JOURNAL OF DAIRY SCIENCE

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THE INFLUENCE OF CRACKED SOYBEANS AND OTHER FACTORS UPON FLAVOR OF MILK AND THE IODINE VALUE OF MILK FAT^{1, 2}

J. B. FRYE, JR., 3 C. Y. CANNON,⁴ AND E. W. BIRD⁵ Iowa State College, Ames

The increased importance of soybeans as a protein supplement for dairy cows, and the feeling among certain workers in Iowa that the feeding of soybeans was contributing greatly to oxidized flavor in milk and cream suggested the need for more information regarding the effect of this feed on the flavor and quality of dairy products. It was thought advisable, therefore, to study the effect of cracked soybeans on the flavor of milk and the iodine value of the milk fat. During the course of the study, additional information was secured on the effect of production and age on the flavor of milk and the relationship of the iodine value of milk fat to environmental temperature.

Although feeds usually impart flavor to milk, the intensity of the flavor may be minimized when fed 2 to 4 hours before milking (3, 11, 15, 17, 30, 31, 32, 39, 40). Data published previously indicate that soybean feeding does not contribute particularly undesirable flavors to milk (4, 12, 21, 25, 26, 28, 34, 41).

The incidence of oxidized flavor in milk has been related to the oxidation of one or more of the lipids present in milk (8, 33, 37, 38) and the degree of saturation of the milk fat (14, 36). It has been shown that milk fat with the higher iodine value usually is more susceptible to oxidation (2, 6).

It is recognized that feeds may have a noticeable influence on the quality of butterfat produced (7, 10, 18, 20, 24). Peterson *et al.* (27) point out that the modification of milk fat by the diet occurs in opposition to the normal tendency of the gland to secrete a product of constant composition. Maynard *et al.* (23) noted that the maximum change was produced in the iodine value of milk fat

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¹ The data contained in this paper are from a thesis presented by the senior author to the faculty of the Graduate School, Iowa State College, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

² Journal paper No. J1662 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project 692.

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แผนกห้องสมุด กรมวิทยาสาสตร์ กระทรวงอุตสาหกรรม within 3 or 4 days when cows were fed rations containing fats having low and high iodine values.

Hilditch and Sleightholme (19) observed a general change in the composition of milk fat, largely in the oleic acid content, which they attributed mainly to "winter conditions" (*i.e.*, either the change from outdoor to indoor conditions or from grass to indoor rations or both), and probably also to seasonal changes of temperature. These workers concluded that the influence of added fat in the diet is minor compared to other causes. Likewise, Dean and Hilditch (9) indicate that the seasonal rise in the iodine value of the fat is rather abrupt with the change being completed within 2 or 3 weeks after the cows have been changed to pasture. Regan and Richardson (29) observed under controlled conditions that when external temperatures went above 80 to 85° F., dairy cows no longer were able to maintain heat balance and that alterations occurred in their milk including, among other things, an increase in the unsaturated compounds of the milk fat. These changes probably were the result of "hyperthermic undernutrition."

EXPERIMENTAL PROCEDURE

Feeding plan. Twenty Holstein cows of the station herd were paired into two groups as equally as practicable. They were milked thrice daily and fed alfalfa hay *ad libitum* and grain mixtures (table 1), which contained cracked

Ingredients	Mixture A	Mixture B	
а. ал	(lb.)	(lb.)	
Cracked corn	400	400	
Oats	200	200	
Wheat bran	200	200	
Linseed meal	100		
Cracked sovbeans		100	
Bonemeal	18	18	
Salt	9	9	

TABLE 1

soybeans and linseed meal as the principal sources of protein, at the rate of 1 lb. grain for each 3 lb. of milk produced. All cows were fed the same ration (mixture A), which contained linseed meal, during a 70-day preliminary period. Then the animals in group 2 were changed to mixture B, which contained cracked soybeans, while those in group 1 continued to receive mixture A. These rations were reversed after 74 days and fed for the remainder of the trial (49 days).

Collection and treatment of milk and cream samples. Individual milk samples were taken in glass bottles and scored for flavor approximately 3 times each week. Composite samples were taken approximately twice each week during the last 3 mo. of the experiment. Usually the milk was scored within 6 hr. after being drawn from the cows. Representative aliquot samples of a day's milk yield from each group of cows were separated promptly after each milking at periodic

INFLUENCE OF CRACKED SOYBEANS

intervals and the cream cooled immediately to 40° F. by means of an ice-bath. The 24-hr. composite sample of cream was churned, and the butter melted, centrifuged, and the fat filtered at a temperature of 60–70° C. The butter oil was stored in glass sample jars at 10° C. until the analyses were completed. Iodine values of the butter oil were determined according to the Hanus method (1) approximately every 5 days during a period of about 6 mo.

RESULTS AND DISCUSSION

Health of cows. Two paired cows were dropped from the experiment because of mastitis and termination of lactation, respectively. The other cows were in excellent health for the duration of the study. The mean gains in live-weights for groups 1 and 2 were 42 and 29 lb., respectively (figure 1).



FIG. 1. Variation of live weights of the animals during the experiment. 0=group 1; x=group 2; ---=Mixture A (linseed meal); _____=Mixture B (cracked soybeans).

Relationship between yield, age of cow and flavor criticisms. Plant operators often have suggested that one of the causes of off-flavored milk is the heavy feeding of cows to obtain high yields. To study this possible relationship, cows were fed so as to obtain their maximum production and individual samples were scored for flavor (table 2).

The differences in effect of mixtures A and B on milk flavor were minimized by the method of statistical analysis (between group correlations) (35). The correlation coefficients between total milk and fat production and percentage observations of (a) feedy, (b) oxidized, and (c) rancid flavors were non-significant (table 3).

This is in agreement with the work of Stebnitz and Sommer (36) and Hening and Dahlberg (17), who found that the level of feeding has no effect upon the quality and flavor of milk. On the other hand, Henderson *et al.* (16) indicate that a high level of feeding increases the susceptibility of milk to development of

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TABLE 2

Data used to study	the relationship between age, milk yield, fat yield	d and
	various observations of off-flavor	

Cow no.	Ago	· Produ durin	uction g trial	Total times	Percenta; vatio	ge distributi ns among fla	ion of off-fla avor classific	vor obser- ations
	Age	Milk	Fat	off-flavor	Feedya	Flat and feedy	Oxidized	Rancid
	(days)	(<i>lb.</i>)	(<i>lb.</i>)					
1497	1424	8892	268	36	72.2	8.33	11.11	13.89
1528	2800	6357	246	31	36.5		3.23	45.16
1544	2052	6913	227	36	88.9	13.89	2.78	8.33
1557	1781	6083	252	31	9.7	3.23	3.23	87.10
1587	1167	6000	213	36	88.9	30.56	2.78	8.33
1599	1163	8515	253	30	50.0	6.67	33.33	16.67
1614	1195	7308	254	34	67.6	14.71		2.94
1708	834	9116	306	36	66.8		16.92	5.56
1712	817	5627	184	30	50.0	30.00	43.33	6.67
1384	1786	7386	240	35 .	82.9	2.87		11.42
1806	1404	7786	280	36	66.6	22.21	13.89	16.91
1518	1322	7026	246	37	97.3	18.92		2.70
1539	2865	8159	284	29	51.8	3.45	10.34	20.69
1553	1591	5193	178	35	94.3	28.57	5.72	
1561	1262	8052	278	36	91.6	19.44	5.56	2.78
1581	1210	7966	254	35	57.2	2.86	31.43	11.42
1696	924	6470	240	30	60.0 .	30.00	30.00	10.00
1713	789	5822	211	30	33.4	26.67	60.00	6.67

* Includes those samples with "flat and feedy" criticism.

oxidized flavor. MacCurdy and Trout (22) report that when cows were fed a given quantity of silage the feed flavor was more intense in milk from cows of least production. Their data indicate that high producers, such as the ones producing approximately 40 lb. daily used in this study, produce milk with less feed flavor than low producers. In this respect, the two experiments are in agreement.

Correlation determined	x	Sx^2	y	Sy ²	Sxy	Correlation coefficient
Milka-feedy flavor	7148	23,232,096	64.7	9151	- 3711	- 0.00
Milk-oxidized flavor	7148	"	15.2	5032	-36.526	-0.11
Milk—rancid flavor	7148	"	15.4	6488	-67.373	-0.17
Milk—flat flavor	" "	" "	14.6	2102	-134.690	-0.61**
Fata-feedy flavor	245	19,122	64.7	9151	-1148	-0.08
Fat—oxidized flavor	" "	·	15.2	5032	-2498	-0.26
Fat—rancid flavor	"	" "	15.4	6488	1902	0.17
Fat—flat flavor	"	" "	14.6	2102	-4128	- 0.65**
Ageb-feedy flavor	1466	6.257.912	64.7	9151	-30.334	- 0.04
Age—oxidized flavor	"	"	15.2	5032	-94.849	-0.53*
Age-rancid flavor	" "	"	15.4	6488	-93.056	-0.46
Age-flat flavor	" "	" "	14.0	2102	-59.322	- 0.52*

TABLE 3 Statistical summary of data used in flavor study

^a Befers to yield.
^b Refers to age of cow.
* = Significant at 5% level.
** = Significant at 1% level.

Significant negative correlation coefficients (table 3) of -0.61, -0.65, and -0.52 between flat flavor and (a) milk yield, (b) fat yield, and (c) age, respectively, indicate that older cows and higher producers are less likely to produce milk having a flat flavor. Usually, flat flavor and fat in the milk are associated together, the milk with the lower butterfat having a "flatter" flavor. The authors wish to emphasize that the total fat yields, and not fat percentages, were used in these comparisons. The correlation coefficient between age and the percentage observations of feedy flavor was non-significant.

The correlation coefficient (-0.46) between age and the occurrence of rancid flavor was 0.004 less than the significant point. The correlation coefficient (-0.53) between age and the occurrence of oxidized flavor was significant, in fact, almost highly significant. Insofar as these data are concerned, the individual sample data indicate that rancid and oxidized flavors occurred more frequently in the milks of the younger cows. These data are in contrast with those of Guthrie and Bruecker (13) who found no apparent relationship between age and the incidence of oxidized flavor. However, they are in agreement with those of other workers (5, 42) who have indicated that young cows are more likely to produce milk with a rancid or oxidized flavor than are older ones. In a 6-mo. study of milk samples from 138 cows, Corbett and Tracy (5) found that 2- and 3-yr. old cows gave milk (1 p.p.m. Cu added) which developed oxidized flavor to a greater degree than did that from older cows. Why young cows, especially first calf heifers, should have a greater tendency to produce milk more susceptible to the development of oxidized flavor than older cows is not known. These data do not mean necessarily that the same cow produces milk less susceptible to the development of oxidized or rancid flavors as she grows older. Perhaps the explanation is that many of the younger animals, which produce milk susceptible to the development of rancid or oxidized flavor, may be culled from the herd for one reason or another and leave cows less likely to produce milk susceptible to the development of these flavors.

Flavor criticisms of composite milk samples. Certain cows in group 1, fed linseed meal (table 4) during the first experimental period, consistently produced milk with a rancid flavor. When the milk from these cows was excluded from the composite milk sample, the flavor was improved considerably. The incidence of rancid milk produced by these cows diminished after they were fed cracked soybeans in the latter part of the experiment. On the other hand, the cows in group 2, (fed cracked soybeans) produced milk quite free from rancidity and there was little change in the quality of the milk after the cows were switched to mixture A. These data do not mean necessarily that the feed contributed to the incidence of rancidity in the milk. They may mean that certain cows are much more susceptible to the feed than others. Factors other than feed may have been responsible for the high incidence of the cows in group 1; the individuality of the cow probably played an important role. It is concluded that, in addition to factors that normally are considered, the selection of cows to be used in flavor studies should be based on the flavors of the milk they produce when fed a common ration.

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It is noteworthy that the oxidized flavor usually characteristic of composite milk samples was absent, despite its presence in many of the individual samples. These changes may indicate that the oxidation-reduction potential of the mixed sample *may be* lowered to a point at which the oxidation is reversed or other flavors "cover" the oxidized flavor.

Q		Group 1	Group 2				
Sampling date	Score	Criticism	Score	Criticism			
	Miz	cture A (linseed meal)	Mixtur	e B (soybeans)			
Jan. 30	20.0	Feedy & slightly rancid	21.0	Feedy			
Jan. 31	20.0	Feedy & slightly rancid	21.0	Feedy			
Feb. 3	20.0	Slightly rancid	21.5	Feedy			
Feb. 5	21.0	Feedy	19.5	Rancid			
Feb. 8	21.0	Feedy	21.5	Feedy			
Feb. 10	19.5	Rancid	21.5	Feedy			
Feb. 13	19.0	Rancid	21.5	Feedy			
Feb. 14	19.0	Rancid	21.0	Feedy			
^b Feb. 25	21.5	Flat & feedy	21.5	Flat & feedy			
^b Feb. 26	21.0	Flat & feedy	21.0	Flat & feedy			
^b Feb. 28	21.0	Feedy	21.0	Feedy			
Mar. 3	18.0	Rancid	20.0	Feedy			
^b Mar. 4	20.5	Slightly rancid	21.5	Flat & feedy			
^b Mar. 5	20.0	Feedy	21.5	Flat & feedy			
Mar. 6	19.0	Rancid	21.0	Flat & feedy			
^b Mar. 10	21.0	Feedy	21.0	Feedy			
Mar. 18	18.0	Rancid	21.0	Feedy			
		Mixture B		Mixture A.			
Mar. 21	19.5	Rancid & feedy	21.0	Flat & feedy			
Apr. 10	20.0	Rancid & feedy	21.5	Feedy			
Apr. 11	21.0	Feedy	21.0	Feedy			
Apr. 18	20.5	Feedy	21.5	Feedy			
Apr. 21	20.0	Rancid & feedy	21.0	Feedy			
Apr. 24	20.5	Feedy	21.5	Feedy			
Apr. 25	20.0	Feedy	21.0	Feedy			
May 2	20.0	Rancid	21.5	Feedy			
May 5	20.5	Feedy	21.0	Feedy			
May 9	21.0	Feedy	21.5	Feedy			

 TABLE 4

 Flavor scores and criticisms of composite milk samplesa

^a Feedy and flat flavors were not considered undesirable.

