseys behaved in a somewhat different manner than did those of the 2-year-olds. The mature cows had an average before-calving weight of 1,201 pounds, 79 pounds or approximately 7 per cent greater than their after-calving weight. This is only 1 per cent less than the shrinkage of the 2-year-olds. Only four cows attained their precalving weights in the tenth month. In the twelfth month all had passed their after-calving weights, but their gain was only 6.6 per cent of the after-calving weight, approximately one third the percentage gain made by the Beltsville 2-year-olds. Their losses in weight during the lactation period were more pronounced than those of the 2-year-olds. All but two had lower weights than the after-calving weight during the lactation period. The low points were very scattered, two of them occurring as late as the eighth and the ninth months of the lactation period. After the first month the Beltsville 2-year-olds showed an average gain each month, while the mature Jerseys, with the exception of the second month, when they showed a loss, just about held the average after-calving weight through the seventh month of lactation. Starting with the eighth month they showed a material gain each month.

THE HOLSTEINS

The average before-calving weight of the Beltsville 2-year-old Holsteins, 1,238 pounds, was almost 12 per cent greater than their after-calving average. Like the 2-year-old Jerseys they made a gain in weight each month, excepting the first, which was the same as the after-calving weight. Only three of them dropped below their after-calving weight at any point in the lactation period. Three of them failed to attain their before-calving weights in the tenth month, and all of them passed their after-calving weights by substantial margins by the twelfth month of lactation. These gains ranged from 95 to 367 pounds, and the average gain of 234 pounds was 21 per cent of the average after-calving weight. This is a larger percentage gain than that made by the Beltsville 2-year-old Jerseys.

Twenty 2-year-old Holstein heifers at the Huntley, Mont., Station had an average before-calving weight of 1,279 pounds, 13.7 per cent greater than their after-calving average. Both the before-calving and the after-calving average weights were somewhat higher than those of the Beltsville 2-year-olds. However, the system of feeding at Huntley did not enable them to gain as consistently during the lactation period as did the 2-year-olds at Beltsville under the system of feeding prevailing at that station. Only 5 of the 12 heifers attained their before-calving weights in the tenth month of lactation, and 17 of the 20 fell below their after-calving weights during the lactation period. On the average the Huntley heifers were below their after-calving weight for the first three months of the lactation. The low weight during the lactation for the 17 heifers showing a loss ranged from 15 to 220 pounds. However, by the twelfth month they had all passed their after-calving weights, the average gain at that time being 180.5 pounds or 16 per cent of the after-calving average. This is less than the percentage gain of the Beltsville 2-year-olds by some 5 per cent. Actually the Huntley heifers made an average total gain during the lactation period of 215 pounds, as compared to an average gain of 234 pounds by the Beltsville 2-year-olds, but the Huntley heifers had an average loss of 30 pounds in the first month to overcome, while the Beltsville heifers had no loss. The Huntley heifers were heavier than the Beltsville heifers at the start of the lactation period by an average of 19 pounds, but they were lighter in the twelfth month of lactation by an average of 28 pounds.

The mature Holstein cows at Beltsville had an average weight before-calving of 1,719 pounds, 8.4 per cent more than their after-calving weight. This is a smaller shrinkage due to calving than was experienced by the Holstein 2-year-olds at Beltsville and Huntley.

On the basis of averages these 9 mature cows remained remarkably close to their after-calving weight during the first, third, and fourth months of lactation. In the second month they dropped 15 pounds below their after-calving weight. From the fifth to the eighth months of lactation their average weights only ranged from 1,607 to 1,611 pounds, but during the remaining 4 months they made consistent gains each month. In the tenth month, only one cow had regained her before-calving weight. In the twelfth month all had gained over their after-calving weights, the average gain of 111 pounds being an increase of 7 per cent. Thus the per cent gain over the after-calving weight in the mature Holsteins was only about one third as great as for the 2-year-old Beltsville heifers. This is almost the same relationship as was shown by the relative gains of the mature Jersey cows to those of the 2-year-olds.

Seven of the 9 Holstein cows had low points in their weights that ranged from 2 to 103 pounds below their after-calving weights. Four of the 7 cows reached the lowest level of weight in the second month, one in the third month, one in the fourth and one in the seventh month of lactation.

CONCLUSIONS

1. The shrinkage from the before-calving to the after-calving weights, on the basis of the per cent of the after-calving weight, was greater in the Holsteins than in the Jerseys and greater in the 2-year-olds than in the mature cows. The greatest shrinkage was in the Huntley Holstein 2-year-olds—13.7 per cent—and the least in the Lewisburg Jersey 2-year-olds—5.5 per cent. The smaller Jersey calf weight accounts for a part of the difference between the Holstein and Jersey breeds.

2. In total average gains from the after-calving weight to the twelfth month of lactation, expressed as per cent of the after-calving weight, the Beltsville 2-year-old Jerseys and 2-year-old Holsteins gained 18.4 and 21 per cent, respectively, and the Beltsville mature Jersey cows and the Beltsville mature Holstein cows gained 6.6 and 7 per cent, respectively. These four groups were under the same system of feeding—requirements plus 10 per cent. It appears that the 2-year-olds—Jersey and Holsteins—made from 2.5 to 3 times the gains of the mature cows. The Lewisburg 2-year-old Jerseys and the Huntley 2-year-old Holsteins had the same average percentage gain—16 per cent. The system of feeding these two groups, while the usual full grain feeding system, is somewhat less liberal than the requirements plus 10 per cent.

3. Under the system of feeding followed at the Beltsville Station the average weights of both the 2-year-old Jerseys and the 2-year-old Holsteins were approximately the same in the first month of lactation as their after-calving weights, but thereafter they made gains each month. The gains were not as rapid in the early months as in the last months of the lactation period but on the average there were no losses. The mature Jerseys and the mature

Holsteins under the same system of feeding showed a different pattern of gains from those of the 2-year-olds but were remarkably similar to each other. The Jersey cows had an average loss of 78 pounds in the second month but gained it back in the third. In the first 7 months of lactation they lost 82 pounds and gained 90 pounds on the average, so that they were just about holding even. In the last 5 months they had an average gain of 68 pounds. The Holsteins had an average loss of 20 pounds in the second month. In the first 7 months they lost an average of 22 pounds and gained an average of 45, so they were a little more than holding even. In the last 5 months their average gain was 89 pounds. The Lewisburg 2-year-old Jerseys held an even weight the first 6 months and made consistent gains the last 6 months. The Huntley 2-year-old Holsteins had an average loss of 30 pounds the first month, and gained each month thereafter.

4. It appears that, with the requirements-plus-10-per-cent system of feeding, 2-year-olds will gain from the first month of lactation, and with mature cows the average gains will somewhat more than balance the losses in the first 7 months and rapid gains will occur during the balance of the lactation. Under the usual full-grain system of feeding, that is 1 pound of grain to each 3 pounds of milk produced, the average losses and gains balanced each other in the first 6 months and consistent gains occurred during the balance of the lactation with 2-year-old Jerseys, and with 2-year-old Holsteins after an average loss the first month, there were gains on the average each month during the balance of the lactation period.

FROZEN HOMOGENIZED MILK. II. EFFECT OF FREEZING AND STORAGE TEMPERATURES ON THE CHEMICAL AND BACTERIOLOGICAL PROPERTIES OF HOMOGENIZED MILK

LIEUTENANT COLONEL C. J. BABCOCK, Sanitary Corps, AUS, MAJOR RICHARD N. ROERIG, Sanitary Corps, AUS, CAPTAIN JOSEPH N. STABILE, Sanitary Corps, AUS, CAPTAIN WILLIAM A. DUNLAP, Sanitary Corps, AUS, AND COLONEL RAYMOND RANDALL, Veterinary Corps, USA.

Army Veterinary School, Medical Department Professional Service Schools, Army Medical Center, Washington, D. C.

In part I, "Effect of Freezing and Storage Temperature on the Physical Characteristics of Homogenized Milk" (1), it was shown that freezing and storage temperatures affect the physical character of homogenized milk. To determine if these conditions cause chemical changes which may contribute to the physical changes, a study was made of the shift of the chemical constituents in samples of homogenized milk frozen and stored under the same conditions as the samples used to study the physical changes. Bacterial counts were also made on a number of the samples to determine whether biological changes occur in frozen homogenized milk.

In a study on frozen homogenized milk, Cvitl (2) analyzed the outer layer, the part which froze first, as well as the top, middle and bottom portions of the remainder of the sample and found that the central portion was richer in fat, casein, albumin, globulin, sugar, and chloride ion than the upper or lower portions and that the outer layer was the poorest in these constituents. Baldwin and Doan (3) reported that when milk, whose creaming ability was destroyed by heat or homogenization, was frozen, the fat concentration of the unfrozen portion increased progressively with the extent of freezing, while that of the frozen portion decreased at first, but finally approached the fat percentage of the original milk as the extent of freezing approached 100 per cent. Trout (4) reported that when homogenized milk was frozen and then thawed a marked settling of the fat and solids-not-fat was noted. The lower 15 per cent of creaming cylinders of slowly thawed frozen homogenized milk contained as high as 7.7 per cent fat and 24.60 per cent total solids in contrast with 2.0 per cent and 5.50 per cent, respectively, in the upper 15 per cent layer. Fabian and Trout (5) found that from a bacteriological standpoint there is no reason why clean, wholesome, fresh cream cannot be pasteurized and stored for a period of 1 year in glass, paper, or tin containers at temperatures ranging from $-5°$ to $-10°$ F.

Received for publication September 24, 1946.

PROCEDURE

Sections of the homogenized milk were obtained for analysis by dividing the quart samples, while frozen, either into thirds, or into halves.