^b When milk from cows gave rancid milk was excluded from the sampling, the composite sample was not rancid.

Iodine value of milk fat. The iodine value of the milk fat was used to determine when the full effect of the feed on the milk fat was reached. It was supposed that the iodine values of the milk fat would soon stabilize themselves when the cows were fed a common ration. However, it became apparent as the experiment progressed that the iodine values did not stabilize as rapidly as had been supposed by some workers, and that it was necessary to determine the time required to stabilize the iodine values before making a "cross-over" of feeds. This determination is more easily and more accurately accomplished when the iodine value is determined frequently, as was done in this experiment. Changes in fat composition made when the iodine value was determined only 2 or 3 times each month might fail to reveal many of the fluctuations of the iodine value and indicate a false stabilization. Since the literature did not disclose trends in iodine values of milk fat except in relatively short-time feeding trials, a new objective, determination of the long-time effect of feed on the iodine values of milk fat, was injected into the experiment. Consequently there was no change



FIG. 2. The iodine values of milk fat and the mean external temperatures one day before that on which the milk fat was obtained. ----= Mixture A (linseed meal); ----== Mixture B (cracked soybeans).

in the feeding program after the end of the preliminary period until the latter part of the trial. The iodine values (figure 2), which were determined weekly, were larger in the milk fat produced by the cows in group 2 fed on mixture B (soybeans) than that of group 1 which received mixture A. The full effect of the soybeans on the iodine value of the milk fat seemed to be attained in about 15 days after the cows were changed to this ration. The differences in the iodine values of the milk fats of the two groups were fairly constant until the rations

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were reversed, when the positions of the resultant iodine values soon were reversed. In approximately 15 days, a fairly constant difference in the values was established and the difference was smaller than during the previous period. This small difference was not maintained long, for at slightly past the mid-point of the period the curves behaved randomly and crossed twice. This would indicate that factors other than feed were operating to influence the trend and magnitude of the iodine values. Of these factors, changes in temperature may have played an important role.

The fluctuations of the iodine values and the mean external temperature recorded 1 day prior to taking of samples (fig. 2) were somewhat the same. As the temperature dropped to a low level during the winter months, the iodine

 TABLE 5

 Statistical summary of data used in study of mean external temperature and iodine value relationship

the second se							and the second se	
Correlations between tempera- ture and iodine value ^a	x	Sx²	ÿ	Sy ²	Sxy	Correlation coefficient (r)	Regression coefficient (b)	T-test of regression coefficient
Temp. same day- I ₂ no. and grp. 1	30.1	7473	33.14	124	696	0.72**	0.0931	6.42**
Temp. 1 day be- fore— I_2 no. and grp. 1 Temp. 2 days be-	31.3	6405	33.17	133	755	0.82**	0.1178	8.60**
fore— I_2 no. and grp. 1	29.9	5888	33.17	133	651	0.74**	0.1106	6.54**
Temp. same day— I_2 no. and grp. 2	30.1	7473	33.94	51	317	0.51**	0.0424	3.69**
Temp. 1 day be- fore—I ₂ no. and grp. 2	31.3	6405	33.97	56	397	0.66*	0.0592	5.10*
Temp. 2 days be- fore—I ₂ no. and grp. 2	29.9	5888	33.97	56	412	0.72*	0.0699	6.19*

^a Mean external temperatures were recorded (1) the same day, (2) one day before, and (3) two days before the milk fat samples were taken.

* = Significant at 5% level. ** = Significant at 1% level.

values likewise decreased in value. As the temperature rose with the approach of spring, the iodine values also increased. Correlation coefficients (table 5) between the temperature on the same day, 1 day before, and 2 days before the samples were taken and iodine values were all highly significant. These data indicate that temperature changes show their greatest relationship with butterfat composition 24 to 48 hr. later. Whether or not this correlation is wholly a function of temperature is difficult to state. Changes in hormonal activity with advancement in lactation and pregnancy may have played a role in the iodine value fluctuations. Further investigation of the correlation between the iodine value of milk fat and temperature should be undertaken.

SUMMARY

Twenty Holstein cows of the station herd were used to study the influence of cracked soybeans, level of production and age upon the flavor of milk and the relationship of the iodine number of butterfat to feed and temperature changes.

In addition to the usual factors considered in selecting cows for flavor studies, the flavor of the milk produced by the cows while being fed a common ration should be considered.

There was no indication that cracked soybeans produced an undesirable flavor in milk when constituting approximately 11 per cent of the concentrate mixture.

The extreme fluctuations in iodine value with chronological time and the randomness of the last half of the last feeding period suggest that control groups should be carried continuously on each feed when fat composition changes are studied.

The correlation coefficients between milk and fat yields, and the occurrence of feedy, oxidized and rancid flavors in the milk were non-significant.

Highly significant negative correlations between milk (-0.61) and fat (-0.65) yields and the occurrence of flat flavor indicate that, as the total milk and fat production increase, the tendency for the production of milk having a flat flavor decreases. Likewise, a significant negative correlation (-0.52) was found between age and the occurrence of flat flavor.

The correlation coefficient between age and the occurrence of feedy flavor was non-significant.

The correlation coefficient (-0.46) between age and the occurrence of rancid flavor was only 0.004 below the significant point. Possibly rancid flavors have a greater tendency to develop in the milk of younger cows.

A significant negative correlation coefficient (-0.53) was obtained between age and the occurrence of oxidized flavor.

The maximum effect of a feed on fat composition, as measured by the iodine value, may require at least 15 days.

A close relationship may exist between mean external temperature and the iodine value of the milk fat produced.

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A COMPARISON OF VARIOUS SEMEN DILUTERS IN MAINTAINING MOTILITY OF BOVINE SPERMATOZOA¹

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One of the major problems in the artificial insemination of dairy cattle is the improvement of diluters for the successful storage of semen. Experiments were conducted by Phillips and Spitzer (9) to study the effects of certain protein, lipid and carbohydrate compounds, as well as certain bacteriostatic agents, upon the livability of bull spermatozoa. The egg yolk-citrate diluter reported by Salisbury *et al.* (10, 12) has been used widely in artificial insemination. Swanson (13) reported 3 per cent sodium citrate to be optimum for semen dilution and storage. Increased fertility has been reported by the addition of 300 mg. per cent of sulfanilamide to the egg yolk-citrate by Knodt and Salisbury (4), Salisbury and Knodt (11) and Salisbury *et al.* (12).

Satisfactory conception rates were obtained by use of the liquid and tablet diluters produced by the Ortho Pharmaceutical Co. in comparison with egg yolk-phosphate, egg yolk-citrate and egg yolk-citrate-sulfanilamide diluters (1, 3).

The objective of this study was to compare the efficiency of several diluters now in general use and to attempt to develop an improved diluter by (a) substituting sodium citrate for KH_2PO_4 and Na_2PO_4 as the buffering system in the pabulum diluter suggested by Phillips and Spitzer (9), (b) substituting eggyolk for asolectin in the pabulum diluter to determine if the "protective factors" for spermatozoa are present in comparable quantities and (c) substituting dried egg yolk for fresh egg yolk as a possible means of simplifying laboratory procedure in artificial insemination associations.

In addition, a pabulum diluter supplied by the Ortho Pharmaceutical Co. and control samples of undiluted semen were studied.

EXPERIMENTAL

Semen from ten dairy bulls from the Missouri Station dairy herd totaling 117 samples was used in the comparison of diluters. Each sample was divided in aliquot portions and used in each of the diluters tested. The makeup of these diluters, except the Ortho diluter, is given in table 1. There were 117 comparisons of the egg yolk-citrate diluter and the six pabulum diluters. An undiluted control sample semen was maintained when available and there were 75 comparisons of the undiluted samples and the Ortho liquid diluter.

Immediately after collection of the semen, the vial was placed in a thermos bottle inside a glass tube which was surrounded with tap water at 70° F. About

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TABLE 1Formula and pH of each diluter

	EYC	I	II .	III	IV	v	VI	\mathbf{OL}
Glucose (q.)		1.2	1.2	1.2	1.2	1.2	1.2.	
Galactose (g.)		0.4	0.4	0.4	0.4	0.4	0.4	
KH.PO, (g.)				0.4	0.4	0.4		
Na HPO, (g.)				1.58	1.58	1.58		
Na Citrate (g.)	3.1	3.53	3.53				3.53	
Asolectin (g.)		4.0	4.0	4.0	4.0			
Gum Acacia (g.)		6.0	6.0	6.0	6.0	6.0	6.0	
Sulfanilamide (mg.)		66	66	60	66	66	66	
Water (redistilled over glass)								
to final col. (ml.)	100	200	200	200	200	200	200	
Egg volk (ml.)	100		20		20	20	20	
pH of diluter	6.69	6.5	6.6	6.8	6.87	6.92	6.66	6.3

EYC = egg yolk-citrate; I, II, IV, V and VI are modifications of the synthetic pabulum diluter; III = synthetic pabulum diluter. OL = Commercial Ortho Liquid diluter.

30 min. elapsed between the time of collection, examination and dilution of the semen. Equal volumes of semen and diluter were used in all dilutions. After dilution the vials containing the diluted semen were stored in a refrigerator which maintained an average temperature of 40° F. This procedure in preliminary trials was found satisfactory for lowering the temperature of the diluted semen approximately 1° F. per min.

Motility ratings on the stored spermatozoa were made by daily microscopic examinations.

Since Herman and Swanson (14) and Margolin *et al.* (5) found a highly significant correlation between the length of time a sample retained a "2" motility rating in storage (approximately 20 to 50 per cent motile spermatozoa) and conception rate, the methods suggested by Herman and Swanson (2) and later revised by Swanson and Herman (14) were used.

RESULTS

The average number of hours each diluent maintained a motility of "2" was computed from the data and is presented in table 2. An analysis of variance was

Diluenta		Hr.b	
EYC	*	174.2 ± 44.5	
II .		159.9 ± 45.9 157.7 ± 50.0	
		177 ± 36.3 $178 7 \pm 47.3$	
v		172.7 ± 47.5 182.7 ± 47.6	
VI Ortho liquid		190.6 ± 43.8 109.3 ± 33.2	
Undiluted		82.7 ± 22.9	

 TABLE 2

 Hours ''2 motility'' was maintained in semen under storage conditions

^a Composition of diluents given in table 1.

^b Necessary difference = $\frac{t \sqrt{2}(\sigma^2 \text{ ejaculates} + \text{remainder})}{t \sqrt{2}(\sigma^2 \text{ ejaculates} + \text{remainder})} = 14.7 \text{ hr.}$

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made on the six pabulum diluents and the egg yolk-citrate diluent. Due to the unequal number of samples studied for the Ortho liquid diluter and the undiluted samples, analysis of variance was not made, but these samples were compared by statistically analyzing the difference of the means. The results are presented in table 3. The six pabulum diluents and the egg yolk-citrate diluent were signifi-

Source	D/F	Variance	Mean square
Total	818	4,233,499	
Diluents	6	1,559,970	259,995*
Ejaculates	116	269,592	2,324
Remainder	696	2,403,937	3,454

			TABLE	3		
Inalysis	of	variance	between	diluters	and	ejaculates

* Highly significant (p = 0.01).

cantly superior to the Ortho liquid and undiluted semen at the 1 per cent level.

DISCUSSION

The livability of spermatozoa ranged from 109.3 to 190.6 hr. in the various diluents studied. Since all diluters were made up to have approximately the same osmotic pressure and, with exception of the Ortho liquid diluter, agreed closely in pH, the variations in livability of the spermatozoa under storage conditions apparently were due to physiological differences brought about by the chemical make-up of the medium.

The results of the six pabulum diluters and the egg yolk-citrate diluter were studied for statistical significance by analysis of variance. The Ortho liquid diluter and the undiluted samples, which were in unequal numbers, were compared with the pabulum diluents by a statistical analysis of the difference of the means. A difference of 14.7 hr. was required for significance at the 1 per cent level.

In comparing diluents I and II with diluent III, which is the original synthetic pabulum suggested by Phillips and Spitzer (9), indications are that the replacement of KH_2PO_4 and Na_2HPO_4 with sodium citrate is detrimental to spermatozoa under storage conditions and that the addition of egg yolk fails to improve the storage capacity of these diluents.

In comparing diluents I and II with diluent VI, it appears that sodium citrate and asolectin in combination apparently are antagonistic, since diluent VI is significantly superior at the 1 per cent level. In addition to the increase in mean storage time provided by diluent VI, the spermatozoa are more easily observed under the microscope when asolectin is replaced by egg yolk.

All diluents studied were superior to the Ortho liquid diluent and the undiluted samples, although the Ortho diluent gave a mean of 26.6 hr. greater livability than the undiluted semen.

SEMEN DILUTERS

SUMMARY

A comparison of the egg yolk-citrate diluent and the synthetic pabulum diluent with several modifications for preserving semen was made.

A formula is presented for the preparation of a diluent for use in the artificial insemination of dairy cattle which appears, under conditions of these experiments, to support significantly greater livability of spermatozoa than previously suggested diluters.

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SOME EFFECTS OF HYPERTONIC AND HYPOTONIC SOLUTIONS ON THE LIVABILITYAND MORPHOLOGY OF BOVINE SPERMATOZOA¹

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Studies reported to date on diluting fluids for boyine semen have presented only limited information concerning the effects of varying freezing point depressions of diluents on spermatozoa livability and morphology. Osmotic swelling and distension of the head of mammalian spermatozoa generally has not been observed, according to Anderson (1). He further states, "The tails in hypertonic solutions show irregular zig-zag bends, while in hypotonic solutions, especially in distilled water, the tails are curled in rings." Anderson (1) also calls attention to the statement by Milovanov that mammalian sperm have retained the ability of adaptation to changes in osmotic pressure to a certain extent. The work of Roemmele who found that the osmotic pressure in terms of the freezing point depression of bull semen was -0.62° C. with a range of from -0.54 to -0.73° C., and also Bernstein and Sergin who report an average freezing point depression of -0.609° C. with a range of -0.53 to -0.65° C. is cited by Anderson (1). Salisbury et al. (7) found the freezing point depression of bull semen to be -0.653° C. A positive and significant correlation coefficient of 0.33 between spermatozoa count and the freezing point depression also was reported. As the spermatozoa count decreased the magnitude of the freezing point depression increased.

Salisbury et al. (8) obtained satisfactory results using a M/15 sodium citrate solution with egg yolk. Later, it was indicated by these workers that a M/7.5 solution was being used. Salisbury and Knodt (9) presented a revised formula, using 3.6 per cent sodium citrate dihydrate in the egg yolk-citrate diluent. Salisbury et al. (7) found that fresh normal bull semen has the same osmotic pressure as cattle blood and they recommend 2.9 per cent sodium citrate for the diluent. Swanson (10) found that 3 per cent sodium citrate dihydrate was superior to other concentrations tried. Bratton et al. (3) obtained similar results using 2.9 and 3.6 per cent egg yolk-citrate. Both of these concentrations contained 300 mg. per cent of sulfanilamide.

Swanson (10) found that 5 per cent sodium citrate had an immediate adverse effect on spermatozoa motility and that 1 per cent citrate diluent was tolerated better than 5 per cent. The 1 per cent solution failed to maintain satisfactory motility and resulted in a high proportion of coiled-tail spermatozoa which moved only backwards or in circles. He observed that bovine spermatozoa are more sensitive to hypertonic solutions of sodium citrate than to hypotonic solutions, and offers as explanation the fact that as the semen ages, lactic acid increases, re-

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sulting in an increase in osmotic pressure which is likely counteracted by a hypotonic solution but only aggravates an already incompatible condition in a hypertonic solution.

In view of the limited information on the effect of varying osmotic pressure on bovine spermatozoa, an investigation of some of the effects of hypertonic and hypotonic solutions on spermatozoa livability and morphology was made. The objectives were: (a) to determine the effect of hypertonic and hypotonic solutions on the spermatozoa cell membrane, head shape, and dimensions; (b) the effects of solutions of varying osmotic pressure on livability of spermatozoa in storage; (c) a comparison of the freezing point depressions of various semen diluents now in use; and (d) to determine if the addition of 300 mg. per cent of sulfanilamide to egg yolk-citrate would markedly increase the livability of spermatozoa under storage conditions.

EXPERIMENTAL

The freezing point depression of semen and the various diluents was measured by means of a standard cryoscope which depended upon the evaporation of ether for cooling. A calibrated thermometer measuring temperatures in 0.01° C. was used for all recordings. The apparatus was standardized using varying levels of C. P. sucrose solutions, distilled water and milk. The freezing point of milk was assumed to be -0.55° C. The necessary correction factors were applied in computing all freezing point depressions.

Twenty-two semen samples obtained from five sires in the Missouri Station dairy herd were used in this study. Two ejaculates from each sire were pooled in order to have sufficient volume for measurement of the freezing point depression. The sodium citrate concentrations used in the various diluting solutions are presented in table 1. Isotonic and 12.5 to 100 per cent hypo- and hypertonic diluting solutions were studied.

The livability of spermatozoa in the various strength solutions under storage conditions at 40° F. was measured by microscopic examination. Motility ratings were made immediately after dilution and then at 24-hr. intervals. The samples were retained as long as 20 per cent of the spermatozoa remained progressively motile. This is the lower limit of a "2" motility as suggested by Herman and Swanson (5). All motility ratings were made in intervals of five percentage units.

The morphology of spermatozoa in different strength solutions was studied by use of stained slides. Rose Bengal was used as a stain, according to the method of Herman and Swanson (5). Photomicrographs of the stained spermatozoa were made at a magnification of $430 \times$. The ocular in the camera contained a micrometer divided into squares with a calibration of 0.1×0.1 mm. Slides $3'' \times 4''$ for use in a projection lantern were made from the photomicrographs of spermatozoa in iso-, hypo- and hypertonic solutions. Measurements for spermatozoan head size were made by projecting the slides on a screen at a fixed distance. The micrometer squares when projected on the screen were $50'' \times 50''$, therefore 1 in. on the screen was equal to 2 μ on the slide.

Diluent	$Na_3C_8H_5O_7\cdot 2H_2O$	Egg yolk	F.P. Δ	pH	Livability spermatozoa ^e	S.D.
	$(per 100 ml. H_2O)$	(<i>ml.</i>)	(°C.)		(Mean hr.)	(hr.)
1a	6.2	100	-0.93	6.78	10.9	36
2 ^b	6.2		-1.05	7.37	0.0	
3	5.425	100	-0.85	6.77	38.7	51
4	5.425		-0.94	7.36	0.0	
5	4.65	100	-0.74	6.74	95.5	81
6	4.65		-0.84	7.38	1.1	
7	3.875	100	-0.67	6.71	131.1	68.5
8	3.875		- 0.69	7.46	9.8	
9	3.488	100	-0.61	6.69	149.5	68.3
10	3.488		-0.61	7.43	13.1	
11	3.1	100	-0.59	6.76	163.6	62
12	3.1		-0.57	7.42	18.5	
13	2.713	100	-0.47	6.72	177.8	67
14	2.713		-0.48	7.46	10.1	
15	2.325	100	-0.44	6.75	173.7	69
16	2.325		-0.44	7.47	20.7	
17	1.55	100	- 0.33	6.67	188.5	58
18	1.55		-0.29	7.50	9.3	66
19	0.78	100	-0.22	6.53	162.5	73.5
20	0.78		-0.19	7.50	0.0	
EYC					176.4	63.6
EYC SAd	· · · · · · · · · · · · · · · · · · ·				190.9	82.7

TABLE 1

Make-up of diluents, freezing point depressions, pH and livability of spermatozoa

^a Odd numbers = Na citrate + equal amount of egg yolk.

^b Even numbers = Na citrate buffer only.

• EYC = egg yolk citrate.

^d EYC SA = egg yolk citrate + 300 mg% sulfanilamide. • Necessary difference for significance at 5% level = 29.7 hr.

RESULTS

Data on the mean number of hours each diluent maintained a minimum of 20 per cent motile spermatozoa during storage at 40° F. are presented in table 1. The protective or favorable influence of egg yolk in prolonging livability of spermatozoa in solutions varying considerably from isotonicity is quite apparent.



FIG. 1. The effect of hypertonic and hypotonic solutions on livability of spermatozoa stored at 40° F.

and is illustrated in figure 1. An analysis of variance was made on the egg yolkcitrate samples that were stored sufficiently long for comparisons to be made. This analysis is presented in table 2.

Source	D/F	Variance	Mean sq.
Total	219	1,216,221	2
Diluents	9	745.701	82.855*
Ejaculates	21	166.450	7,926
Remainder	189	304.070	161

 TABLE 2

 Analysis of variance between diluents and ejaculates

* Significant (P<.05) necessary difference 29.7 hr.

An analysis was made of the percentages of progressively motile spermatozoa at intervals during the first 7 days of storage. These averages are given in table 3.

TABLE	3
-------	---

Average per cent live spermatozoa during storage for each motility rating period above 20 per cent motile

CI+					% live s	permato	zoa in d	liluent n	.0.		
51	orage -	5 ª	7	9	. 11	13	15	17	19	EYC	EYCSA
(hr.)										
	1	27	40	50	- 56	56	53	54	37	55	51
	24	24	35	45	50	50	46	50	36	49	42
	48	20	25	32	41	43	41	43	32	43	34
	72		19	23	33	36	33	37	24	36	28
	96			20	28	28	28	33 .	22	31	23
. 3	120				24	25	24	27 .	18	25	19
	144				19	20	19	. 22	10	19	10
2	168							18		10	

^a Diluent no. as given in table 1.

The spermatozoan head dimensions in the different solutions, as measured by projection on a screen, are presented in table 4. There were no measurable

TABLE 4

Spermatozoa head dimensions in hypertonic and hypotonic solutionsa

e e	Freezing point depression		Head width times length	
	(° <i>C</i> .)		(μ)	
	-1.05		4.9×9.7	
	-0.94		5.2×9.7	
	- 0.84	7	5.1×9.8	
	- 0.69		5.1×9.9	
	- 0.61		5.2×10.0	
	- 0.57	· · · · ·	5.2×10.2	
	- 0.48		5.0×10.1	
	-0.44		5.2×10.0	
	- 0.29		5.1×10.1	
	- 0.19		5.4×10.3	

* Average spermatozoa head dimensions = $5.1 \times 10.0 \mu$.

changes in the head dimensions of spermatozoa in the hypertonic and hypotonic solutions studied.

Pictures of a field of spermatozoa in each of the hypertonic and hypotonic solutions are presented in figures 2 and 3. Abnormalities in spermatozoan morphology seem to occur only in the stronger hypertonic and the stronger hypotonic solutions, and are characteristically coiled tails.



FIG. 2. Photomicrographs of spermatozoa in isotonic and hypertonic solutions. A—Freezing point -0.57° C. (Isotonic); B—Freezing point -0.61° C.; C—Freezing point -0.94° C.; D—Freezing point -0.104° C.

DISCUSSION

There is a gradual decline in motility of spermatozoa stored at 40° F. in solutions with increasing hypertonicity, reaching the low of 10.9 hr. in the strongest (100 per cent) hypertonic solution used. This solution has a freezing point depression of -1.05° C. From the data presented in table 1, it would seem that

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a freezing point depression of -0.69° C. would be the uppermost limit in formulating diluters. This conclusion is in agreement with the work of other investigators (1, 3, 7) who found that the freezing point depression of bull semen ranged from -0.54 to -0.73° C.

The effect of hypotonic solutions, as used in this study, on spermatozoan livability are in striking contrast to the results with hypertonic solutions. The liva-



FIG. 3. Photomicrographs of spermatozoa in hypotonic solutions. A—Freezing point -0.19° C.; B—Freezing point -0.29° C.; C—Freezing point -0.44° C.; D—Freezing point -0.48° C.

bility of spermatozoa in the weakest hypotonic solution used (freezing point depression -0.19° C.) was comparable to that obtained in the isotonic solutions with a freezing point depression of -0.57° C. The distribution of the egg yolk in hypotonic solutions with freezing point depressions of -0.19 to -0.29° C. seemed to be more even than in stronger sodium citrate solutions and may be a

factor in preserving longer livability. In the 3 per cent sodium citrate-egg yolk solution as well as all other hyper- and hypotonic solutions, except the two mentioned above, there was a tendency for the egg yolk components to settle out.

Disregarding the two weakest hypotonic solutions discussed above, it would appear that diluents with freezing points ranging from -0.44 to -0.61° C. would be optimal for spermatozoa survival, since there is no significant difference in any of the diluents studied within this range. In terms of buffer solutions used for artificial insemination this would require 2.3 to 3.5 per cent sodium citrate dihydrate per 100 ml.

Since there were no differences observable in the head size of spermatozoa in the hypertonic and hypotonic solutions, the conclusion that bovine spermatozoa have a very low permeability for salts must be drawn. Abnormalities consisting of a low percentage of coiled tails were observed in the stronger hypertonic and the weaker hypotonic solutions, but in these cases the head dimensions of the spermatozoa were not affected in measureable amounts.

Anderson (2) reported the dimensions of the average bull spermatozoa head to be 5μ long and 2μ wide. Savage and Williams (6), in studying the head length variability of bovine spermatozoa and its application to the determination of fertility, found the mean head length to range from 9.4 to 9.6 μ . In this study the average spermatozoa head dimension was found to be $5.1 \times 10 \mu$ and agrees closely with the results obtained by Savage and Williams (6) in their study of fertility.

SUMMARY

1. A study was made of the effects of several hypertonic and hypotonic solutions on livability and morphology of spermatozoa. The freezing point depressions ranged from -0.19° to -1.05° C.

2. The optimum range for spermatozoa survival was -0.44 to -0.61° C. in terms of freezing point depressions or 2.3 to 3.5 per cent in terms of sodium citrate dihydrate concentration.

3. There appeared to be little difference in the spermatozoa head dimensions in the various hypertonic and hypotonic solutions. Coiled tails were observed in the two strongest hypotonic solutions and in the strongest hypertonic solution.

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THE COMPARATIVE VALUE OF LADINO CLOVER, BIRDSFOOT TREFOIL, TIMOTHY AND ALFALFA HAYS FOR YIELD AND QUALITY OF MILK

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For several years experiments have been in progress at Cornell University to obtain more complete data on the value for milk production of certain hay crops, adapted to the northeastern United States. As a part of this program, studies were made during the winters of 1947-48 and 1948-49 to compare birdsfoot trefoil (*Lotus corniculatus*) and ladino clover hay with timothy and alfalfa hay harvested at two stages of maturity. While birdsfoot trefoil and ladino clover are used most commonly as pasture plants in mixtures with the grasses, it sometimes is desirable to harvest them as hay or hay-crop silage. It appeared desirable to learn more about the value of hay made from ladino clover and birdsfoot trefoil. Timothy and alfalfa hay also were studied for comparative purposes.

EXPERIMENT I

The early-cut timothy hay was mowed on June 16 and 21, 1947, before the plants had headed out. The late-cut timothy was harvested on August 7, 1947, when the seeds were becoming hard. The early-cut timothy hay yielded 3,498 lb. and the late-cut 4,078 lb. of dry matter per acre. Yield data were not obtained for the other hays. The early-cut timothy was no. 1 and the late-cut, no. 3. The legume hays used were second cutting. This was selected because it was possible to obtain a stand freer from weeds and grasses than with first cutting. Alfalfa was made at two stages of maturity as with timothy. The early cutting was made when the first blossoms appeared and the late stage was past full bloom with some seed pods present. Both hays were fine-stemmed, leafy and bright in color and were graded as no. 1 leafy alfalfa. The ladino clover was cut in July before blossoms had appeared. The birdsfoot trefoil was cut during September and October when the forage was in the pre-bloom stage and approximately 10 in. high.