The following methods of analysis were used:

a. Protein—Kjeldahl-Gunning-Arnold Method using the factor of 6.38.
b. Fat—Mojonnier Method.
c. Total solids—A.O.A.C. Method.
d. Lactose—Munson-Walker Method.
e. Chloride ion—Volhard Method using the milliequivalent value of 0.00355.
f. Ash—Heated in a muffle furnace at a temperature not higher than 525° C.
g. Bacteria—The bacteria content of the milk was determined by the standard plate count in accordance with the method as outlined in Standard Methods for the Examination of Dairy Products, APHA, 8th edition, 1941. The plates were incubated at 37° C.

EXPERIMENTAL RESULTS

Chemical

The results of the chemical analyses of aliquots from different sections of quart samples of homogenized milk, frozen in paper containers of one quart capacity and stored under various conditions, are shown in table 1. The analyses of two samples of the homogenized milk prior to freezing gave the following average values: protein, 3.24 per cent; fat, 3.72 per cent; total solids, 12.26 per cent; lactose, 4.77 per cent; and chloride, 0.095 per cent.

Table 1 shows that when homogenized milk was frozen and stored in the frozen state the solid constituents were more concentrated in the bottom section. When the quart samples were divided into two equal parts the lower halves contained a larger proportion of the milk solids. Analyses of the frozen samples after divisions into three equal parts disclosed the fact that the highest concentration of milk solids was in the bottom third, the next highest concentration was in the middle third, and the lowest was in the top third. It may also be seen from table 1 that the analyses of the middle third were in good agreement with those of unfrozen milk, as well as samples of milk which had been frozen and stored and then thawed. Those slight discrepancies which occurred may be attributed to experimental error, especially in samples showing separation.

The data in table 1, A, were obtained by the analysis of milk samples frozen and held at −10° C. (14° F.) for 21 to 100 days, at −32.8° C. (−27° F.) for 30 to 109 days, and at −40° C. (−40° F.) for 51 to 82 days. The analyses of the individual samples indicated that the freezing and storage temperatures as well as the storage time may influence the distribution of the milk solids between the various sections of the frozen milk.

TABLE 1

Chemical analyses of different sections of homogenized milk frozen in quart paper containers and stored under various conditions

No. samples	Section analyzed	% Protein	% Fat	% Total solids	% Lactose	% Chlorides	% Ash
A. Frozen and stored at constant temperature (–10° C., –32.8° C., –40° C.)							
	Top third	2.55	2.77	9.85	3.85	0.077	0.58
8	Middle third	3.17	3.48	12.27	4.81	0.095	0.74
	Bottom third	3.66	4.23	13.94	5.45	0.104	0.82
6	Top half	3.09	3.16	10.88	4.11	0.093	....
	Bottom half	3.88	3.91	13.65	5.13	0.116	....
11	Whole quart	3.35	3.64	12.66	4.79	0.096	0.73
B. Frozen and held at –32.8° C., or –10° C., followed by storage at a lower temperature (–40° C. or –32.8° C.)							
6	Top half	3.03	3.03	10.71	3.99	0.093	....
	Bottom half	4.00	3.92	13.94	5.20	0.117	....
C. Frozen and held at –40° C., –32.8° C., or –10° C., followed by storage at a higher temperature (–32.8° C., –10° C., or –3° C.)							
	Top third	2.25	2.56	8.77	3.33	0.067	0.51
10	Middle third	3.14	3.30	12.15	4.67	0.093	0.73
	Bottom third	3.98	4.04	15.17	6.07	0.115	0.90
6	Top half	3.16	3.33	11.21	4.14	0.093	....
	Bottom half	3.80	3.93	13.51	4.99	0.117	....
D. Frozen and held at –32.8° C. or –10° C., exposed to room temperature (23° C.) for ½ hour, then stored at –10° C.							
	Top third	2.37	2.39	9.44	3.49	0.070	0.53
24	Middle third	3.15	3.14	12.06	4.61	0.094	0.69
	Bottom third	3.75	3.74	14.24	5.56	0.107	0.81
2	Top half	2.95	2.99	10.46	4.00	0.091	....
	Bottom half	3.97	3.94	13.91	5.35	0.117	....
E. Frozen and held at –32.8° C. or –10° C., exposed to room temperature (23° C.) for 1 hour, then stored at –10° C.							
	Top third	2.53	2.52	9.97	3.84	0.076	0.61
24	Middle third	3.08	2.71	12.33	4.83	0.095	0.73
	Bottom third	3.36	3.42	13.58	5.15	0.099	0.78
2	Top half	3.04	3.13	10.98	4.20	0.095	....
	Bottom half	3.84	3.80	13.38	5.01	0.112	....
F. Frozen and held at –32.8° C. or –10° C., exposed to room temperature (23° C.) for 2 hours, then stored at –10° C.							
	Top third	2.51	2.61	9.82	3.64	0.070	0.54
24	Middle third	2.83	2.87	12.04	4.62	0.093	0.67
	Bottom third	3.66	3.40	14.12	5.47	0.106	0.82
2	Top half	2.87	2.90	10.23	3.85	0.088	....
	Bottom half	3.97	3.87	13.96	5.29	0.120	....
G. Frozen and held at –32.8° C. or –10° C., exposed to room temperature (23° C.) for 4 hours, then stored at –10° C.							
	Top third	1.83	2.09	7.58	2.72	0.054	0.50
24	Middle third	2.81	2.75	11.42	4.33	0.084	0.70
	Bottom third	4.47	3.92	17.69	7.01	0.136	0.99
2	Top half	1.83	1.88	6.56	2.40	0.056	....
	Bottom half	4.93	4.58	17.32	6.57	0.145	....

Table 1, B, presents the data obtained when two samples of homogenized milk were frozen at – 32.8° C. (– 27° F.) then moved to – 40° C. (– 40° F.); two frozen at – 10° C. (14° F.) then moved to – 32.8° C.; and two frozen at – 10° C. then moved to – 40° C. The milk was held at the initial freezing temperature for 9 days and at the lower temperature for 54 to 80 days prior to analysis. The results given in table 1, A and B, show that lowering the storage temperature of frozen homogenized milk did not significantly affect the distribution of milk solids.

As indicated in table 1, C, some of the samples were frozen at – 40° C. (– 40° F.) and moved to – 32.8° C. (– 27° F.) or to – 10° C. (14° F.); some were frozen at – 32.8° C. then moved to – 10° C. or to – 3° C. (26.6° F.); and others were frozen at – 10° C. and moved to – 3° C. The samples were held for an average of 3 days at the lower temperature and for an average of 70 days at the higher temperature prior to analysis. A comparison of the results in C with those in A and B (table 1) indicates that moving frozen milk to a higher storage temperature does not materially affect the results of the chemical analyses of the different sections of the sample.

The data presented in table 1, E, F, G, and H, were obtained by the analysis of samples which were exposed to room temperature for various

TABLE 2

Effect of freezing and storage temperatures on the standard plate count of homogenized milk

No. samples	Average storage time (days)	Average standard plate count per ml.
A. Frozen and held at constant temperature (– 40° C., – 33° C., or – 10° C.)		
3	56	11,000
3	88	12,000
B. Frozen and stored at a constant temperature (– 10° C.) then moved to a lower temperature (– 33° C.)		
1	59	15,000
1	92	20,000
C. Frozen and stored at a constant temperature (– 33° C. or – 40° C.) and then moved to a higher temperature (– 10° C. or – 33° C.)		
3	53	2,000
3	85	3,000
D. Frozen and stored at a constant temperature (– 33° C. or – 10° C.) exposed to room temperature, then stored at – 10° C.		
2 (exposed ½ hr.)	59	4,000
2 (exposed ½ hr.)	92	7,000
2 (exposed 1 hr.)	59	3,000
2 (exposed 1 hr.)	92	4,000
2 (exposed 2 hrs.)	59	3,000
2 (exposed 2 hrs.)	92	6,000
2 (exposed 4 hrs.)	59	3,000
2 (exposed 4 hrs.)	92	6,000

lengths of time between storage at two different freezing temperatures. These conditions were intended to simulate those which occur when frozen milk is moved from storage to a freezer on a ship. A comparison of the results shown in E, F, G, and H with each other and with those in C demonstrates that such conditions did not affect the distribution of milk solids unless the frozen milk was exposed to room temperature for four hours. After four hours there was a considerable increase in the concentration of milk solids in the lower section and a corresponding decrease in the upper section.

Bacteriological

Standard plate counts were performed on samples of milk prior to freezing and again after freezing and storage under different conditions in order to determine whether these environments permit multiplication of bacteria. The average plate count of the milk prior to freezing was 28,000 per ml. Table 2 shows the average plate count after the milk had been frozen and stored.

The data in table 2 indicate that freezing milk and storing it in the frozen state had a tendency to lower the number of bacteria per milliliter as determined by the standard plate count and further that the bacterial content was not materially affected by changes in storage time and temperature, or by exposure to room temperature for four hours.

Results obtained on individual samples indicated that the count was not influenced by the freezing or storage temperatures.

SUMMARY

It has been found that when homogenized milk is frozen the solid components tend to concentrate in the lower portions of the sample. This distribution was not materially affected by changes in freezing and storage temperature. Exposure of the frozen milk to room temperature (23° C.) less than four hours did not alter the distribution of the milk solids, but at that time there was a significant shift of the solid components toward the lower portion.

Changes in the temperature at which frozen homogenized milk was stored did not materially affect the chemical composition of the different sections of the quart samples.

The chemical analyses of the various sections of frozen homogenized milk were not affected by exposure to room temperature, 23° C. (73.8° F.), unless the milk was exposed for four hours. When the milk was exposed for four hours there was a considerable increase in the percentage of milk solids in the bottom third and a considerable decrease in the percentage of the constituents in the top third of quart samples.

Homogenized milk that was frozen and subsequently thawed at room temperature (23° C.) changed in physical character. The degree of change was dependent upon the freezing and storage temperature and the length of storage. However, these conditions did not cause any significant change in the chemical character of the milk, indicating that the chemical character of frozen homogenized milk does not contribute to the physical changes.