After a period of wilting in the sun, the hays were picked up with a field chopper, cut into approximately 4-in. lengths and blown into racks which were connected to a drier in such a manner that heated air could be blown through the chopped hay. Artificial drying was used to prevent curing variables owing to weather damage. During the curing process some molding was encountered in the ladino clover hay because the green material packed together so that it was difficult to force the heated air through it. These molded spots were sorted

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out before the hay was fed, but it is likely that the spoilage reduced somewhat the carotene content of the hay. The chemical composition of the hays used is shown in table 1.

		* 8					
Type of hay	Moisture	Protein	Fat	Fiber	N.F.E.	\mathbf{Ash}	Carotene
	(%)	(%)	(%)	(%)	(%)	(%)	(mg./lb.)
Experiment I							
Alfalfa, early-cut	9.9	17.6	1.7	30.2	33.5	7.0	33.7
Alfalfa, late-cut	7.8	14.0	1.9	30.6	39.0	6.7	34.0
Birdsfoot 'trefoil	9.5	13.1	2.1	28.4	41.0	6.0	33.0
Ladino clover	11.6	21.4	1.4	18.6	36.8	10.4	16.2
Timothy, early-cut	9.2	9.3	2.0	31.9	41.0	6.7	22.0
Timothy late-cut	10.0	4.9	1.3	37.9	40.8	5.2	2.3
Experiment II	2010						
Alfalfa	7.5	12.3	2.2	26.3	45.5	6.1	55.4
Birdsfoot trefoil	7.9	16.8	2.2	25.7	41.0	6.4	54.0
Ladino clover	7.6	17.7	2.3	24.8	39.8	7.8	81.3
Timothy	7.0	6.0	1.7	35.7	46.3	3.3	11.8

TABLE 1The chemical composition of the hays

The Holstein cows used in the study were removed from pasture and allowed a 1-wk. adjustment period before they were placed upon the experiment. The grain mixture fed was adjusted at the start of each period to the rate of 1 lb. for each 5 lb. of 4 per cent fat-corrected milk (FCM). Hay was fed three times daily in liberal amounts so that each cow refused 1 to 3 lb. per day. Corn silage was fed at a constant rate of 1.5 lb. for each 100 lb. of bodyweight. Records were kept of the feed allowed and refused. The milk production was recorded at each milking and an aliquot sample taken of four milkings each week for fat test by the Babcock method. At the end of each experimental period, samples of milk were obtained for tests on flavor, stability and vitamin content.

Fifteen cows were used in the lactation experiment. The plan of study involved an incomplete block design³ set up with four experimental periods of 5 wk. each. In the plan of the experiment, ten observations were to be made on each of the six types of experimental hay. However, the quantity of ladino clover was insufficient to complete the study and this hay was not fed during the fourth experimental period.

RESULTS

The average daily intake of the various hays, the actual and adjusted production of 4 per cent FCM and the gain or loss of body weight are shown in table 2.

From these data it is clear that the late-cut timothy was appreciably less palatable than were the other hays, since only 11 lb. were consumed per day, as compared with 24 to 28 lb. of the other types of hay. In every case, when a cow was shifted from another type of hay to late-cut timothy, her intake immediately fell and she declined in milk production very rapidly, so that within 3 wk. the

³ For the design see Statistical Tables for Biological, Agricultural, and Medical Research, R. A. Fischer and F. Yates. Oliver and Boyd, Ltd., London. Pp. 14 and 57. 1943. daily FCM yield was only approximately 70 per cent of the initial production even though her grain and silage allowances were kept constant. No such declines in the intake of hay or in milk production were observed in changing among the other types of hay. The effect upon production clearly is evident from the average data (table 2), appreciably less FCM being produced on latecut timothy than on any other hay. Furthermore, the cows uniformly lost weight when late-cut timothy was fed, whereas, in almost every instance, they maintained their weight or gained when the other hays were fed. As an average, the cows lost 2.07 lb. in weight each day on late-cut timothy whereas they gained from 0.68 to 0.90 lb. per day on the other types of hay.

Part of the difference in milk yield can be accounted for by the fact that the cows used differed in initial production and in the rate of decline with advancing lactation. The experimental design makes it possible to adjust for these differences. When the adjustments are made, a more accurate estimate is obtained of the comparative value of the hays for milk production. Such an estimate is presented in the last column of table 2.

The	average daily	hay	intakes, produc	tion of the cows	4% fat-co (expt. I)	rrected	milk and	change in	, weight of
Type of hay		Av. wt.	Avera	ge daily i	ntake	Gain in	TOM	Adjusted	
	2	of cows	Hay	Silage	Grain	wt.	LOW	FCM	
			(1b.)				(1b.)	(1b.)	(1b.)

18.1

15.6

16.9

17.1

16.9

17.2

8.7

7.1

7.2

8.7

8.0

7.6

0.73

0.89

0.68

0.73

0.90

-2.07

34.3

33.2

33.9

39.0

34.0

24.8

25.1

28.1

27.1

24.5

23.7

11.2

1305

1179

1145

1244

36.0

28.1

33.6

34.2

32.7

24.2

TABLE 2

a 4% fat-corrected milk.

Alfalfa, early-cut ..

Alfalfa, late-cut .

Birdsfoot trefoil

Ladino clover

These data still overestimate the value of the late-cut timothy hay for milk production, since the cows lost body weight on this hay and undoubtedly converted body energy into milk. In order to evaluate the importance of this change in weight, an estimate was made of the productive T.D.N. value of the hay by allowing for the maintenance requirements of the cows, for the changes in weight which occurred during the experiment, for the actual milk secreted and for the other feeds consumed. In making this estimate, it was assumed that 8 lb. of T.D.N. were required for the maintenance of a 1,000-lb. cow. T.D.N. values of 75 per cent for grain and 19 per cent for silage were used in all comparisons. It was assumed that 0.32 lb. of T.D.N. were required for each pound of FCM produced, that each pound gain in body weight required 3.53 lb. of T.D.N. and that each pound of body weight lost was equivalent to 2.73 lb. (Knott *et al.*, 1). The estimated productive T.D.N. value of the hays, based on these data, are shown in the last column of table 3. Also there are presented in table 3 the average digestion coefficients and the T.D.N. (total digestible nu-

		Diges	tion coeffi	Total	Productive		
Type of hay	Dry matter	Crude protein	Ether extract	Crude fiber	N.F.E.	digestible nutrients	T.D.N. of the hays ^b
R.	(%)	(%)	(%)	(%)	(%)	(lb./100 lb.)	(lb./100 lb.)
Experiment I	(1-)	()-)	(
Alfalfa. early-cut	62.1	68.2	20.0	60.7	64.5	52.7	53.3°
Birdsfoot trefoil	64.3	68.5	31.7	54.1	72.0	54.7	48.6
Ladino clover	73.1	78.8	15.8	65.3	77.1	57.9	60.4
Timothy, early-cut	65.0	61.4	41.6	65.6	67.1	55.9	59.1
Timothy, late-cut	45.6	24.4	23.0	45.3	49.7	39.2	11.6
Experiment II							10.0
Birdsfoot trefoil	64.8	75.6	31.8	55.7	72.0	59.0	49.0
Ladino clover	70.0	74.2	37.2	65.2	76.8	61.8	43.5

TABLE 3 The average digestibility and total digestible nutrient value of the haysa

^a Four animals were used with each type of hay.

^b Estimated from the lactation study.
^c Late-cut alfalfa showed a value of 52.0 for T.D.N.

trients) for the different hays as determined with yearling wethers. Four wethers were fed each hay in turn as the only feed in a digestion study. Sheep were used because insufficient hay was available for the use of dairy animals after completion of the lactation study. Unfortunately, the late-cut alfalfa was used completely in the lactation study and its digestibility was not obtained.

Ladino clover hav showed higher digestion coefficients (table 3) than any of the other hays for dry matter, protein and nitrogen-free extract, and it was highest in T.D.N. by both measures used. All nutrients in the late-cut timothy hay, except ether extract, were decidedly less digestible than in the other hays; the T.D.N. value also was inferior.

Samples of hay were taken at each period in the lactation study for carotene analyses. The average values obtained are shown in table 1. The carotene, vitamin A and total tocopherol content of the milk fat samples taken at the end of each experimental period are shown in table 4. From these data it is clear

	Milk fat	Samples showing		
Type of hay	Carotene	Vit. A	Tocopherols	oxidized flavor
				(%)
Alfalfa early-cut	4.9	5.6	23.7	0
Alfalfa, late-cut	6.4	6.0	23.8	0
Birdsfoot trefoil	7.4	7.0	28.3	0
Ladino clover	4.3	4.1	17.7	57
Timothy, early-cut	4.7	5.2	22.0	0
Timothy, late-cut	2.6	4.7	19.0	0

TABLE 4 The vitamin content and the stability of the milk. (expt. I)

that the late-cut timothy contained less carotene than any of the other hays and that ladino clover was next to the lowest. In general, the carotene and vitamin A content of the milk tended to follow the order of the carotene content of the

hay samples except for ladino clover. Also, the milk produced during the ladino clover periods was significantly lower in tocopherol content than when the other hays were fed. Tests made for flavor and stability showed that off-flavor milk occurred only during periods when ladino clover hay was fed. The oxidized flavor in the milk appears to be correlated with the lower tocopherol content (Whiting *et al.*, 3; Krukovsky *et al.*, 2), suggesting that the content of this vitamin in the ration may be related to the stability of milk. Milk produced on birdsfoot trefoil was highest in carotene, vitamin A and tocopherol content and it had excellent keeping qualities.

It appeared possible that changes during the curing of ladino clover which resulted in the development of slight molding may be related to the low carotene content of the hay and the low vitamin content of the milk when this hay was fed. In experiment II, special attention was given to curing the ladino clover and to testing the vitamin content and stability of the milk.

	U. S.	Botanical	Crean calar
Designation of hay	Grade of hay	compositiona	Green color
		а ж	(%)
Alfalfab	A. no. 1 grass hay	32% legumes	64
First cutting	B. no. 3 mixed hay	59% grasses 9% weeds	29
Birdsfoot trefoil First cutting	Not under U. S. standards	47% legumes 52% grasses 1% weeds	52
Ladino clover Second cutting	U. S. no. 1 extra green mixed hay	70% legumes 20% grasses 10% weeds	63
Timothy First cutting	U. S. no. 1 timothy light grass mixed	(Not sorted)	49

TABLE	5
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The U.S. grade, botanical composition and green color index of the hays

^a Based on weighed separations made at the time of cutting.

^b Approximately $\frac{1}{3}$ of the alfalfa had browned slightly during curing and green and brown samples were graded separately.

EXPERIMENT II

Four types of hay were compared in the second study during the fall and winter of 1948-49. These included alfalfa, timothy, birdsfoot trefoil and ladino clover. Only one stage of maturity was available because of a shortage of material, and all of the legumes were heavily mixed with grasses (table 5), although they had been planted as pure stands for this experiment only 2 yr. before. The timothy hay was cut in the bloom stage and field-cured. The alfalfa was in early bloom but the grasses in the mixture were not headed out at the time of cutting. The ladino clover and birdsfoot trefoil were cut before bloom, somewhat earlier than generally would be recommended for hay. The U. S. grades, the botanical composition as estimated by sorts at cutting and the green color rating of the hays are shown in table 5.

The amounts of hay produced were less than planned and, as a result, only

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four cows could be used in the lactation study. The 4×4 Latin square design was employed with each period 4 wk. in length. In order to increase the accuracy and control of the test, a group of cows was studied for 6 wk. on pasture before they were started on the hay experiment. From the data collected, four cows were selected which were very uniform in production, stage of lactation and gestation, body size and age, and these cows were allotted at random to the treatments. The feeding and management was similar to the first experiment. The chemical composition of the feeds is shown in table 1. The values shown are averages of samples taken and analyzed during the different periods of the lactation trial. The management of the cows and collection of samples were the same as for experiment I. The data on feed intakes and milk production are shown in table 6.

TA	B	LE	6

The average daily feed intakes, yield of 4% fat-corrected milk and gains in body weight of the cows. (expt. II)

	Aver	age daily	intake	Average	e daily	Productive
Type of hay -	Hay	Grain	Corn silage	Gain in wt.	FCM	T.D.N. of the hays
	(<i>lb.</i>)	(<i>lb.</i>)	(1b.)	(<i>lb.</i>)	(1b.)	(lb./100 lb.)
Alfalfa	37.6	8.0	20.0	0.82	35.9	44.2
Birdsfoot trefoil	34.6	8.0	20.0	0.88	36.4	49.0
Ladino clover	34.7	8.0	20.0	0.35	36.9	43.5
Timothy	31.2	8.0	20.8	-0.28	30.9	35.7

As an average, the same amounts of corn silage and grain were fed with all the hays. Alfalfa was slightly more palatable than the other hays and timothy hay was appreciably less palatable. Approximately equal amounts of milk were produced on the three legume hays, but when timothy hay was fed the cows produced significantly less 4 per cent fat-corrected milk (odds, 99:1). As an average, 3 wk. after the cows were changed from a legume to timothy hay they were producing only 80 per cent as much FCM as they were giving at the start of the period. Furthermore, the cows lost weight on timothy but gained on the other hays. This lowered production on timothy undoubtedly was due to the later stage of maturity of the timothy at harvest, since in experiment I, fully as much milk was produced on early-cut timothy hay as on early-cut legume hay. The estimated productive T.D.N. value of the timothy hay was appreciably less than for the legumes. Digestion studies were made with the birdsfoot trefoil and ladino clover hays using four lambs. The digestion coefficients obtained (table 3) are in close agreement with those from experiment I.

Samples of milk and blood were obtained from the cows each week during the pasture period and also during the hay-feeding experiment. The samples were analyzed for carotene, vitamin A and total tocopherols. The stability of the milk fat was measured during a 7-day storage period with added copper. The vitamin content of the milk fat and the blood plasma and the relative stability of the milk during the last week of each period is summarized in table 7.

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Although the ladino clover was highest in carotene content (table 1), the blood plasma and milk fat were lowest in vitamin A value when ladino clover hay was fed. The tocopherol content of the milk fat and the stability of the milk were lowest on ladino clover and highest on birdsfoot trefoil, in agreement with the data from experiment I. The differences were less marked, however, than in the first test. It appears that the dilution of the legumes with grasses, in comparison with the clear legumes fed in the first study, may explain the smaller relative effects on milk quality, but it is important that the differences persisted in spite of the presence of the grasses. The vitamin content of the milk fat and its relationship to the roughage fed and to the stability of milk is illustrated in fig. 1. In general, the milk showed a striking tendency to develop oxidized flavors during storage when the milk fat contained less than 20_{γ} of tocopherols per gram of fat.

TABLE 7	TA	BI	\mathbf{E}	7
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The carotene, vitamin A and tocopherol content of the blood plasma and milk, and the stability of the milk. (expt. II)

	Blood pla (γ/	sma conce /100 ml.)	ntrations of :	Milk (*	fat concen $\gamma/100 \ g.)$	tration of :	Samples showing
Type of forage	Caro- tene	Vita- min A	Toco- pherol	Caro- tene	Vita- min A	Toco- pherol	oxidized flavor
							(%)
Pasture							
Ladino-orchard							
grass	1,372	22	695	886	1,066	2,934	50
Birdsfoot trefoil-							
blue grass	1,375	56	975	982	1,024	4,225	0
Hay	,				· ·		
Alfalfa	800	70	546	486	733	2,116	40
Birdsfoot trefoil	654	68	466	436	593	2,290	33
Ladino clover	691	56	452	434	434	1,951	100
Timothy	631	64	491	410	652	2,155	50

DISCUSSION

These experiments illustrate the high value for milk production of early-cut, well-cured hay. The excellent quality hays successfully maintained milk yield even when very limited amounts of corn silage and grain mixture were fed. In these tests the hay furnished fully two thirds of the T.D.N. required. By contrast, in earlier studies (4) when late-cut timothy hay was fed, cows failed to maintain normal rates of milk production when the grain-feeding rate was reduced so that the cows had to obtain more than 25 per cent of their T.D.N. requirements from the hay.

The legume hays, alfalfa, ladino clover and birdsfoot trefoil, when cut in early bloom and properly cured, were approximately equal in value for milk production, on the basis of the two studies conducted. Timothy hay cut at heading stage or earlier appeared equal in value to the legumes, but when timothy was cut in bloom or later it was markedly inferior in feeding value.

Both experiments agree with other studies (Krukovsky et al., 5) in showing

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that the type of roughage fed may have a marked effect upon the stability of the milk produced. The results suggest that ladino clover, whether fed as hay or pasture, may predispose the milk to the early development of oxidized flavors. Other types of high quality roughage, especially birdsfoot trefoil, appear to increase the stability of milk. These implications of the influence of roughages on milk quality are very important and warrant further research. Because of the importance of ladino clover as a pasture and silage crop, if further studies confirm these preliminary indications that ladino may influence milk quality adversely, means should be sought to overcome the defect by selecting improved varieties, growing plant mixtures or feeding richer sources of tocopherols.



FIG. 1. Illustration of trends in total tocopherols, carotene and total vitamin A in the milk fat in the milk of a cow fed successively, birdsfoot trefoil pasture, ladino clover hay, birdsfoot trefoil hay, timothy hay and alfalfa hay. All cows showed similar responses. The minus (-) and plus (+) signs indicate absence or presence and intensity of oxidized flavors in milk.

SUMMARY

Two experiments are reported on the value of different hays for milk production. In the first study, 15 Holstein cows were fed six types of hay in an incomplete block design experiment involving four periods of 5 wk. each. The hays studied included early-cut timothy, late-cut timothy, second crop alfalfa cut at early and late stages of maturity, birdsfoot trefoil (*Lotus corniculatus*) and ladino clover. Measurements were made of the palatability of the hays and of their effects upon milk production, and on the carotene, vitamin A and tocopherol contents and stability of the milk.

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The legume hays and early-cut timothy were approximately equal in value, but the late-cut timothy proved much less palatable and resulted in lower milk production than any of the other hays. On *ad lib*. feeding the average intake of late-cut timothy was only 35 to 44 per cent as much as of the other hays and the actual milk production was approximately 25 per cent lower.

Milk of poor keeping qualities resulted during ladino clover feeding and appeared to be correlated with a low content of tocopherol in the milk fat.

A second study with similar hays using four cows in a 4×4 Latin square design gave data in good agreement with the first test.

ACKNOWLEDGMENT

The assistance of Frank Whiting in making the tocopherol analyses of blood plasma and milk samples is gratefully acknowledged.

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IN VITRO STUDIES ON THE CONVERSION OF CAROTENE TO VITAMIN A IN DAIRY CALVES¹

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The fact that certain carotenoids are the mother substances of vitamin A synthesized in animals is well known. However, limited knowledge exists concerning the mechanism of the conversion of carotenoids to vitamin A, particularly as it affects the site of conversion in the organism.

The early experiments of Moore (14), since amply confirmed by numerous investigators, clearly established the appearance of vitamin A in the liver of rats following oral administration of carotene. It generally has been assumed that an enzyme "carotenase," in the liver, is responsible in effecting the conversion of carotenoids to vitamin A, but direct experimental evidence of a satisfactory character has not been fully advanced to substantiate this hypothesis.

The site of conversion of carotene to vitamin A in the rat was reported to be the liver by Olcott and McCann (15) on the basis of *in vitro* experiments. Sexton (18), Rea and Drummond (17) and Ahmad (1) were unable to confirm the work of Olcott and McCann. Negative results were reported on *in vitro* experiments using shark liver by Euler and Euler (5), on cat liver by Drummond and McWalter (3), Ahmad (1) and Rea and Drummond (17). Parienti and Ralli (16) obtained one positive test out of four on dog livers, while Euler and Klussman (6) reported positive conversion of carotene to vitamin A when cow liver was incubated *in vitro* with a carotene solution. Wilson *et al.* (21) reported positive results on rabbit liver. More recently, Glover *et al.* (7), Mattson *et al.* (12), Wiese *et al.* (20), McCord and Clausen (13) and Krause and Pierce (11) have presented evidence demonstrating that the transformation of carotene to vitamin A in the rat occurs in the small intestine.

Goodwin and Gregory (8) have presented evidence that the conversion of carotene to vitamin A occurs in the intestine in the case of sheep, goats and rabbits. Klosterman *et al.* (10) suggest that carotene is converted to vitamin A during digestion and/or absorption in sheep. Swick *et al.* (19) have shown that carotene is converted to vitamin A in the intestinal wall of the pig.

Elliott (4) recently has reported an increase in the vitamin A value of the blood plasma of the intestinal wall and jugular circulation following the ingestion of carotene by dairy calves. He reported no rise in the vitamin A content of the blood plasma of the calf following intravenous injections of high-carotene cow plasma but reported that the vitamin A content of the liver increased following such injections.

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This investigation was undertaken in the hope that further information might be obtained regarding the site of conversion of carotenoids to vitamin A in dairy calves. It was decided that this conversion might be demonstrated more effectively *in vitro*. In the intact animal, it is assumed vitamin A would be removed about as quickly as formed, especially in the case of synthesis in the intestinal mucosa.

METHODS

The calves used in this experiment were males of the Holstein-Friesian, Guernsey and Jersey breeds dropped in the Missouri Station herd. The calves were allowed to remain with the dam for 3 to 4 days and were permitted colostrum feeding as usual. At 4 days of age they were removed from the dam and received mixed herd milk (butterfat content 3.9 to 4 per cent) until 3 to 4 wk. of age. At 2 wk. of age the calves were given free access to a "calf starter ration" low in carotene content and made up of: 400 lb. white corn, 300 lb. ground oats, 300 lb. wheat bran, 100 lb. linseed oil meal, 60 lb. non-fat dry milk solids, 20 lb. soluble blood flour and 1 lb. irradiated yeast.

Straw containing 1.87γ of carotene per g. (dry basis) was fed ad *libitum* as the sole source of roughage. The animals were bedded with wood shavings in individual stalls, except for a brief period each day when they were allowed to exercise in a dry lot.

The calves were slaughtered when blood plasma vitamin A values reached lowered levels ranging from 5.16 to 14.5γ per 100 ml. plasma. Care was exercised to prevent the animals being depleted of vitamin A to the point that deficiency symptoms occurred.

The age of slaughter and time required for depletion are shown in table 1.

		experime	nts	
No. of animal	Breed	Age when killed	No. of days in depletion period	Blood plasma vitamin A
		(<i>d</i> .)		$(\gamma/100 \ ml)$
200	Guernsey	156	38	6.49
130	Holstein	127	97	7.89
489	Guernsey	135	105	5.92
528	Jersey	156	126	9.07
504	Jersey	150	120	7.77
509	Jersey	116	86	5.16
119	Holstein	121	91	14.50
495	Guernsey	153	123	11.63

TABLE 1

The age and the time required for depletion of vitamin A reserves of calves used in in vitro experiments

The animals were stunned by a blow on the head and the left carotid artery was severed to permit hemorrhage. The small intestine was removed immediately, ligated at both ends and placed in Ringer-Locke solution² having a temperature of 38° C. Likewise, the liver was removed and placed in Ringer-Locke solution having a temperature of 38° C.

² The Ringer-Locke solution employed had the following composition: NaCl, 0.9%; KCl, 0.042%; CaCl₂, 0.024%; NaHCO₃, 0.05%; MgCl₂, 0.02%; and glucose, 0.05%.

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The contents of the small intestine were flushed out three times with warm 0.9 per cent saline solution and the washings discarded. Two 3-ft. sections then were taken from the mid-portion of the small intestine. A small amount of intestine was removed at the juncture of the two sections immediately after slaughter for analysis of carotene and vitamin A.

To one portion, 250 ml. of a colloidal carotene solution³ were added and both ends ligated. This section was placed in a container of Ringer-Locke solution. The colloidal carotene solution was prepared by dissolving the carotene in acetone. The resulting solution then was mixed with water and the acetone evaporated under a vacuum.

The mixture containing the carotene was stabilized by adding 1 g. of Tween 80^4 to each 5 ml. of solution. The carotene concentration of the solution was varied. The levels used in each experiment are shown in table 2. Ringer-Locke solution was placed inside the other section of intestine and it too was placed in a container of Ringer-Locke solution after having been ligated. The containers into which the two sections had been deposited were placed in a glass chamber in an atmosphere of nitrogen. They were incubated for 3 hr. at 38° C. In some cases, a third section of intestine containing the carotene solution was incubated for 8 hr. at 38° C., together with the corresponding section containing no carotene, which served as a control.

After incubation, the sections of intestine were removed from the chamber, the contents flushed out three times with 0.9 per cent saline and the washings analyzed for vitamin A. The intestines were minced in a food chopper and an aliquot taken for analysis. The intestinal wall was analyzed for carotene and vitamin A by the method of Davies (2) for liver, using the Carr-Price reaction for the determination of vitamin A.

The liver was finely ground by means of an ordinary food chopper. To 150 g. of minced liver, 100 ml. of a colloidal carotene solution and 250 ml. of a buffer solution⁵ were added. The concentration of the carotene solution used was varied. Concentrations for each experiment are given in table 2. This sample was incubated for 24 hr. at 38° C. A control sample composed of 150 g. of liver, 100 ml. of distilled water and 250 ml. of the buffer solution was incubated under the same conditions. This is essentially the same procedure outlined by Euler and Klussman (6). A sample of minced liver was analyzed for carotene and vitamin A immediately after slaughter. These samples were analyzed for carotenoid and vitamin A by the method of Davies (2).

Samples of blood plasma were incubated with a colloidal carotene solution for 24 hr. at 37° C. A control sample containing no carotene was incubated

³ The crystalline carotene used in this experiment was furnished by Valley Vitamins Inc., McAllen, Texas.

4 "Tween" 80 was obtained from the Atlas Powder Co., Wilmington, Delaware.

⁵ The buffer solution was made up as follows: 39.5 ml. of 0.2 N NaOH, 50 ml. of 0.2 M acid potassium phosphate and this made up to 200 ml. with distilled H₂O. The pH of this solution was 7.4.

		The in	vitro conver	sion of carote	ene to vitamin	A in the i	ntestinal w	all of the a	Jairy calf	
Calf	Breed	Int (non-in	cestine icubated)	Intestine as co	: incubated	Intestine i 3 hr. with	ncubated carotene	Intesti 8 hr. w	ne incubated ith carotene	Concentration of carotene
-01		Carotene	Vitamin A	Carotene	Vitamin A	Carotene	Vitamin A	Carotene	e Vitamin A	solution
200 528 504 119 495	Guernsey Guernsey Jersey Jersey Jersey Holstein Guernsey	$\begin{array}{c} (\gamma/100 \ g.\\ 23.54\\ 154.65\\ 103.50\\ 68.77\\ 63.20 \end{array}$) (γ/ <i>100 g.</i>) 16.16 40.05 17.30 21.30 9.73	$(\gamma/100 g.)$ 62.28a 25.94a 126.50a 46.00b 59.50b 55.88b	$(\gamma/100 g.)$ 11.05 5.80 28.29 28.0 12.6	$\begin{array}{c} (\gamma/100\ g.)\\ 522.00\\ 848.40\\ 390.10\\ 228.3\\ 1,108.0\end{array}$	$\begin{array}{c} (\gamma/100\ g.)\\ 7.26\\ 20.50\\ 41.75\\ 39.00\\ 45.60\\ 114.20\end{array}$	$(\gamma/100 g)$ 345.0 615.0 318.9	.) (γ/100 g.)	(1/ml.) 226.8 226.8 226.8 226.8 780.0 780.0 780.0 780.0
а Ца	ncubated 4 hr ncubated 8 hr					•	c u			ž.,
	2			e. C						
					TABLE	3				
			The in vit	ro conversion	of carotene to	vitamin A	by minced l	liver tissue		
Calf no.	Bree	P	Liver (uni	ncubated)	Liver as	incubated control	I	liver incubs with car	tted 24 hr. otene	Concentration of carotene
,			Carotene	Vitamin A	Carotene	Vitamin	A C	arotene	Vitamin A	solution
200 130	Guerns Holste	sey in	$(\gamma/150 g.)$ 374.76 616.50	$(\gamma/150 g.)$ 77.70 186.60	$(\gamma/150 g.)$) $(\gamma/150 t$	7.) (γ 4 4	/ <i>150 g.</i>) 6,903.0 6.962.0	$(\gamma/150~g.)$ 638.75 641.35	$(\gamma/ml.)$ 560.00 560.00
489	Guerns	sey	623.25	211.50	550.40	232.47	ιΩ –	0,040.0 8 200	1,145.40	560.00 996 80
504	Jersey		131.25	156.30	63.35	61.48		8,920	296.70	127.60
509 119	Jersey Holste	'n	348.45 302.5	464.55 266.25	306.75 268.0	357.08		9,512.5 8,680	1,195.43 416.76	127.60 127.60
495	Guerns	sey	478.5	483.90	246.95	190.44		8,762.5	560.62	127.60

TABLE 2

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under identical conditions. The carotene and vitamin A content of the blood plasma samples was determined by the method of Kimble (9).