Freezing and storing homogenized milk in the frozen state had a tendency to lower the number of bacteria per milliliter as determined by the standard plate count. This decrease was not materially affected by freezing and storage temperatures, by changes in the storage temperature, or by exposure to room temperature for four hours.

ACKNOWLEDGMENT

The authors wish to express their appreciation of the technical assistance of Technician Fourth Grade E. S. Windham.

REFERENCES

(1) Babcock, C. J., *et al.* Effect of Freezing and Storage Temperature on the Physical Characteristics of Homogenized Milk. Jour. Dairy Sci., 29: 699–706. 1946.

(2) Cvitl, Josefa. Einfluss des Gefrierens auf einige Bestandteile und Eigenschaften der Milch. Milchw. Forsch, 12: 409–432. 1931.

(3) Baldwin, F. Bruce, Jr., and Doan, F. J. Observations on the Freezing of Milk and Cream. Jour. Dairy Sci. 18: 629–637. 1935.

(4) Trout, G. M. The Freezing and Thawing of Milk Homogenized at Various Pressures. Jour. Dairy Sci. 24: 277–287. 1941.

(5) Fabian, F. W., and Trout, G. M. Influence of Various Treatments on the Bacterial Content of Frozen Cream. Jour. Dairy Sci. 26: 959–965. 1943.

TOXICITY OF PHENOTHIAZINE DERIVATIVES EXCRETED IN THE MILK OF DAIRY COWS TREATED WITH MASSIVE DOSES OF THE DRUG*

GEORGE H. WISE,[1] C. A. JAMES, III,[2] AND G. W. ANDERSON[3]
Dairy Department, South Carolina Agricultural Experiment Station, Clemson College, Clemson, S. C.

The effectiveness of phenothiazine as an anthelmintic has resulted in its widespread and, in some cases, indiscriminate administration to animals. In recent years the recognition of the toxic reactions of this drug has led to increased caution in its dosage. Stewart (8), in a review of the subject, indicated that man and the bovine are the most susceptible species to phenothiazine poisoning, and that the young are less resistant than the adults. Hence, it would appear that the infant might be highly sensitive to this drug.

Portions of phenothiazine derivatives are excreted in the milk of lactating ewes (9) and goats (6) following medication. Though milk contaminated with these derivatives usually is diverted from food channels, occasionally it is offered inadvertently for human consumption (1), thus constituting a potential health hazard.

Adult cattle ordinarily are not heavily infested with internal parasites, but the unthrifty condition of a cow in areas where parasitic infestation is common may lead to phenothiazine therapy. The possibility that milk from a cow treated with this drug might be fed to infants presented a problem warranting investigation. In this study single massive doses of phenothiazine were given to individual lactating cows for the purpose of ascertaining: the clinical effects on the cows, the period of elimination of the phenothiazine derivatives in the milk, and the toxic effects of the contaminated milk on young rats.

EXPERIMENTAL

Effects of massive doses of phenothiazine on lactating dairy cows. A representative of each of three breeds, Guernsey, Holstein, and Jersey, were used in this investigation. Pertinent data on the experimental subjects are presented in table 1.

The cows were in an excellent state of health. They were subjected to standard managerial and feeding practices; the rations, consisting of a

Received for publication September 26, 1946.

* Technical publication No. 138. Presented with the approval of the Director of the South Carolina Agricultural Experiment Station.

[1] Now Department of Dairy Husbandry, Kansas State College.

[2] Presented data in a thesis as partial requirement for the degree of Bachelor of Science in Dairying, 1943.

[3] Associate Animal Pathologist, South Carolina Agricultural Experiment Station.

TABLE 1

Experimental cows that received massive doses of phenothiazine

Breed	Age	Body weight	Stage of gestation	Stage of lactation
	years	*lbs.*	*days*	*days*
Guernsey	7	1055	78	210
Holstein	5	1065	154	182
Jersey	8	990	51	174

concentrate mixture, beet pulp and either hay or silage, were fed twice daily, at the milking periods.

Each cow was dosed with 125 grams of commercial phenothiazine, which amount was approximately twice the maximum recommended for adult cattle. Observations during the four days following medication revealed no changes except a precipitous drop in the milk production of two of the cows and a slight decrease in that of the third. The milk yields persisted at the lowered level for two to three days but subsequently returned to the pre-treatment level for the Holstein and the Jersey cows, the higher producers, but remained low for the Guernsey.

Abnormal red coloration was observed on the udders of the cows the day following the administration of the drug. This, presumably, was the result of oxidation of the phenothiazine conjugates (5, 9) in the urine that had come in contact with the surface of the udder.

Period of excretion of phenothiazine derivatives in the milk. In accordance with common practices the cows were milked at 12-hour intervals. Samples of milk from the individual animals were collected at each milking for a period of 72 hours following administration of the drug.

Determinations of the presence of phenothiazine derivatives were made by qualitative methods described by Collier (5). Acidification of the milk samples with strong hydrochloric acid, producing a mauve color, was the most satisfactory test used. Exposure of the samples to air and light for several hours resulted in the development of a pink color in the serum phase of the milk. This color was difficult to detect in samples having a high carotenoid content; the yellow seemed to mask the pink. In addition to the procedures indicated by Collier (5), it was found that mixing "Aerosol",

TABLE 2

Period of elimination of phenothiazine derivatives in milk following medication

Breed	Hours after dosing					
	12	24	36	48	60	72
Guernsey	+++	+++	++	+	+	−
Holstein	+++	++	+	−	−	−
Jersey	+++	+++	++	+	+	−

a surface-tension-reducing reagent, with milk containing the conjugates of phenothiazine produced a transitory pink color, which was adequate for detection but unsatisfactory for estimating the degree of concentration.

As shown in table 2, the phenothiazine products were in the milk for periods of 36 to 60 hours after dosing. The highest concentrations apparently were in the first milking following administration.

Toxicity of phenothiazine derivatives excreted in the milk of the cows. Samples of milk collected from the individual cows at the 12-hour and the 24-hour periods were fed to young rats to ascertain whether any toxic reactions would be evinced. Immediately after the collections, half of each sample was stored in the raw state at 35° F., but the other half was boiled for three to five minutes (recommended treatment of milk for infant feeding) before storing.

Thirteen month-old rats, grouped as indicated in table 3, were restricted to diets of the various milk samples for 72 hours. During a preliminary

TABLE 3

Rates at which young rats consumed various samples of milk containing phenothiazine derivatives

Samples of milk fed		No. of rats	Av. wt. of rats	Daily consumption per 100 grams of body wt.	
Period of collection	Treatment			Average	Range
			grams	*cc.*	*cc.*
12-hour	None	3	55	70	63–78
	Boiled	3	55	74	72–79
24-hour	None	3	52	74	71–80
	Boiled	3	55	71	63–83
Daily (herd)	Pasteurized	1	57	77	....

adjustment period of 60 hours, the individual rats were fed pasteurized whole milk *ad lib.* The pasteurized milk diet was replaced by the experimental samples, a fresh supply being provided twice daily.

The rate of consumption of the milk samples, as shown in table 3, reveals a marked individual variation but no significant group differences. Evidently the presence of the phenothiazine conjugates in the milk did not change its palatability. Clinical examinations of the rats during and after the milk feeding period revealed no discernible toxic effects.

DISCUSSION

In accord with the report of Britton (4), the phenothiazine derivatives eliminated in the milk seemed to have a preservative value. The milk samples containing the conjugates were in excellent condition after storage for 31 days at 35° F. Furthermore, as noted by Swales and Collier (9), samples exposed to light and air in a warm room for several days showed no evidence of decomposition. These properties, either bacteriostatic or bactericidal, have been ascribed to the oxidation product, thionol (4). The microbiological phase of the subject merits further investigation.

Boiling the milk for several minutes apparently modified neither its physiological effects on rats nor its qualitative reactions to various agents. The effects of extensive boiling, producing a concentration of the products, were not investigated. This type of treatment, however, is beyond the limits of practical measures used in the home preparation of milk for direct consumption.

Although phenothiazine derivatives are eliminated in the milk of cows treated with the drug, the concentration of these conjugates from recommended therapeutic doses probably is too small to cause serious toxic reactions in the consumer. No ill effects have been demonstrated in pigs (2), kids (6) and lambs (9) that have consumed milk from their respective dams treated with the commonly prescribed doses of phenothiazine. In recovery trials with sheep Swales and Collier (9) observed that between 80 and 85 per cent of a therapeutic dose of phenothiazine was eliminated in the feces and urine; thus only a small percentage could be excreted in the milk.

Though it is hazardous to attempt to translate experimental findings, particularly in toxicity studies, from young rats to infants, the results of this investigation suggest that milk from cows given a therapeutic dose of phenothiazine is not likely to be toxic to the normal human subject. The cows in this experiment were given twice the recommended amount, which should have produced a concentration of derivatives in the milk at least as great as the maximum from the standard doses given to any other adult cattle. Furthermore, the rats, though more resistant than the human being (8), consumed quantities of milk per unit of weight from five to six times greater than normally would be fed to babies (7).

The element of human variation in susceptibility to phenothiazine, as indicated in results reported by Bercovitz *et al.* (3), warrants adherence to the general recommendation that milk from cows treated with the drug either be discarded or be used for purposes other than human consumption during the period that the derivatives are excreted. This introduces the problem of determining whether or not the conjugates are in the milk. Since the pink color that develops upon exposure to air frequently is difficult to detect in milk having highly pigmented fats, this procedure, though practical, cannot be regarded as an infallible indicator of the absence of the derivatives. Therefore, as a precautionary measure, it probably is well to divert the milk from food channels for a period of two to three days following medication.