RESULTS

The results of the incubation of the small intestine of dairy calves with a carotene solution are shown in table 2. Negative results were obtained with the intestine of calf 200 which was incubated for only 3 hr. In all other cases, there was an increase in the vitamin A content of the intestinal wall incubated with carotene above that present in the nonincubated intestine and above that present in control samples. There was no vitamin A in the material washed out of the intestine.

It is felt that the results here do not necessarily represent the rates of absorption and conversion as present in the intact animal, since the carotene is present in a different carrier. However, in spite of the difference in physiological conditions existing between *in vivo* and *in vitro* methods, it is believed that conversion of carotene to vitamin A by the intestine is clearly indicated.

In all cases, there was a conversion of carotene to vitamin A when livers from depleted calves were incubated with a carotene solution (table 3). The fact that conversion in Guernseys appeared to be equal to or in some cases higher than Jerseys and Holsteins is unexplained. It generally is believed that the conversion of carotene to vitamin A in Guernseys is less efficient in the living animal than is the case with some of the other dairy breeds. It should be emphasized that since *in vitro* experiments were carried out caution is necessary in the application of these results to the living organism.

In no case was carotene converted to vitamin A by blood plasma. This is in agreement with the results of Elliott (4) and Von Euler and Klussman (6).

SUMMARY

1. Data obtained from the *in vitro* incubation of small intestine of dairy calves with a colloidal carotene solution indicate that the small intestine is a site of conversion of carotene to vitamin A.

2. The incubation of minced liver tissue with a colloidal carotene solution resulted in a conversion of carotene to vitamin A.

3. Conversion of carotene to vitamin A apparently is not a function of blood plasma.

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ASSOCIATION ANNOUNCEMENTS

Forty-Fifth Annual Meeting Cornell University Ithaca, N. Y.

June 20, 21, 22, 1950

REGISTRATION AND HOUSING

Registration and housing headquarters will be in Willard Straight Hall, Cornell University, Ithaca, New York. Housing facilities will be available in University dormitories. Meals can be obtained at university cafeterias. A return card and a letter giving detailed information relative to advanced registration, housing, transportation and entertainment will be sent to members of the Association early in May.

PROJECTION EQUIPMENT

Lanterns will be available in all lecture rooms for the projection of $34'' \times 4''$ and $2'' \times 2''$ slides. Those wishing other projection equipment should notify their section chairman.

COMMITTEE AND SPECIAL MEETINGS

Those wishing rooms for section committee meetings or special meetings should contact B. L. Harrington, Stocking Hall, Cornell University, Ithaca, New York. Provision can be made for special breakfasts, luncheons or dinners by writing to S. E. Smith, Wing Hall, Cornell University, Ithaca, New York, by June 1.

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ABSTRACTS OF LITERATURE

Prepared in cooperation with the International Association of Ice Cream Manufacturers and the Milk Industry Foundation

BOOK REVIEWS

251. Guide to the Dissection of the Cow. R. E. HABEL, New York State Veterinary College, Ithaca, N. Y.

This booklet should provide an excellent dissection guide for veterinary students, the purpose for which it is intended. Some parts might readily prove of help to others, such as students of dairy husbandry receiving limited instruction in this field. The brief references to the clinical and surgical importance of various tissues are a helpful addition. For instance, in regard to the obturator nerve, mention is made of the possibility of injury during parturition with resultant paralysis of the adductor muscles. Even more such references might have been included to advantage.

The author is to be commended for the evident thought and care that have been expended in the development of this booklet. With its adequately large type, having the names of the various structures underlined when first encountered, being ring-bound and of moderate size, it should facilitate placing increased emphasis on cattle in veterinary anatomy laboratories.

W. D. Pounden

252. Outlines of Food Technology. 2nd ed. HARRY W. VON LOESECKE. 585 p. Reinhold Publishing Corp., 330 W. 42nd St., New York 18, N. Y. \$7.50. 1949.

The revised edition follows quite closely the organization of subject matter presented in the earlier edition published 8 yr. ago. The revision appears to consist essentially of added material, with less emphasis on rewriting of the original discussion. The 15 chapters cover the tin can and glass container, fruits, vegetables, dairy products, meats and poultry, fish products, grain products, fats, oils, sugars and starches, nuts, spices and flavor materials, beverages, confectionary and preserves, freezing and storage and marketing. The author has endeavored to provide a good insight into prevailing practices, and characteristics of products and materials used in the food industries.

He has provided useful information on typical procedures suitable for survey instructional purposes. The section on dairy products is in great need of re-organization and revision in light of proportion, order and obsolescence of material. K. G. Weckel

253. Brucellosis. 2nd ed. H. J. HARRIS. Paul B. Hoeber, Inc., New York 16, N. Y. 617 pp. \$10.00. 1950.

The presentation is largely that of the physician interested in the control of human brucellosis. However, much information on the control of animal reservoirs of the disease is included. The presentation is very complete and very well documented, 742 references, many of them recent publications, being included in the literature cited. A good index is provided.

In addiiton to extensive coverage of symptomology, diagnosis and treatment of human brucellosis, much material on etiology, epidemiology and prophylaxis is presented. The role of milk and milk products in the transmission of the disease is discussed in detail and pasteurization is advocated as the primary basis for control. A holding period of at least 6 mo. for cheese made from raw milk is considered necessary. The blood test for agglutinins is not considered a satisfactory procedure from the public health standpoint because of the possibilities that animals giving titers below those usually considered as positive may be shedders of the Brucella organisms. The role of meats and direct contact in dissemination of the causative organisms also is discussed.

This is a valuable reference book in an area of importance to all in the dairy industry.

F. E. Nelson

254. Food Poisoning, rev. ed. G. M. DACK. University of Chicago Press, Chicago. 179 pages. \$3.75. 1949.

Three of the reasons for the many advanced principles of sanitation technology existing in the

dairy industry are the potential vector properties of milk, the wide spread use of milk as a food by people and its use as an ingredient in many food products. Fortunately, food poisoning is not frequently attributed to the use of dairy products because of the sanitation techniques employed. Nevertheless, sanitarians must understand the potentialities, and not lose sight of the principles incorporated in sanitation practice requirements. The book has been revised from the excellent original issue by incorporation of much information gained during World War II. The subject matter is divided into 8 chapters (involving foods) on chemical poisoning, poisonous plants and animals, botulism, staphylococcus food poisoning, Salmonella, alpha-type streptococci and food poisoning, other bacteria and food poisoning and infections differentiated from food poisoning. The characteristics of the various forms of poisoning are interestingly reviewed, case examples are cited and control measures commented upon. The book is very readable. It is one every handler, processor and supervisor of foods should have since it provides an excellent fund of information on this subject. K. G. Weckel

255. Advances in Agronomy. Vol. 1. A. G. NORMAN, editor. Academic Press, Inc., New York, N. Y. 439 pp. \$7.50. 1949.

This volume, prepared under the auspices of the American Society of Agronomy, inaugurates a new series of annual reviews in a field not covered previously. The subjects covered are: Plant growth in saline and alkali soils, by H. E. Hayward and C. H. Wadleigh; New fertilizers and fertilizer practices, by R. J. Jones and H. T. Rogers; Soybeans, by M. G. Weiss; The clay minerals in soils, by J. E. Gieseking; Alfalfa improvement, by W. J. White; Soil microorganisms and plant roots, by F. E. Clark; Weed control, by A. S. Crafts and W. A. Harvey; Boron in soils and crops, by K. C. Berger; Potato production, by O. Smith; and Fixation of soil phosphorus, by L. A. Dean. Each review is accompanied by a table of contents and apparently adequate subject and author indices for the entire volume are included. Those interested in certain aspects of the feeding of dairy cattle will find much of in-F. E. Nelson terest in this volume.

ANIMAL DISEASES

W. D. POUNDEN, SECTION EDITOR

256. Penicillin-streptomycin bougies in the treatment of acute infectious mastitis. C. S. BRYAN, V. P. LABRANCHE and A. R. DRURY, Mich. State College, East Lansing. North Am. Veterinarian, 31, 1: 20-25. Jan., 1950.

Results of *in vitro* studies showing the influence of penicillin, streptomycin and penicillin plus streptomycin on strains of streptococci and staphylococci originally isolated from cases of infectious mastitis indicate that streptomycin was effective in inhibiting growth of both of the above; penicillin alone was much more effective and produced the same results as the combination of the two antibiotics.

A second part of this paper involved a study of the irritant effects of these antibiotics using both aqueous and bougie administration. Neither penicillin or streptomycin alone nor the combination of the two produced irritation of the udder tissue as indicated by the leucocyte count of the milk.

The penicillin and streptomycin combination was successful in 1 case of experimentally produced coliform mastitis, 18 cases of chronic streptococcic mastitis, and 9 cases of naturally occurring coliform mastitis. R. P. Niedermeier

257. The combined use of the Hotis and microscopic tests for mastitis samples. L. W. VAN DER HUVER, Germiston, S. Africa. J. So. African Vet. Med. Assoc., 20, 1: 16–20. March, 1949.

A comparison between the microscopic and Hotis test for detection of mastitis milk is presented. Negative findings were in agreement in 94.5% of the samples. Of 31 samples which gave questionable microscopic readings, 33% were positive to the Hotis test. The author concludes that the most reliable results can be obtained by using both tests. The Hotis test assists materially in clarifying doubtful microscopic findings.

K. M. Dunn

258. Determinatie van Mastitis-verwekkende Bacterien (Determination of bacteria causing mastitis). (English Summary). C. F. VAN OYEN and G. B. R. WILLEMS, Laboratory for knowledge of human food from animal sources of the State University at Utrecht, Holland. Tydschrift voor Diergeneeskunde, 74, 2: 91–96. 1949.

Authors describe the determination of pathogenic bacteria occurring in milk or udder secretion from cases of acute or chronic mastitis in cows. Methods were based on the work of A. F. van der Scheer (thesis 1941, College of Agriculture, Wageningen, Holland). Pure cultures are cultivated first and then the different bacteria, *Streptococcus agalactiae, dysgalactiae, uberis* or *pyogenes* determined by the way they react on selective media and solutions of different carbohydrates. Selective media were: agar-agar with horse-serum and broth of calfsmeat, meat broth, litmus-milk, gelatin, sodium-hippurate solution, esculin agar, horse blood-agar plate. Carbohydrates were: Saccharose, raffinose, salicin, mannite, sorbite, trehalose, inulin, amygdalin and arbutin; solutions were made in broth containing Difco-meat extract, Difco-neopepton, horse-blood serum and sodium chloride with bromo-cresol-purple as indicator.

There was a good correlation between these bacteriological determinations and clinical observations. A. F. Tamsma

259. Control and eradication of brucellosis in animals. Report No. 1 of the National Research Council, Committee on Public Health Aspects of Brucellosis. W. W. SPINK, L. M. HUTCHINGS, C. K. MINGLE, C. L. LARSON, W. L. BOYD, C. F. JORDAN and ALICE C. EVANS. J. Amer. Med. Assoc., 141, 5: 326–329. Oct. 1, 1949.

This special article is an excellent, concise and complete summary of the best knowledge and opinion on the subject. About 5% of the adult female cattle in the U.S. are affected with brucellosis. This involves at least 1,300,000 dairy and 800,000 beef cows. These are confined to about 20% of the herds. The total annual loss from decreased milk production and veal calves, and replacements of dairy cows approximates \$92,000,000. Between 1 and 3% of swine are infected, based on packing house surveys. Unlike other livestock disease problems, no single plan of control has proved effective under all conditions with brucellosis. Confusion has resulted from the ardent sponsorship of the proponents of different plans. Agreement on basic procedures and nationwide acceptance of these procedures are needed.

Twenty-one fundamental items of knowledge about the disease in general are listed. These are too long to reproduce in abstract form but should be studied carefully by all interested persons. Under a separate discussion of bovine brucellosis, 11 procedures are itemized as recommendations for state legislation, including 4 plans for eradication. Educational policies are also discussed.

Swine brucellosis is discussed separately and 2 plans of control are presented. Control and eradication of brucellosis in other animals probably do not require a nationwide uniform program, so essential in cattle and swine, but it should be recognized that other species may be affected and may transmit the disease to other animals and to man. Since man is infected by exposure to infected animals and animal products, the problems are largely those of the veterinarian.

D. P. Glick

260. A new aid for the control of brucellosis. G. C. VAN DRIMMELEN, Inst. of Onderstepoort, Pretoria, S. Africa. J. So. African Vet. Med. Assoc., 20, 2: 80–88. June, 1949. The author presents a modification of a previous ring test (J.S.A.V.M.A., 19, 2: 130–134. 1948) used for detecting brucellosis-infected milk. The modified test can be read on individual cows and gives a high percentage of accuracy.

The new test not only has the advantage of use on individual cows but can be used to determine whether an animal is responding to the test due to infection reactions or resulting from vaccinal reaction. This is done by degree of color reaction when the antigen is added.

K. M. Dunn

261. Aureomycin therapy in human brucellosis due to Brucella abortus. A. I. BRAUDE, W. H. HALL and W. W. SPINK, Univ. of Minnesota, Minneapolis. J. Amer. Med. Assoc., 141, 12: 831. Nov. 19, 1949.