SUMMARY

1. Oral administration of 125 grams of commercial phenothiazine, over twice the maximum recommended therapeutic dose, to healthy adult lactat-

ing cows produced no detectable deleterious effects other than a temporary repression of milk production.

2. Derivatives of phenothiazine were detected in the milk for periods of 36 to 60 hours following administration of the drug.

3. Young rats restricted to diets of the milk collected at the 12-hour and the 24-hour periods after dosage manifested no discernible symptoms of toxicity.

REFERENCES

(1) ANONYMOUS. Colored Milk. Dairy Goat Jour., 24(1): 16–17. 1946.

(2) ANDREWS, J. S., AND CONNELLY, J. W. The Value of Phenothiazine for the Removal of Nodular Worms from Pregnant and Nursing Sows. Helminthol. Soc. Wash., Proc., 11(1): 13–15. 1944.

(3) BERCOVITZ, Z., PAGE, R. C., AND DE BEER, E. J. Phenothiazine: Experimental and Clinical Study of Toxicity and Anthelmintic Value. Amer. Med. Assoc. Jour., 122(15): 1006–1007. 1943.

(4) BRITTON, J. W. The Materia Medica of Phenothiazine. Cornell Vet., 31(1): 1–12. 1941.

(5) COLLIER, H. B. The Fate of Phenothiazine in the Sheep. Canad. Jour. Res., Sect. D, Zool. Sci., 18(7): 272–278. 1940.

(6) HABERMANN, R. T. The Effect of Phenothiazine on Pregnant Goats and their Offspring. Vet. Med., 38(3): 96–99. 1943.

(7) LENROOT, K. F. Infant Care. Children's Bureau, U. S. Dept. Labor, Pub. 8, p. 81. 1943.

(8) STEWART, M. A. Phenothiazine in Veterinary Practice. Jour. Amer. Vet. Med. Assoc., 106(817): 217–222. 1945.

(9) SWALES, W. E., AND COLLIER, H. B. Studies on Effects and Excretion of Phenothiazine when Used as an Anthelmintic for Sheep. Canad. Jour. Res., Sect. D, Zool. Sci., 18(7): 279–287. 1940.

A DEVICE TO AID IN DETERMINING THE EFFECTIVENESS OF DAIRY DETERGENTS

E. L. FOUTS AND T. R. FREEMAN
Florida Agricultural Experiment Station, Gainesville, Florida

A wide variety of water types is found in Florida. Because of the widespread limestone deposits, waters of widely varying degrees of hardness are encountered. Also, because of the proximity of the Atlantic Ocean and the Gulf of Mexico considerable concentrations of salt are found in the water in certain areas. A project is in progress to determine the most suitable washing powders to use with the various types of water. It is not the purpose of this paper to report the results of the experiments on washing

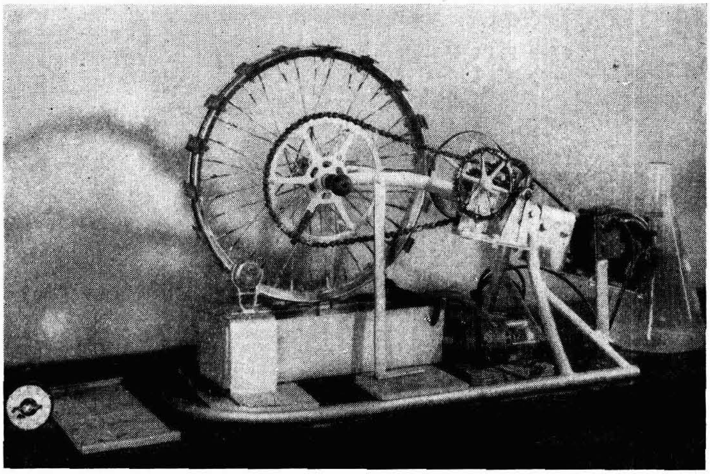


FIG. 1. Deterg-O-Meter—An apparatus designed to test the efficiency of dairy cleaners. Glass slides with a baked-on milk film are fastened onto the rim of the wheel by means of metal clips. The wheel is then lowered into water at 50° C. containing the washing powder to be tested. The wheel turns slowly, dipping the slides into the water and then rubbing them against the sponge rubber brush. The average number of revolutions required to clean the slides gives an index of the efficiency of the cleaner.

powders but to describe the apparatus being used to aid in determining the effectiveness of various washing powders in cleaning dairy equipment.

The wide scope of this problem suggested the need for a mechanical device to aid in making washing trials. Since no such device was available, one was built. It has been named the Deterg-O-Meter. It consists of a 16-inch metal bicycle wheel mounted in a pivoted frame which permits vertical movement, powered by an electric motor and geared to turn at 7 r.p.m. Evenly

Received for publication September 30, 1946.

TABLE 1

Method of determining the "soil removal index"

Revolutions	Trial number 1: Slide number		Trial number 2: Slide number		Trial number 3: Slide number	
	Washing powder No. 1					
40	1, 13	80	14	40	5, 6	80
50	2, 3, 4, 6, 8, 9, 10, 12, 16	450	1, 8, 9, 12, 17, 2, 10, 11	400	2, 4, 8, 9, 10, 11, 13	350
60	5, 11, 14, 17, 18	300	5, 6, 7; 13, 16, 18	360	1, 3, 12, 14, 16, 17, 18	420
70	7	70	3, 4	140	7	70
		900		940		920
	$\frac{900}{17} = 52.9$		$\frac{940}{17} = 55.3$		$\frac{920}{17} = 54.1$	
	$\frac{52.9 + 55.3 + 54.1}{3} = 54.1$ soil removal index					
	Washing powder No. 2					
20	18	20	1, 2, 7, 12, 13, 16	120	11, 12	40
30	1, 2, 5, 6, 7, 11, 12, 13, 14, 15, 16	330	8, 10, 11, 14, 17, 18	180	1,3,4,6,9,13,14,15	240
40	3, 4, 9	120	4, 5, 6, 9	160	2,5,7,10,16,17	240
50	8, 10	100	3, 15	100	18	50
60					8	60
		570		560		630
	$\frac{570}{17} = 33.5$		$\frac{560}{18} = 31.1$		$\frac{630}{18} = 35.0$	
	$\frac{33.5 + 31.1 + 35.0}{3} = 33.2$ soil removal index					
	Washing powder No. 3					
30	4	30	7	30		
40					12	40
50					13	50
60	9, 11	120	1, 2, 6, 12	240	2, 9, 11	180
70	5, 8, 10, 12, 18	350	9, 11, 13, 15	280	1, 3, 6, 10, 14, 17	420
80	2, 3, 7, 14, 17	400	5, 8, 10, 14, 17	400	15, 18	160
90	6, 13, 16	270	16, 18	180	4, 7	180
100	1	100			8	100
110			4	110		
120	15	120			5	120
130						
140			5	140		
		1390		1380		1250
	$\frac{1390}{18} = 77.2$		$\frac{1380}{18} = 76.6$		$\frac{1250}{17} = 73.5$	
	$\frac{77.2 + 76.6 + 73.5}{3} = 75.7$ soil removal index					

spaced around the rim of the wheel are 18 numbered metal clips, which hold securely 18, 3 by 1 inch glass microscope slides.

Milk films are prepared on one side of the clean slides by spreading 0.4 ml. of whole milk evenly and uniformly over a rectangular area $\frac{3}{4}$ by $1\frac{1}{8}$ inches. The slides then are heated in an oven for 3 hours at 120° C. which produces a tough hard film which is very resistant to cleaning.

Four liters of the water to be tested containing a weighed amount of the washing powder to be tested are warmed to 50° C. and poured into the pan. The slides are slipped under the numbered clips and the wheel is lowered so that when it revolves it dips into the water. The temperature of the water is maintained at 50° C. by means of a hot plate under the water bath. Immediately after dipping into the water, the slides rub against the sponge rubber brush. As the slides become clean they are removed from the wheel and a record is made of the number of revolutions required to remove the film. The average number of revolutions required to clean the 18 slides is determined.

Second and third runs are made and if these 3 runs check within 5 revolutions, the average of the 3 runs (54 slides) is accepted as being accurate. If the first 3 trials fail to check within 5 revolutions, additional runs are made until satisfactory checks are obtained. The brush is made of sponge rubber refrigerator door gasket material and a new brush is installed after each 20 runs. The data shown in table 1 illustrate the procedure used to calculate the "soil removal index." Other tests also are being made to aid in determining which powders are most suitable for washing dairy equipment in the various types of Florida water.

ASSOCIATION ANNOUNCEMENT

NOMINATING COMMITTEE

The nominating committee consists of the following members:

Chairman: A. C. RAGSDALE, University of Missouri, Columbia, Missouri

J. A. NELSON, Montana State College, Bozeman, Montana

I. W. RUPEL, Texas A. & M. College, College Station, Texas

FLOYD JOHNSTON, Iowa State College, Ames, Iowa

H. W. NORTON, Holstein-Friesian Ass'n of America, Brattleboro, Vermont

The Constitution and By-laws of the American Dairy Science Association provides for the publication of the names of the nominating committee in the January issue of the JOURNAL OF DAIRY SCIENCE. It is the duty of this Committee, of which **A. C. Ragsdale** is the present chairman, to send its report to the secretary not later than April 1. The secretary will then send out the ballots to secure a final vote before the annual meeting. The results of the election will be announced at the annual meeting.

As a mmber of the Association, it is your obligation to express your wishes for officers and directors to any member of this Committee. Two candidates for vice-president and four for directors will be nominated. The present vice-president automatically becomes president.

The Nominating Committee will give consideration to the wishes of the members as expressed by correspondence and also will consider additional candidates. They have been instructed to study the list of past officers and directors (see pages 803 and 804 of the August, 1943, Journal) to plan to secure good geographic distribution and to recognize the desirability of representation from all lines of activity of our members.

This change in the Constitution was made so that our Association could elect its officers in a democratic way. This can only be done, however, if our members are prompt in giving their opinions freely to the Nominating Committee.