The treatment of 16 patients from whose blood Br. abortus was isolated by culture is described. All cases required hospitalization. Seven patients had shown symptoms for less than 2 mo. and were considered to have acute infections; symptoms had been present in the remaining patients for more than 4 mo. and these were considered chronic. Ages ranged from 18 mo. to 60 yr.; 14 patients were male and 2 were female. In 6 patients there were either other diseases or complications due to brucellosis. Arthritis of the hip was present in 2 boys. The 18-mo. old infant suffered severe anemia. Seven patients had been treated previously with other drugs, presumably unsuccessfully. Dosages and results are described for each patient and these and other data are presented in tabular form.

Rapid and striking improvement occurred in all cases. There was bacteremia after treatment in only 1 patient and clinical relapse in 2 others. Aureomycin is believed to be superior to other drugs in the treatment of brucellosis.

D. P. Glick

262. Infectious or epizootic infertility of cattle. M. W. HENNING, Inst. of Onderstepoort, Pretoria, S. Africa. J. So. African Vet. Med. Assoc., 20, 1: 9–15. March, 1949.

This is an insidious, infectious disease of the genital organs of the bovine. The female will show a thick, tenacious, muco-purulent discharge from the vagina and in the male there is fibrosis and induration of the epididymis and testis. The etiological agent is not known. However, it is believed to be one of the most serious diseases of breeding stock. The disease can be spread by coitus only. The incubation period is a matter of a few days in the cow, but clinical evidence in the bull may not be manifested for 4 to 10 wk.

There is no sure treatment for this disease.

The cow may fail to show active symptoms after a period of time but it is felt that she is still an active transmitter of the disease. Various antiseptics are being used in irrigating the vagina and uterus. Lugol's iodine, $KMnO_4$ and flavine preparations have been of some value for treatment. None of these have given 100% recovery. The use of artificial insemination seems to be the best method of preventing a spread of the disease. K. M. Dunn

263. Foot and mouth disease problems in southern Africa. GILLES, De Rock Inst. of Onderstepoort, Pretoria, S. Africa. J. So. African Vet. Med. Assoc., 20, 1: 1–8. March, 1949.

The first outbreak of foot and mouth disease in southern Africa occurred in 1931. Since that time there has been a gradual spread of the disease throughout the area. Several measures have been undertaken to combat the disease. Some areas have resorted to the vaccination of all infected and contact herds with virulent virus. These workers obtain 99% infection and in a short period of time all infection was eliminated from the herds naturally and artificially infected. However, the use of the virulent virus will aid in the spread of the disease to non-immune cattle. Other areas have set up a program of isolation of infected cattle by fencing in areas where outbreaks have occurred. This method has not had a great deal of success. Still another program, which has given by far the best success, is the "slaughter-out policy." The author points out that this latter program should be followed wherever possible and if this cannot be accomplished, a program of vaccination with either a vaccine prepared according to the method of Schmidt-Waldmann or the crystal violet vaccine. Vaccination with a virulent virus should not be used.

Several different strains of foot and mouth disease virus have been isolated in various infected areas. This has added to the general confusion of the possible original source of infection for the southern African area. K. M. Dunn

Also see abs. no. 253.

CHEESE

A. C. DAHLBERG, SECTION EDITOR

264. Improved sweet curd cottage cheese. N. G. ANGEVINE, Meyer-Blanke Co., St. Louis, Mo. Milk Plant Monthly, 39, 1: 58-60, 67. Jan., 1950.

The manufacture of sweet curd cottage cheese by the short method involved pasteurization of fresh good quality skim milk at 143.5° F. for 30 min. or 161° F. for 15-19 sec. Following pasteurization, the temperature is reduced to 90° F.

and 5-6% of fresh active starter added. In about 1-1.5 hr. the proper amount of coagulator may be added with proper but not prolonged agitation. Then as soon as the curd is sufficiently firm, usually 3.5 hr. after setting and a whey acidity of 0.50-0.52%, the curd should be cut into even sized 0.5-0.625 in. cubes. Cooking during the first 15 min. should be at a temperature of 110° F. The average cooking time will vary from 50 min. to 1.5 hr., and involves a final temperature of 120° F. The whey then may be drained and the curd washed with tap water at a temperature of 85° F. The second washing should be at 50–60° F. Following drainage, the curd may be creamed in the vat by adding 40 lb. of 14% dressing to each 100 lb. of curd and salted at the rate of 2 oz./gal. of dressing. J. A. Meiser, Jr.

265. Manufacture of American type cheese. J. B. STINE. (Assignor to Kraft Foods Co.) U. S. Patent 2,494,638. 3 claims. Jan. 17, 1950. Official Gaz. U. S. Pat. Office, **630**, 3: 710. 1950.

American cheese is made by setting, cutting and cooking the curd in the conventional manner, draining off a portion of the whey, adding salt to the curd suspended in the remaining whey, cooking further, then draining the whey after forming the curd into blocks, and finally curing in the usual way. R. Whitaker

266. Method of pressing cheese. R. MIOLLIS. U. S. Patent 2,492,878. 7 claims. Dec. 27, 1949. Official Gaz. U. S. Pat. Office, **629**, 2: 1138. 1949.

This process provides for a method of removing whey by pressing cheese in forms in multiple vertical columns. R. Whitaker

267. Cheese manufacture. J. B. STINE. (Assignor to Kraft Foods Co.) U. S. Patent 2,494,-637. 1 claim. Jan. 17, 1950. Official Gaz. U. S. Pat. Office, **630**, 3: 710. 1950.

Cheese curd of the Swiss type when still submerged in the whey in the vat is packed into a mold and formed into the desired shape. The whey is then drained off, the curd allowed to mat and knit, after which it is cured in the usual way. R. Whitaker

268. Emmenthaler cheese. J. B. STINE. (Assignor to Kraft Foods Co.) U. S. Patent 2,494,-636. 4 claims. Jan. 17, 1950. Official Gaz. U. S. Pat. Office, 630, 3: 710. 1950.

Swiss cheese is sealed in a flexible, elastic moistuse proof bag, placed in a mold and cured.

R. Whitaker

269. Beitrag zur Käsereitauglichkeit von Silo-

milch und Bakteriologie des Tilsiter Käses. (A contribution to the fitness of ensilage milk for cheese making and the bacteriology of Tilsit cheese.) (English Summary.) K. J. DEMETER, A. JANOSCHEK and A. RAU. Die Milchwissenschaft, 4, 1: 3–14. Jan., 1949.

Comparison trials were made on the making and ripening of tilsit cheese from lots of raw milk obtained from selected groups of cows fed on different rations. One group was fed a normal ration consisting primarily of alfalfa hay, grains and straw, whereas the other group was fed a silage ration consisting primarily of alfalfa hay, silage (clover grass silage, corn silage) and straw.

Results of 69 trials showed that curd formation was somewhat slower with milk from cows on silage ration than with milk from cows on normal ration. This was due chiefly to the lower initial acidity of the milk and the slower action of rennet upon the milk from cows on silage ration. The ripened cheese made from the latter milk frequently was criticized for having a sweetish putrid taste and was inferior to the cheese made with milk from cows on normal ration.

Bacteriological studies did not show any pronounced difference in the microbial flora of the cheese made from the 2 types of milk.

I. Peters

CONDENSED AND DRIED MILKS; BY-PRODUCTS

F. J. DOAN, SECTION EDITOR

270. Formulas for the commercial use of whey in bakery goods. L. V. ROGERS, Bureau of Dairy Industry, USDA. BDIM-Inf.-89. (Mimeoprint) Jan., 1950.

Whey incorporation in bakery goods results in more tender products which remain soft and of good eating quality longer. The advantages of different whey products are discussed. Formulae for white whey-bread, rich yellow layer whey-cake, cocoa whey-cookies, oatmeal coconut whey-cookies, yeast raised whey-doughnuts and whey sweetdough are given, along with directions for the making of each product. F. E. Nelson

271. Confection stock. M. P. ANNARILLI. U. S. Patent 2,495,217. 16 claims. Jan. 24, 1950. Official Gaz. U. S. Pat. Office, **630**, 4: 945. 1950.

A candy base is described containing, in addition to sugar, cocoa, cream of tartar and flavoring, a combination of powdered cream, whole milk, skimmilk and roasted milk. R. Whitaker

DAIRY BACTERIOLOGY

P. R. ELLIKER, SECTION EDITOR 272. The problem of coliform bacteria in market milk. K. G. WECKEL, Univ. of Wisc., Madison. Milk Plant Monthly, 39, 1: 16–18, 20. Jan., 1950.

The source and significance of coliform organisms in raw and pasteurized milk are discussed. Methods of detecting these organisms and interpretation of these tests are presented. Supervisory measures necessary for controlling contamination of dairy products are (a) preventing contamination of the pasteurized product with raw milk or extraneous matter, (b) adequate and complete pasteurization of milk products and (c) thorough sterilization of processing equipment.

J. A. Meiser, Jr.

273. The problem of thermophilic and thermoduric bàcteria in milk. R. N. DOETSCH, Univ. of Maryland, College Park. Milk Plant Monthly, 38, 12: 32, 33, 36. Dec., 1949.

Pasteurization at either 143° F. for 30 min. or 161° F. for 16 sec. supposedly reduces the bacteria count of milk 90-99%. When the expected "kill" is not obtained, it is due to the growth of thermophilic bacteria or the survival of thermoduric organisms. Thermophilics, having an optimum growth temperature of 55-70° C., seldom are a problem until the milk arrives at the dairy plant. Preheating and pasteurization equipment, if used for several hours, favors the growth of these organisms, especially if residual milk solids accumulate. Their presence can be detected by the agar plate or oval tube method, using a 55° C, incubation temperature, or the Breed method. Thermoduric, unlike thermophilic, organisms usually are introduced into the milk at the farm in large numbers from improperly cleaned and sterilized equipment. Once in the plant they seed the equipment and become a problem. Although detectable by agar plate incubation at 35° C., they must be controlled by proper sanitation techniques in the plant and on the dairy farm. J. A. Meiser, Jr.

274. Hexadecenoic acid as a growth factor for lactic acid bacteria. J. B. HASSINEN, G. T. DUR-BIN and F. W. BERNHART. Wyeth, Inc., Mason, Mich. Arch. Biochem., 25, 1: 91–96. Jan., 1950.

Employing the usual acidimetric procedures for microbiological assays, the growth-promoting properties of oleic acid (9-octadecenoic acid) and palmitoleic acid (9-hexadecenoic acid) were compared for *Lactobacillus arabinosus* 17-5 (ATCC) and a mutant strain of *L. bifidus*. At low levels $(10-20 \ \gamma/ml.)$ hexadecenoic acid accelerated the growth of *L. bifidus*, but slightly higher levels $(30 \ \gamma/ml.)$ depressed its growth entirely. It was demonstrated that the inhibition due to high levels of hexadecenoic acid was removed by either palmitic acid or stearic acid and most effectively by a mixture of these 2 acids. Both low and high levels of oleic acid (as much as 200 γ /ml.) supported good acid production, and the synergistic action of oleic acid and a mixture of palmitic and stearic acid was slight. In the absence of biotin, L. arabinosus responded similarly to oleic acid and hexadecenoic acid; with the latter levels up to 100 γ /ml. were not toxic. Decreased acid production occurred when a mixture of palmitic, stearic and oleic acids was included in the medium; however, a mixture of hexadecenoic, palmitic and stearic acids greatly stimulated the growth of L. arabinosus. H. J. Peppler

275. Neue Züchtungsverfahren für Penicillium camemberti. (New methods of culturing Penicillium camemberti.) (English Summary.) W. KUNDRAT. Die Milchwissenschaft, 4, 1: 23–24. Jan., 1949.

Cultures of *Penicillium camemberti* grown on sterilized potato cubes (7–10 mm.³) produced twice as many conidiospores as cultures grown on parchment moistened with sterile whey. However, mold contaminants can be detected, more easily on the parchment layer and the parchment with the mold on it can be dried, packaged in sterile containers and shipped more economically than if the mold is grown on potato cubes.

I. Peters

Also see abs. no. 254, 257, 258.

DAIRY CHEMISTRY

H. H. SOMMER, SECTION EDITOR

276. Colorimetric determination of reducing sugars with triphenyltetrazolium chloride. A. M. MATTSON and C. O. JENSEN, Pa. State College, State College. Anal. Chem., 22, 1: 182–185. 1950.

An aqueous solution of triphenyltetrazolium chloride is colorless, but it forms a red, water-insoluble compound, triphenylformazan, when it is reduced by reducing sugars. The quantity of formazan formed is proportional to the quantity of reducing sugars present. By controlling time, temperature and alkalinity, the reaction can be used as the basis of a colorimetric method for the determination of reducing sugars. The method is applied to the determination of lactose in milk and of glucose and fructose in honey.

B. H. Webb

277. Kenetics of the enzyme-catalyzed oxidation of lactic acid. I. M. Sosquet and K. J. LAIDLER. Catholic Univ. of America, Washington, D. C. Arch. Biochem., 25, 1: 171–184. Jan., 1950.

Lactic dehydrogenase extracted from calves' hearts was employed in a detailed study of the reaction, lactic acid + coenzyme I \rightarrow pyruvic acid + reduced coenzyme I. The rate of reaction was observed to reach a constant limiting value with respect to lactic acid concentration, but reaches a maximum and then diminishes with respect to coenzyme concentration. The data obtained with this system suggest that the coenzyme can be absorbed on its own type of site as well as on the lactic acid type of site. The lactic molecule, however, can be adsorbed only on one type of site. Marked increases in activation energy with increasing concentrations of lactate and coenzyme provide evidence that binary and ternary complexes (apoenzyme-lactate-coenzyme) are formed exothermically and with an entropy decrease; the ternary complex being more stable than the binary complex by 4 kcal. In contrast with this behavior of hydrogenases, the process of complex formation for reactions catalyzed by urease and pepsin is reported to proceed endothermically and is accompanied by an increase in H. J. Peppler entropy.

278. Studies of the nutritive impairment of proteins heated with carbohydrates. II. In vitro digestion studies. J. R. LowRY and R. THIESSEN, JR., General Foods Corp., Hoboken, N. J. Arch. Biochem., 25, 1: 148–156. Jan., 1950.