OFFICERS AND COMMITTEES OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

ASSOCIATION OFFICERS

FORDYCE ELY, Kentucky, *President*

P. H. TRACY, Illinois, *Vice President*

R. B. STOLTZ, Ohio, *Secretary-Treasurer*

ASSOCIATION COMMITTEES

BORDEN AWARDS COMMITTEES

Manufacturing

K. G. WECKEL, Wisconsin, *Chairman*

B. E. HORRAL, Indiana

BEN GOODALE, South Carolina

Production

J. B. FITCH, Minnesota, *Chairman*

C. W. TURNER, Missouri

G. M. CAIRNS, Maryland

RESOLUTIONS COMMITTEE

W. E. KRAUSS, Ohio, *Chairman*

K. L. TURK, New York

G. H. WILSTER, Oregon

J. H. HILTON, North Carolina

GLENN VERGERONT, Wisconsin

NOMINATING COMMITTEE

A. C. RAGSDALE, Missouri, *Chairman*

J. A. NELSON, Montana

FLOYD JOHNSTON, Iowa

I. W. RUPEL, Texas

H. W. NORTON, Vermont

PROGRAM COMMITTEE

J. A. NELSON, Montana, *Chairman*

C. L. HANKINSON, Minnesota

D. M. SEATH, Louisiana

W. T. CRANDALL, New York

Ontario Agricultural College Representative

JOURNAL MANAGEMENT COMMITTEE

GEORGE E. HOLM, Washington, D. C., *Chairman*

W. E. PETERSEN, Minnesota

T. S. SUTTON, Ohio

F. E. NELSON, Iowa, Ex-officio

R. B. STOLTZ, Ohio, Ex-officio

HONORS COMMITTEE

A. C. DAHLBERG, New York, *Chairman*

R. B. BECKER, Florida

H. S. WILLARD, Wyoming

AUDITING COMMITTEE

O. F. GARRETT, Ohio, *Chairman*

RICHARD A. LARSON, Ohio — W. E. KRAUSS, Ohio

NECROLOGY COMMITTEE

E. S. GUTHRIE, New York, *Chairman*

R. B. BECKER, Florida — H. S. WILLARD, Wyoming

OFFICERS AND COMMITTEES OF THE MANUFACTURING SECTION

SECTION OFFICERS

C. L. HANKINSON, Minnesota, *Chairman*

PAUL R. ELLIKER, Indiana, *Vice-Chairman* — J. M. TRIMBLE, Indiana, *Secretary*

MANUFACTURING SECTION COMMITTEES

Standing Committee on Milk

E. O. HERREID, Illinois, *Chairman*

HENRY TRANMAL, Illinois — D. V. JOSEPHSON, Ohio

Standing Committee on By-Products

H. C. JACKSON, Wisconsin, *Chairman*

J. B. STINE, Illinois — A. O. CALL, Illinois

Standing Committee on Dried Milk

G. C. SUPPLEE, New York, *Chairman*

ARNOLD H. JOHNSON, Maryland — A. D. HOLMES, Massachusetts

Standing Committee on Cheese

P. R. ELLIKER, Indiana, *Chairman*

C. A. PHILLIPS, California — A. B. ERICKSON, Wisconsin

Standing Committee on Evaporated Milk

B. H. WEBB, Washington, D. C., *Chairman*

D. V. JOSEPHSON, Ohio — E. B. OBERG, Wisconsin

Standing Committee on Butter

G. H. WILSTER, Oregon, *Chairman*

D. K. HOWE, Nebraska — C. JENSEN, North Dakota

Standing Committee on Ice Cream

H. H. SOMMER, Wisconsin, *Chairman*

C. A. IVERSON, Iowa — W. C. COLE, California

Standing Committee on Products Judging

G. M. Trout, Michigan, *Chairman*

P. A. Downs, Nebraska — E. L. Fouts, Florida

C. J. Babcock, Washington, D. C. — E. O. Anderson, Connecticut

Standing Committee on Program

B. E. Horrall, Indiana, *Chairman*

F. J. Babel, Iowa — W. C. Loy, Illinois

Temporary Committee on Reorganization and Records

S. T. Coulter, Minnesota, *Chairman*

D. V. Josephson, Ohio — R. Whitaker, Maryland

OFFICERS AND COMMITTEES OF THE PRODUCTION SECTION

SECTION OFFICERS

D. M. Seath, Louisiana, *Chairman*

G. H. Wise, Kansas, *Vice-Chairman* — L. A. Moore, Maryland, *Secretary*

PRODUCTION SECTION COMMITTEES

Program Committee

D. M. Seath, Louisiana, *Chairman*

G. H. Wise, Kansas — G. W. Salisbury, New York

Breeds Relations Committee (Joint with Extension Section)

Production Section

H. A. Herman, Missouri, *Chairman*

K. L. Turk, New York — W. W. Yapp, Illinois

Extension Section

Lynn Copeland, Tennessee — E. C. Scheidenhelm, New Jersey

Floyd Johnston, Iowa

Dairy Cattle Breeding Committee (Joint with Extension Section)

Production Section

E. E. Heiser, Wisconsin — L. O. Gilmore, Minnesota

J. L. Lush, Iowa

Extension Section

E. J. Perry, New Jersey, *Chairman*

C. L. Blackman, Ohio — S. J. Brownell, New York

Dairy Cattle Health Committee (Joint with Extension Section)

Production Section

D. M. Seath, Louisiana — L. A. Moore, Maryland

W. E. Peterson, Minnesota

Extension Section

C. G. BRADT, New York, *Chairman*

J. W. LINN, Kansas A. I. MANN, Connecticut

OFFICERS AND COMMITTEES OF THE EXTENSION SECTION

With the exception of the Program Committee, all committee members are appointed for a period of three years.

The Program Committee is automatically appointed by the election of the officers of the Extension Section: It consists of the Chairman, Vice-Chairman, Secretary, and an Extension Representative from the host state.

Committees made up of five members retire one member every third year, and at the two intervening years two men each are retired. Vacancies caused by the expiration of a term are filled by three-year appointments. All appointments expire immediately following the annual meeting in the year designated.

In addition to five committees made up of members entirely in the Extension Section there are three joint committees with the Production Section. These committees have three men represented from each section and each year one man retires from each sectional group. The chairman of these committees is selected jointly by the two section chairmen.

To be a member of a committee an extension dairyman must be a member of the American Dairy Science Association.

PROGRAM COMMITTEE

Chairman—W. T. CRANDALL, Cornell University, Ithaca, New York
E. H. LOVELAND, University of Vermont, Burlington, Vermont
A. R. PORTER, Iowa State College, Ames, Iowa
Appointment from host state to be announced later

EXHIBIT COMMITTEE

	Term Expires
Chairman—To be appointed from host state	1949
L. A. JOHNSON, Michigan State College, East Lansing, Michigan	1947
J. A. AREY, University of North Carolina, Raleigh, North Carolina	1947
D. L. MURRAY, Michigan State College, East Lansing, Michigan	1948
I. E. PARKIN, Pennsylvania State College, State College, Pennsylvania	1948

BREED RELATIONS COMMITTEE

(Members appointed by Production Section)

Chairman—	H. A. HERMAN, University of Missouri, Columbia, Missouri	1949
	K. L. TURK, Cornell University, Ithaca New York	1947
	W. W. YAPP, University of Illinois, Urbana, Ill.	1948
	(Members appointed by Extension Section)	
	LYNN COPELAND, University of Tennessee, Knoxville, Tennessee	1947
	E. C. SCHEIDENHELM, Rutgers University, New Brunswick, New Jersey	1948
	FLOYD JOHNSTON, Iowa State College, Ames, Iowa	1949

DAIRY CATTLE BREEDING COMMITTEE

(Members appointed by Extension Section)

Chairman—	E. J. PERRY, Rutgers University, New Brunswick, N. J.	1949
	C. L. BLACKMAN, Ohio State University, Columbus, Ohio	1947
	S. J. BROWNELL, Cornell University, Ithaca, N. Y.	1948
	(Members appointed by Production Section)	
	E. E. HEISER, University of Wisconsin, Madison, Wisconsin	1947
	L. O. GILMORE, University of Minnesota, St. Paul, Minnesota	1948
	J. L. LUSH, Iowa State College, Ames, Iowa	1949

DAIRY CATTLE HEALTH COMMITTEE

(Members appointed by Extension Section)

Chairman—	C. G. BRADT, Cornell University, Ithaca, N. Y.	1947
	J. W. LINN, Kansas State College, Manhattan, Kansas	1948
	A. I. MANN, University of Connecticut, Storrs, Connecticut	1949
	(Members appointed by Production Section)	
	D. M. SEATH, Louisiana State University, Baton Rouge, Louisiana	1947
	L. A. MOORE, Bureau of Dairy Industry, Washington, D. C.	1948
	W. E. PETERSEN, University of Minnesota, St. Paul, Minnesota	1949

DAIRY RECORDS COMMITTEE

Chairman—J. F. KENDRICK, Bureau of Dairy Industry, Washington, D. C. 1947
W. T. CRANDALL, Cornell University, Ithaca, N. Y. 1947
C. R. GEARHART, Pennsylvania State College, State College, Pennsylvania 1948
A. R. PORTER, Iowa State College, Ames, Iowa 1948
E. J. STALLARD, University of Wisconsin, Madison, Wisconsin 1949

4-H CLUB COMMITTEE

Chairman—G. W. VERGERONT, University of Wisconsin, Madison, Wisconsin 1947
IVAN MCKELLIP, Ohio State University, Columbus, Ohio 1947
J. C. NAGEOTTE, Pennsylvania State College, State College, Pennsylvania 1948
GEORGE MCINTYRE, U. P. Experiment Station, Chatham, Michigan 1948
H. A. WILLMAN, Cornell University, Ithaca, N. Y. 1949

OFFICERS OF THE EXTENSION SECTION

Chairman—W. T. CRANDALL, Cornell University, Ithaca, N. Y.
Vice-Chairman—E. H. LOVELAND, University of Vermont, Burlington, Vermont
Secretary—A. R. PORTER, Iowa State College, Ames, Iowa

VOLUME XXX JANUARY, 1947 NUMBER 1

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, 1105 Barr Bldg., Washington, D. C., Exec. Sec.

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

CONTENTS

THE SCIENCE PRESS PRINTING COMPANY LANCASTER, PA.

PUBLICATIONS AND ABSTRACTS

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 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

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

Oil and Soap

Pacific Dairy Review
Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture
Southern Dairy Products Journal

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers

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

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

BOOK REVIEW

1. Modern Development of Chemotherapy. E. Havinga, H. W. Julius, H. Veldstra, and K. C. Winkler. Edited by I. R. Houwink and J. A. A. Ketelaar. 175 pages. $3.50. Elsevier Publishing Company, Inc., New York. 1946.

This publication represents one of a series of monographs on the progress of research in Holland during the war. These monographs, begun during the war, contain information most of which was kept secret until the end of the war.

The discussions include: (1) An introduction which emphasizes the important aspects of chemotherapy; (2) Bacteriological and physiochemical investigations on the mechanism of the action of the sulfonamides and of para-aminobenzoic acid; (3) Chemical investigations including synthesis and activity of sulfonamide derivatives and related compounds, action of sulfonamides on enzymes and analytical experiments on quantitative determination of sulfonamide derivatives and para-aminobenzoic acid; (4) Investigations on pharmacology, immunology, and clinico-therapeutical results including studies on streptococci, pneumococci, meningococci, gonococci, and other organisms; (5) Mycotherapy investigations on expansine, a product stemming from studies on antagonistic effect of antibiotics on plant pathogens.

The monographs are well written and presentations of data enhanced by numerous tables, figures, and structural formulas. P.R.E.

BACTERIOLOGY

2. The Selective Action of Penicillin in the Isolation of *Brucella abortus* from Milk. Helen A. Lacy, L. J. Rode, and V. T. Schuhardt, Brucellosis Research Project of the Clayton Foundation, University of Texas, Austin, Texas. Jour. Bact., *52,* 3: 401. September, 1946. Abs. Proc. of Local Branches.

"Pooled milk samples from the four quadrants of the udder were collected in sterile test tubes by hand milking from 564 cows. The cream from these samples was plated in duplicate on the usual gentian violet tryptose agar (GVTA) and on this medium containing 1 Oxford unit of penicillin per cubic centimeter (PGVTA). *Brucella abortus* colonies were isolated a total of 87 times from the two media. In 58 instances *B. abortus* was isolated on the PGVTA and not on the duplicate GVTA. In only 1 instance was the reverse of this situation true. In 20 instances the PGVTA plates showed more than 50 *B. abortus* colonies, whereas not one of the GVTA plates showed more than 50 colonies. In 12 instances the PGVTA plate showed more than 50 colonies of *B. abortus*, whereas not a single colony was found on the duplicate GVTA plate. *B. abortus* was isolated from 86 (15.24 per cent) of the 564 samples on PGVTA and from 29 (5.14 per cent) of the samples on GVTA." D.P.G.

BUTTER

3. **Testing Sour Cream for Extraneous Matter.** KENNETH M. RENNER, Texas Technological College, Lubbock, Texas. Southern Dairy Products Jour., *38,* 4: 64. October, 1945.

The following methods of filtering four-ounce samples of sour cream were used: (1) Soda Solution (Illinois Method), (2) Dry Soda Method, (3) Acid (HCl) Method recommended by Prof. M. G. Pederson of Texas Technological College, (4) Texas Tech. Method (Calgon–Diversey–USN–Citric Acid), (5) Special Solution designated by the Diversey Company as X–300, (6) Special Powder Solution, designated by the Diversey Company as D–229.

The first four tests have been recently described by the American Butter Institute. Method 5 consists in adding nine ml. of Solution X–300 to the cream sample, stirring for one minute, thoroughly stirring in eight ounces of water at 180–190° F. and filtering. For Method 6 make a 10% solution of D–229 in distilled water, heat to 160–180° F., stir frequently, allow to cool, and filter. Add two ounces of this stock solution to a sample, mix, allow to stand two or three minutes, add eight ounces of 180–190° water, mix well, and filter.

All methods filtered ordinary farm cream successfully except that Method 1 did not filter 35–50% cream five days old and Method 2 was not successful at five days for 50% cream and at seven days for 35–40% cream. When one ounce of a 50% solution of citric acid was added to each gallon of water used for diluting the cream, Methods 1 and 2 were successful on Grade A cream until it was at least seven days old. The use of untreated water with a hardness exceeding 15 grains caused difficulty in the alkaline methods.

Good results were obtained from Method 1 when the cream was allowed to stand three minutes after the addition of dry sodium bicarbonate, hot water added at 180° and the mixture stirred for three minutes before filtering.

Any differences between the methods in dissolving some of the sediment were not considered of material importance. Results were satisfactorily duplicated by each method provided the cream was thoroughly mixed before sampling. F.W.B.

CHEESE

4. **Paying for Swiss Cheese on a Solids and Fat Basis.** ARTHUR B. EREKSON, Plymouth, Wisconsin. Natl. Butter and Cheese Jour., *37,* 10: 48. October, 1946.

This method of payment is intended to give the producer of Swiss cheese an incentive to make cheese with optimum amounts of fat and moisture. It may also serve to protect the buyer who wishes to store cheese with high fat and low moisture and is willing to pay for it. Cheese with more fat or less moisture, or both, under this plan commands a proportionately higher price. Cheese with less fat or more moisture or both is worth less. It is calculated that cheese of optimum composition containing 61% dry matter, of which 45% is fat, has 0.2745 pounds of fat per pound of cheese. Cheese with the same dry matter, of which 46% is fat, contains 0.2806 pounds of fat and 0.3294 pounds of solids-not-fat per pound of cheese. This amount of solids-not-fat requires only 0.2695 pounds of fat to give the cheese the desired 45% fat in the dry matter so there is an excess of 0.0111 pounds of fat for which extra payment is needed. All of the value of the cheese price is assigned to the dry matter. The difference between the cheese-solids price and the price of butterfat in cream then is used to calculate the value of the amount of fat over or under the optimum. These calculations have been made and tabulated to show the value of a wide range of cheese compositions at the market price for Swiss cheese of 33 cents per pound. In order to sell the cheese beyond the primary market so that variations in purchase price will be fairly covered, it is recommended that the average compositions of cheese in each grade on the market be used to calculate the solids-plus-fat value of the cheese in those grades. W.V.P.

5. **A Discussion on Cheese Standards of Identity.** RAYMOND MIOLLIS, Natural Cheese Co., Maywood, Illinois. Natl. Butter and Cheese Jour., *37,* 11: 36. November, 1946.

The proposed "Standards of Identity for Cheese" is inadequate, especially for semi-hard and soft cheese of the imported type. The European nomenclature can be disregarded because the names are meaningless and obsolete for purposes of definition in the United States. The descriptions of manufacturing processes in the proposed standards are vague, erroneous and incomplete. Pasteurization of milk for all cheese should be compulsory and without the 60-day optional curing alternative. The amount of milk fat to be left in the cheese "should be left to the discretion of the cheesemaker, and after the cheese is made every cheese should be branded . . . with the butterfat content in multiples of five, followed by the sign +." Semi-hard and soft cheese should have no moisture limits. W.V.P.

ICE CREAM

6. Research on Milk Solids-Not-Fat. B. I. MASUROVSKY. Ice Cream Trade Jour., *42,* 6: 68. June, 1946.

Serum solids consist of milk protein, such as casein and albumen, which are used to build tissue and muscles. They also include the milk minerals to aid in the formation of bones and teeth. The average satisfactory serum solids in ice cream is about 11 per cent, depending upon the butterfat content of the mix. A high butterfat content requires less serum solids, but in no case should the combined milk solids exceed 22 per cent. Serum solids for ice cream are furnished by concentrated skim milk, plain or superheated; sweetened condensed skim milk; skim milk powder (spray process); and modified milk solids containing reduced quantities of sugar. Also, sweet buttermilk solids may be used. Skim milk used in the manufacture of skim milk solids should be tested for acidity, flavor, and sanitary quality.

W.H.M.

7. The Use of Processed Fruits, Nuts, and Other Flavors. E. C. WETMORE, Richardson Corp., Rochester, N. Y. Ice Cream Trade Jour., *42,* 6: 56. June, 1946.

Some of the advantages of using processed fruits, nuts, and other flavors in ice cream are uniform flavor and color in the finished ice cream, convenience in using, reduction of contamination of the ice cream because they are pasteurized after packing and sealing, and insurance of the maximum amount of flavor, because such fruits are usually selected and packed when they are at the right stage of ripeness. Nuts processed and packed in syrup retain their flavor and crispness in ice cream. Other flavors such as chocolate can also be obtained in sealed cans, and such flavors are usually uniform due to the ability of the processor to select the right blend of cocoa and chocolate liquor.

W.H.M.

8. Powdered Ice Cream Mix. S. T. COULTER. Ice Cream Trade Jour., *42,* 5: 42. May, 1946.

Dry ice cream mix is processed by condensing the milk-cream mixture which has been adjusted to the desired ratio of fat to solids-not-fat. Stabilizer dissolved in hot water, color, and sugar are then added to the condensed milk, and the mixture spray-dried to about 1 per cent moisture.

The capacity of the drier can be increased by adding only a portion of the sugar to the liquid mix prior to drying, and then blending the remainder of the sugar with the dry mix. Vegetable stabilizers are preferred to those of animal origin. Glycerol monosterate, egg yolk solids, powdered buttermilk, and sodium caseinate improve the whipping properties of dry ice cream mix. The composition of dry ice cream mix varies, but the following is typical:

Fat	27–29 per cent
M.S.N.F.	26–27.5 per cent
Sugar	40–44 per cent
Stabilizer	0.6–1 per cent or more
Moisture	1.2 per cent

The milk products are usually preheated to 190° F. for 5 minutes or more or to a higher temperature for a shorter holding period, to retard oxidative deterioration. Prompt cooling of the powder to 100° F. or less before it is packed is desirable. Cooling decreases cooked flavor and the rate of development of stale flavor. Low moisture and oxygen levels and storage of the powder at a low temperature (below 70° F.) are the principal means of retarding the development of stale flavor. W.H.M.

9. **Ice Cream Through Countless Ages.** ANONYMOUS. Southern Dairy Products Jour., *38*, 4: 34. October, 1945.

Marco Polo during his journeys through the Orient in the fifteenth century became so fond of wines and sweetened water iced with snow from the mountains that he introduced the delicacy to his native Italy upon his return home. The Italians soon discovered that snow treated with saltpeter produced a mixture capable of freezing water ices.

About 1550 the Italians flavored the sweetened water with fruit juices and then substituted milk for water in the mixture. More and more cream was used. In the same century Catherine de Medici brought water ices into France and Italians set up water-ice shops in that country. Fancy molds were first introduced in 1774. The Germans introduced ice cream decorating as an art.

Ice cream was brought to England by Carlo Gatti from France, and King Charles I introduced it to his court. There are many conflicting stories as to who introduced ice cream to the United States. There are accounts of the serving of ice cream at the White House during the administrations of Andrew Jackson and James Madison and the product was advertised in New York and Baltimore 1786 to 1789 and in New Orleans in 1808.

The beginning of the wholesale manufacture of ice cream is credited to Jacob Fussell of Baltimore, Maryland, in 1850. The commercial manufacture spread to most of the other states during the remainder of the century.

Inventions of the Mojonnier milk tester in 1915, the ice cream overrun tester in 1917, the ice cream packaging machine in 1920, the Creamery Package 80-quart freezer in 1917, the ice cream cone in 1904, and the Eskimo Pie in 1921 were noteworthy contributions to the industry. Pennsylvania State College began instruction in the manufacture of ice cream in 1892 and Iowa State College in 1901. F.W.B.

10. The Use of Fruit Purees in Ice Cream. C. L. Bedford, Dept. of Horticulture, State College of Washington, Pullman, Washington. Ice Cream Trade Jour., *42,* 5 : 44. May, 1946.

Unsweetened fruit purees may be made by passing such fruits as raspberries, loganberries, boysenberries, youngberries, strawberries, Santa Rosa plums, and similar fruits through a tomato-juice extractor or a finisher such as is used to remove peel from cooked squash or pumpkin. The fruits should be pureed at 40–50° F. and then frozen. A deaerator may be used to remove air. This prevents changes in color and flavor during freezing, storage, and thawing. Peaches, apricots, and pears should be scalded or steamed for 4 to 5 minutes to prevent darkening when exposed to air.

Fruit purees may also be prepared by adding sugar or syrup to the puree. Two volumes of berries, sour cherries, plums, and strawberries may be frozen with 1 volume of 67% syrup; apricots and nectarines, 1 volume pulp to 1 volume of 50% syrup; and blackberries, Bing cherries, pears, 3 volumes pulp to 1 volume of 67% syrup.

Other types of fruit purees contain gelatin or pectin, and they may be used in making fruit ribbon, ripple, or marble ice cream, or in making a product developed by the Western Regional Research Laboratory called "Velva Fruit".

The formula for "Velva Fruit" is varied slightly for different fruits, but two typical formulas for 100 gallons of mix are given.

For unsugared fruit puree with high acid and low pectin content—such as raspberries, boysenberries, loganberries, youngberries, Santa Rosa plums, strawberries, and similar fruits:

Puree	640 lbs.	610 lbs.	
Sucrose	265 lbs.	170 lbs.	(high-conversion corn
Gelatin (275 Bloom)	5 lbs. 13 ozs.	5 lbs. 13 ozs.	sirup—125 lbs.)
Water	60 lbs.	60 lbs.	

For fruits with low acid and high pectin content, such as unsugared apricots, pears, peaches, and similar fruits:

Puree	680 lbs.
Sucrose	225 lbs.
Gelatin (275 Bloom)	5 lbs. 13 ozs.
Water	60 lbs.
Citric acid	1 lb. 14 ozs.

In the high-acid fruits the soluble solids content should be about 37 to 38 per cent with about 1 part sugar to 2.4 parts of fruit puree. Corn sirup can be substituted for one-third of the sugar. It must be added in a 3 to 2 ratio to maintain the same sweetness.

In the low-acid fruits a soluble solids of 34 to 35 per cent and a sugar-fruit ratio of 3 to 1 is satisfactory.

In the preparation of the mix, the puree, sugar, and citric acid (if used) are mixed together until well dissolved. This should be kept relatively cool. The gelatin is mixed with ten times its weight of water and is heated to 170 to 180° F. to dissolve and "sterilize" it. During the addition of the gelatin sol the mix is stirred in order to prevent the formation of stringy gelatin in the mix. If a batch freezer is used, the gelatin sol can be stirred into the mix in the freezer before the refrigerant is turned on. W.H.M.

11. Blower-Type Evaporators in Ice Cream Plants. C. H. MINSTER. Ice Cream Trade Jour., *42*, 8: 34. August, 1946.

The blower type evaporator for ice cream plants has several advantages over the conventional unwieldy multiple-coil evaporator. It takes up less space, hardens ice cream faster, permits use of higher back pressures, lowers operation cost, is easily moved from one location to another, is easily defrosted, and requires little time for installation.

Two common troubles encountered in the operation of blower evaporators are frost on the coil and oil congealing in the float, surge drum, or coils. Most low-temperature units are equipped with a device for defrosting with calcium chloride brine. Sometimes these defrosters give trouble because of clogged brine spray, failure to close suction and liquid valves, weak brine, tendency to stop brine circulation before coils are completely defrosted, and the tendency to defrost only when frost has built up to a point where the circulation is reduced to a minimum. Heating the brine tended to offset these difficulties.

Some of the problems encountered with oil are: (1) Oil congeals in the float-valve orifice, preventing ammonia from entering the coils. Result: The evaporator would pump out and, with no refrigerant in it to absorb heat, all refrigeration would stop. (2) Oil, passing through the float-valve orifice with the float open, would congeal as soon as it hit the lower temperature of the float housing. Here it would build up and support the float in an open position. Result: Ammonia entered the coils in a steady stream and in quantities in excess of that required to maintain proper ammonia level. This ammonia would flood back on the compressor. (3) Oil would gradually accumulate and congeal in the bottom coils of the evaporator, resulting in reduced or completely shut off entrance of ammonia to coil, which further resulted in either refrigerant starvation or complete pump-out of the coils, thus slowing or stopping refrigeration. (4) The bottom coils became filled with fluid oil, resulting in reduced efficiency and heat transfer, and impediment of ammonia travel.

Remedies: (1) Maintain coils frost-free. (2) Constantly circulate air (from the room to be cooled) over the coils and back to the room. (3) Maintain the highest possible back pressure within the coils. (4) Keep the entire unit oil-free.

Low-temperature blower type evaporators work better if installed in a separate room from the room to be refrigerated. Some of the advantages of such an installation are: (1) Maintenance work on the unit can be more readily performed. (2) Defrosting can be accomplished with plain water. (3) The unit can be warmed up while defrosting with a minimum rise in hardening room temperature. (4) Oil can readily be drained from the unit.

W.H.M.

12. **Ice Cream with Less Sugar.** E. L. FOUTS, Dairy Technologist, Florida Experiment Station, Gainesville, Florida. Southern Dairy Products Jour., *38*, 5: 96. November, 1945.

In 1943 the Florida Dairy Products Laboratory published Bulletin No. 393, entitled "The Preparation and Use of Invert Sirup in the Manufacture of Ice Cream." In this bulletin, it was shown that it was possible to increase the sweetening power of cane or beet sugar by inversion.

It is possible to lower the sugar content of ice cream to 12% or even less by increasing the serum solids proportionately. For example, if ice cream is being made with 10.5% fat, 11% serum solids, 14% sugar, and 0.25% stabilizer, the sugar can be reduced to 12% with a corresponding increase in serum solids from 11% to 13%, producing an ice cream which is quite satisfactory in sweetness and in other respects. Trials have shown that the serum solids content can be increased to 13.5% if necessary. The inversion of not more than 25% of the sugar also will tend to give increased sweetness. The use of invert sirup in excess of 25% of the total sugar lowers the freezing point of an ice cream mix so that it may be difficult to harden.

It has been proven that the degree of sweetness in ice cream is influenced by the amount of water in the ice cream mix. This may be a partial explanation of why the sugar content can be reduced when the serum solids contribute additional milk sugar. Actually, then, when the sugar content is reduced from 14 to 12% and the serum solids increased from 11 to 13%, the sucrose content is reduced 2% but in turn the lactose content is increased 1%. If part of the sugar is inverted, the serum solids should be increased to maintain the same total solids in the mix, since the invert sugar sirup contains only about 70% sugar solids.

The additional serum solids seem to cover up or absorb vanilla flavor. It is suggested that a little extra vanilla be added when increasing the percentage of serum solids. To reduce the sugar content of ice cream enough to be worthwhile without making other changes will result in a thin coarse-textured ice cream definitely lacking in sweetness and flavor. F.W.B.

13. Chocolate Ice Cream. C. D. DAHLE, Pennsylvania State College. Southern Dairy Products Jour., *38,* 5: 28–30. November, 1945.

A sirup of two pounds of cocoa, two pounds of sugar and enough water to make a gallon of sirup is sufficient to flavor 10 gallons of finished ice cream. The reduction in the fat content of the mix from the addition of the sirup must be taken into account. The fresher the sirup the better is the flavor of the ice cream.

The flavor, body and texture of chocolate ice cream are improved by making a chocolate mix. The main drawback is that frequently the viscosity of the mix is so increased that cooling is difficult. The causes of high viscosity of the mix are: (1) stabilizer, (2) pressure, (3) acidity, (4) amount and kind of chocolate, (5) composition of mix, and (6) pasteurizing temperature.

Certain stabilizers cause more trouble than others. Reduce the amount used 20 to 30 per cent or more.

Single-valve homogenization will cause greater viscosity than "two-stage". The pressure on the single valve may be reduced from 2500 pounds to 1500 or less and in two-stage homogenization to 1500 and 500 pounds on the respective valves. The temperature of pasteurizing and homogenizing should be at least 160° F.

The acidity of the unflavored mix should be standardized and vary from about 0.15% for 8% M.S.N.F. to 0.20% for 12% M.S.N.F.

The more chocolate used the thicker and darker will be the product. The normal amount is 3–3½ per cent. The flavor is carried by the cocoa solids-not-fat and not the fat. The amount of each chocolate product needed to flavor 10 gallons of ice cream is about as follows: chocolate liquor (50% cocoa fat), 3.0 lbs.; blend (35% fat), 2.3 lbs.; cocoa (25% fat), 2.0 lbs.

Chocolate ice cream contains more sugar than vanilla ice cream to reduce the bitterness from the flavor. The more cocoa used, the more sugar is needed. A lower cocoa content may be compensated by a reduction in sugar to make the cocoa "taste stronger".

Chocolate is a relatively inexpensive flavor. In 1938, it was used in flavoring 16.36% of the ice cream and was surpassed only by vanilla, used in 51.26%.

Variegated chocolate ice cream may be made by adding a thick sweetened sirup to the ice cream as it is discharged from the freezer. The sirup may be purchased or made in the plant to contain 45–50% sugar, 1% stabilizer and 15% cocoa.

Sweetened slab chocolate may be melted at 105° F. and added to the ice cream as it comes from the freezer to give the ice cream a specky appearance. The colder the chocolate and the ice cream, the larger will be the pieces.

(The original article appeared in Serum Solids Digest and was reprinted by permission of Prestige Products Company, New York.) F.W.B.

14. Frozen Food Packaging—A Preliminary Study of Cavity Ice. C. I. SAYLES, W. A. GORTNER, AND FRANCES E. VOLZ, School of Nutrition, Cornell University, Ithaca, New York. Food Freezing, *1*, 11: 430. September, 1946.

The term "cavity ice" is suggested to designate the formation of ice in the air spaces inside a package of frozen food stored in a cabinet. The condition is found even though water-vapor transmission is at a minimum because of protective covering. The condition arises from dehydration of the food within its protective covering, the resulting withdrawn moisture being deposited as ice crystals within the cavities of a loosely packed product like snap beans or on the surface of a solid product like meat. The authors attribute the phenomenon in part to radiant heat transfer of moisture from the food to the air within the package. Interposition of foil prevented the formation of cavity ice because of its radiant heat transfer barrier between the package and side wall plates. Maintenance of temperature uniformity is highly important in order that the temperature gradient within the package will be small, thus keeping down moisture abstraction from the food. Insulation of package was found to be effective in keeping down temperature fluctuation but at present would be prohibitive in cost. In general, cabinet design which would favor a higher humidity level than that commonly found would prevent moisture transferal. Also, keeping down the temperature change of refrigerated surface in cycling will aid materially. Seventeen illustrations and three diagrams. L.M.D.

15. Frozen Food Stores. VINCENT M. RABUFFO. Ice Cream Trade Jour., *42*, 7: 26. July, 1946.

The Ice Cream Trade Journal has made an ice cream sales survey in specialized frozen food stores in 17 eastern and midwest communities. It was found that the volume of sales ranged from 5 gallons to 300 gallons a week. All stores sold ice cream made by commerical manufacturers and only one store expressed a desire to make its own ice cream. Sixty per cent handled a deluxe high-fat ice cream, while 40% handled the regular commercial grade. Packaged ice cream was sold by 95% of the stores. The other 5% handled both bulk and packaged ice cream. Most of the stores were not interested in dipping ice cream. The price on deluxe ice cream ranged from 38 cents to 50 cents per pint, and standard grades averaged 30 cents per pint. Most of the deluxe grade sold for 45 cents per pint.

The price paid to manufacturers for the regular grade ranged from $1.25 to $1.60 per gallon, with most of them paying $1.50. These prices prevailed during July before any general advance went into effect. The wholesale price for the deluxe grade ranged from $2.00 to $2.85 per gallon.

Seventy-seven per cent of the stores handling the deluxe grade had a mark-up of 50% or more. It has been established that a good quality ice cream at a good price can be sold by these stores. These mark-ups have been higher than those enjoyed by other retail outlets on ice cream. W.H.M.

PHYSIOLOGY

16. **The Relation of Temperature and the Thyroid to Mammalian Reproductive Physiology.** RALPH BOGART AND DENNIS T. MAYER, Missouri University; College of Agriculture, Columbia. Amer. Jour. Physiol., *147,* 2: 320–328. October, 1946.

High temperatures cause a marked lowering in the activity of the reproductive organs of rams.

Thyroxine or thyro-active proteins given to rams during periods of high temperature stimulate the reproductive organs and restore most of the reproductive activities to a level near that of the breeding season.

Changes in semen characteristics similar to those resulting from high environmental temperatures are induced during the breeding season by administration of thiouracil. Thyro-active materials counteract the detrimental effects of thiouracil upon reproduction.

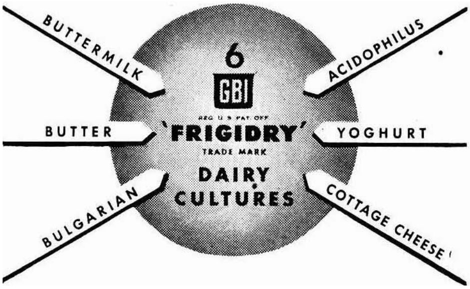
Since the temperatures which will reduce fertility in the ram are below the temperature at which the testes normally function, and since thyro-active materials restore reproductive activity during periods of high temperature, it is concluded that temperature is not influencing reproductive physiology by its direct effect on the testes.

The stimulating effect of thyroxine during periods of high temperatures and the harmful effect of thiouracil administered during the normal breeding season suggest that the level of thyroid function influences the relative activity of the reproductive organs. D.E.

MISCELLANEOUS

17. **Styrofoam—A New Thermal Insulation.** O. R. MCINTIRE AND D. W. MCCUAIG, The Dow Chemical Company, Midland, Michigan. Refrigerating Engineering, *52,* 3: 217. September, 1946.

A polystyrene foam, "Styrofoam", now being produced in limited quantities, is an extremely light plastic structure composed of many small plastic bubbles, each bubble being completely enclosed to make the entire plastic structure impermeable. Styrofoam 103.7 has a K factor of 0.27 to 0.29 and cell sizes of 1/32 to 1/16 inch. Experimentally a product with aluminum powder incorporated in it has a K factor of 0.20 due to decreased infrared transmission. Styrofoam has in addition the following desirable factors: low specific gravity, low water absorption, high resistance to vapor diffusion, structural strength yet bendable, easily installed in sheets. Because it is made from polystyrene, a thermoplastic, Styrofoam begins to distort upon continuous exposure to temperatures above 180° F. but at low temperatures it becomes tougher and stronger. Installation procedure in commercial applications such as cold storage plants can be followed as for corkboard with the single precaution that asphalt temperature must be kept low enough (not over 175° F.) to prevent the Styrofoam from softening. Due to its very light weight it lends itself to the insulation of mobile equipment where the minimizing of weight is of prime importance. It should prove to be of exceptional value in the field of frozen foods transportation where the maximum of insulation effect is needed to hold low temperatures together with a maximum of goods weight and maximum of cargo space. L.M.D.



Make Uniformly Good Cultured Dairy Products

In Just 3 Easy Steps

GBI 'FRIGIDRY' Cultures are easy to use because they are vigorous and rapid growing. This means mother culture can be made in one generation, eliminating transfers and saving several days' time.

Each of the six 'FRIGIDRY' cultures is tailor. made for its purpose. Uniformity is assured by selection and blending of the special strains of acid and aroma forming organisms. The 'FRIGIDRY' sub-zero, high-vacuum, drying process "fixes" and holds the cultures in a dormant state until needed. Added to milk, they are energized into teeming activity.

You Follow These 3 Simple Steps
Save Time - Save Money - Avoid Trouble

1. To make mother culture merely add contents of one vial of GBI 'FRIGIDRY' CULTURE to ⅔ quart prepared milk and incubate.
2. To make Starter, add the above mother culture to 10 gallons of prepared milk and incubate.
3. To make Commercial quantity of cultured dairy products, add proper proportions of Starter to vat and ripen.

Step up your sales by producing uniform, top-quality products the easy 'FRIGIDRY' way. Your customers get the "buying habit" when they know they will get the same fine quality in your product day after day.

livery on any of our six cultures-through your jobber-or direct.

GENERAL BIOCHEMICALS, INC.

20 LABORATORY PARK
CHAGRIN FALLS, OHIO

"HANSEN'S" DAIRY PREPARATIONS

CHEESE RENNET AND COLOR
ANNATTO BUTTER COLOR
CERTIFIED BUTTER COLOR
ICE CREAM COLOR
LACTIC FERMENT CULTURE
BULGARIAN CULTURE

*

TESTING SOLUTIONS
RENNET TESTS

*

Chr Hansen's Laboratory, Inc.
Milwaukee 14, Wisconsin

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