Protein-dextrose complexes prepared by autoclaving equal weights of moist casein or wheat gluten with dextrose were digested in vitro by pepsin, chymotrypsin and pancreatin but were resistant to trypsin and papain. Amino groups resembling lysine and arginine, in the side chain of the enzyme substrate, were found to be vital to the action of trypsin. Lysine appeared to be especially important because some of its amino groups are free to combine with reducing sugars. When zein, a protein low in lysine, is autoclaved with dextrose, the light-colored complex is readily digested by trypsin. Since papain attacks linkages similar to those split by trypsin, the reaction of dextrose with free amino groups in the side chains also produces a protein complex resistant to digestion. When the enzymes are employed in physiological sequence at the proper pH, the prior digestion with pepsin does not alter the activity of trypsin. If the in vitro blocking of tryptic action reported here also occurs in vivo, the failure of the casein-dextrose complex to support the growth of young rats H. J. Peppler would be explained.

279. The "browning" reaction of proteins with glucose. A. MOHAMMAD, H. FRAENKEL-CONRAT and H. S. OLCOTT. Western Regional Research

Laboratory, Albany, Cal. Arch. Biochem., 24, 1: 157–178. Nov., 1949.

A detailed investigation was made to determine the effects of temperature, pH, and other variables on the rate of browning, the properties of such "browned" protein derivatives and the protein groups involved in the reaction of crystalline bovine serum albumin (BSA) in buffered solutions with glucose. The typical procedure used to measure the development of color employed 1 g. of protein dissolved in a mixture of 2 ml. $3.4M \text{ K}_2\text{HPO}_4$ buffer (pH 7.6) and 10 ml. 37.5%glucose solution. After the reaction period, samples of 1 ml. were diluted to 10 ml. for transmission data in a spectrophotometer at 500 m μ .

The rate of the browning reaction is proportional to the temperature and pH. In the temperature range of $25-65^{\circ}$ C. the same reaction mechanism occurs. A short induction period is followed by a protracted period during which the increase in color is linear with time. Increases in alkalinity accelerate the browning reaction, suggesting hydroxyl-ion catalysis. The development of browning was essentially the same when the buffer was phosphate, carbonate or veronal.

Traces of Cu accelerated the rate of browning of BSA in glucose solution, but it did not appear to affect the disappearance of amino groups.

Derivatives isolated after the reaction of BSA and glucose revealed similar properties. The BSA-glucose product was insoluble at its isoelectric region (pH 4.2-4.4) and resisted coagulation by heat in solutions heated at 100° C. for several hours, both below (pH 3.5) and above (pH 7.0) the isoelectric region. Details of electrophoretic homogeneity, osmotic pressure measurements, ultracentrifuge pattern, amino acid analyses and relative rates of trypsin digestion of BSA and its glucose derivative are discussed.

The primary site of the browning reaction is at the free amino groups, which decrease as the reaction proceeds. Masking them, as by acetylation, prevents browning at 53° C. or lower. At 70° C. secondary reactions, possibly due to guanidyl and indole groups, are involved.

From the observations that the browning of proteins proceeds more readily with acetaldehyde and propionaldehyde than with glucose, it is apparent that the aldehyde group is essential.

H. J. Peppler

280. X-ray diffraction analysis of vaccenic acid. J. H. BENEDICT and B. F. DAUBERT. Univ. of Pittsburgh. J. Am. Chem. Soc., 71, 12: 4113–4. Dec., 1949.

A comparison of X-ray data obtained for natural vaccenic acid and synthetic vaccenic acid with those obtained for elaidic acid reveals that synthetic vaccenic acid and elaidic acid possess similar crystal structures. Dissimilarities observed in the diffraction patterns were attributed chiefly to differences in the angles of tilt in the crystals; however, the possibility of structural differences could not be eliminated. Vaccenic acid obtained as a product of the hydrogenation of β -elaeostearic acid exhibited a pattern similar to that obtained with the natural vacenic acid. XI. J. Peppler

281. Mikrobiologische Bestimmung von Wuchsstoffen in Normal- und Silage Milch. (Microbiological determinations of growth factors in normal and in ensilage milk.) (English summary.)
E. F. Möller. Die Milchwissenschaft, 4, 1: 14–18. Jan., 1949.

Microbiological assays were made on milk dialysates for the determination of thiamine, pantothenic acid, nicotinic acid and p-amino benzoic acid with *Streptobacterium plantarum* and *Proteus vulgaris* as test cultures. Results of trials conducted over a 2-yr. period using milk from cows fed on a silage ration or on a normal ration showed that both milks had a similarly high concentration of the above growth factors, which concentrations were sufficiently high to permit proper growth of *Streptococcus lactis* in the milk. Apparently, however, silage milk was lower in an unknown factor I, required for the growth of *S. plantarum*.

The author believes failure to manufacture hard cheese from silage milk cannot be attributed to the lack of growth factors in such milk.

I. Peters

282. Ultracentrifugal study of bovine plasma protein fractions. V. L. KOENIG and K. O. PED-ERSEN. Univ. Upsala, Sweden. Arch. Biochem., 25, 1: 97–108. Jan., 1950.

Ultracentrifugal studies on the bovine plasma protein fractions resulting from the application of low temperature alcoholic fractionation procedures developed by E. J. Cohn and his associates were made with the Svedberg oil turbine velocity centrifuge operating at 59,000 r.p.m. The sedimentation diagram for Fraction I (fibrinogen) indicates a good preparation of the protein, having only a small amount of a heavier component. The sedimentation diagram of Fraction II (γ -globulin) gave evidence of about 18% of a heavier component, while that of Fraction III-1 $(\beta$ -globulin) reveals the presence of at least 2 heavier components amounting to about 13% and a very small quantity of a lighter component. Fraction IV (a-globulin and other components) presents a complex mixture of proteins consisting of 3 main components. Crystalline albumin, considered one of the purest of the plasma proteins isolated, gave evidence of small quantities of nondescript heavier components and a very small amount of lighter material. The values for the sedimentation constants extrapolated to zero concentration and zero n, the refractive index increment, were found to be as follows: Fraction I, 8.43–8.62S; Fraction II, 7.28–7.31S; Fraction III-1, 7.37S; Fraction IV, 19.45–19.68S, 7.31–7.46S, and 5.64–5.76S; crystalline albumin, 4.73S. H. J. Peppler

283. Some characteristics of mare's colostrum and milk. A. D. HOLMES and H. G. LINDQUIST, Mass. State Coll. J. Am. Diet. Assoc., 23, 11: 957-961. Nov., 1947.

Determinations were made of pH, fat, total solids and reduced ascorbic acid for 23 d. of milk from 3 Percheron mares, and for 15 d. of milk from 1 Palomino mare. The pH value of the colostrum was very stable for the first 4 d; on the 5th d. it was decidedly higher and from the 5th to the 21st d. it was quite constant. The averaged fat for the 1st 4 d. of lactation was 2.5%. The fat decreased slowly from the 5th d. to the end of the experimental period. The reduced ascorbic acid was relatively low in the colostrum but increased fairly steadily from the 1st to the 16th d. of lactation and then decreased slightly. At the 1st estrual period, about 9 d. postpartum, both the fat and ascorbic acid content changed from the values before or after the estrual period. R. N. Davis

Also see abs. no. 309.

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DAIRY ENGINEERING

A. W. FARRALL, SECTION EDITOR

284. Method and apparatus for heating milk. LE R. R. HAWK. (Assignor to Golden State Co.) U. S. Patent 2,492,635. 6 claims. Dec. 27, 1949. Official Gaz. U. S. Pat. Office, 629, 4: 1075. 1949.

Milk or other liquid is heated rapidly in this device which consists of a perforated blade revolving in a housing, similar in design to a simple centrifugal pump. Steam is fed into the housing where it is mixed intimately with the milk by the revolving blade. The heated milk is discharged continuously through an opening in the periphery of the housing. R. Whitaker

285. Process for heat treating milk and cream in containers. J. O. FowLER. U. S. Patent 2,493,-663. 2 claims. Jan. 3, 1950. Official Gaz. U. S. Pat. Office, 630, 1: 264. 1950.

To prevent breakage of bottles of hot milk and cream following in-bottle pasteurization, the bottles are held for 2–4 min. in a moisture-free, still

atmosphere at $40-50^{\circ}$ F. to cool the bottles through the cooling effect of evaporating the film of water on the outside surface. Following this step, the bottles may be submerged in chilled water to complete cooling. R. Whitaker

286. Process for heat treating milk and cream. J. O. FOWLER. U. S. Patent 2,493,664. 3 claims. Jan. 3. 1950. Official Gaz. U. S. Pat. Office, 630, 1: 264. 1950.

An in-bottle pasteurizing system for milk and cream is described. The bottles are placed in racks and heated and cooled by moving the racks through a succession of tanks of hot and cold water. R. Whitaker

287. Pumps for pure liquids. F. A. KRISTAL. Operating Engr., 3, 1: 38-39. Jan., 1950.

Pumps for handling foods must be resistant to corrosion and easy to take apart for cleaning. They must not churn the liquid. Some pumps must handle solids such as vegetables in soups without injuring the solids. All food pumps must be designed so that food will not be tainted or contact lubricants.

The sanitary pumps designed for food products are the centrifugal with flat-blade impellor, centrifugal with 3 curved blades, internal gear, rotary and reciprocating. Photographs and drawings are offered to aid in explaining the pumps.

H. L. Mitten, Jr.

288. How much torque is needed to start centrifugal pumps? R. CARTER, Worthington Pump & Machinery Corp., Harrison, N. J. Power, 94, 1: 88–90. Jan., 1950.

Proper selection of a power unit for a centrifugal pump seldom causes worry, for centrifugal pumps are relatively easy to start. Time needed for starting and bringing the load to speed depends upon the margin of torque available to accelerate the load and the flywheel effect of rotating parts. Centrifugal pumps have low flywheel effect and low-starting torque requirements, so high-starting torque motors are not required. Curves are presented to show characteristics of typical centrifugal pumps. H. L. Mitten, Jr.

289. BTU are good to last drop. A. W. SHEP-PARD, San Diego, Calif. Operating Engr., **3**, 1: 28–29. Jan., 1950.

When a boiler is taken out of service it must be cooled down. Where there is not a great reserve capacity it may be advantageous to conserve as much of the heat as possible rather than to waste the heat in the normal cooling procedures. Where the boiler has a superheater with drains to the blowdown tank and a low-pressure exhaust system used for a secondary purpose, connections can be made to connect the high and low pressure systems. The purpose of the connections is to take the heat from the high pressure side in small usable amounts and rise it in the low pressure system. When the boiler is to be taken out of service the fans are shut off and the boiler doors are left closed. The valve connecting the systems is then opened slowly. This permits even cooling of all boiler parts at a rate which prevents harmful stresses. Proper relief valve and safety devices should be provided. H. L. Mitten, Jr.

290. Winter tips on cooling towers. H. E. DEG-LER. Operating Engr., **3**, 1: 36–37. Jan., 1950.

To avoid difficulties follow the manufacturer's operating instructions. Fog is usually worse during mild winter weather of $50-60^{\circ}$ F. Fog is airborne droplets formed by vapor condensation. Reduce fog trouble by placing tower away from railroad tracks and highways, maintain low air temperatures at tower outlet, put as much air through tower as conditions permit and keep to minimum the ice formation on towers. Icing may be prevented during cold weather by keeping the tower temperatures as high as practicable by reducing fan speeds, reducing water flow and by passing water to part of tower.

H. L. Mitten, Jr.

291. New water-hardness test is faster and gives more accurate results. J. M. MARCY, Hall Laboratories, Inc., Pittsburgh, Pa. Power, 94, 1: 105–108. Jan., 1950.

The test is sensitive to small amounts of water hardness, 1ppm. of hardness as $CaCO_3$ being detectable. There is no limitation on sample size, since no scum or salt effect obscures the endpoint. The test is rapid and is applicible to high or low hardness and may be used in brines. Reagents consist of a buffer containing NH₄OH and NH₄Cl together with small amounts of magnesium and disodium salt of ethylene-diamine-tetra-acetic acid; sulphide solution containing Na₂S and NaOH; an indicator solution of adjusted chromeblack T in methyl alcohol; and a titrating solution containing complex-forming disodium salt of ethylene-diamine-tetra-acetic acid.

In making the determination, the water sample is buffered at a pH of 10 and, if necessary, sulphide solution is added. The indicator is added and the sample is titrated with the disodium salt of ethylene-diamine-tetra-acetic acid. The end point occurs when the last trace of reddish tinge disappears. H. L. Mitten, Jr.

292. Simplifying plant lubrication. J. G.

O'NEILL, JR., Sinclair Refining Co., New York City. Power, 94, 1: 86–87. Jan., 1950.

Recommendations in instruction books and on machine name plates are generally confusing. Some manufacturers list oil by brand name, some by viscosity at various temperatures, others by SAE (Society of Automotive Engineers) grade or AGMA (American Gear Manufacturers Association) number. The plant operator in his attempt to follow the manufacturers' instructions soon has many different lubricants on hand and has invested considerable in dispensing equipment for each product.

In an effort to simplify the lubrication problem, leading machinery manufacturers were consulted and mechanical units were classified. The type and viscosity range of the required oils were listed. This showed that many machines could use the same oils. In applying this information, 1 plant using 376 different lubricants reduced the number to 15. Another using 99 found it possible to get along with 9.

A chart listing the Saybot Universal Viscosity, SAE grade and the AGMA number along with a classification of applications is presented so the reader can easily convert any unit of viscosity to any other unit and compare the applications of the various oils. H. L. Mitten, Jr.

DAIRY PLANT MANAGEMENT AND ECONOMICS

L. C. THOMSEN, SECTION EDITOR

293. Controlling wastage in milk plants. H. HELMBOLT. Sheffield Farms, Springdale, Conn. Milk Plant Monthly, **38**, 11: 34–35, 53. Nov., 1949.

Wastage in milk plants is not confined to the product alone but occurs in supplies as well. Keeping these latter losses to a minimum involves (a) accurate inventory records so organized as to show where the losses occur, (b) teaching plant personnel the importance of thrift, (c) foresight as to more efficient methods of plant operation and (d) perseverance. Reducing wastage is not an expensive program but does require constant thought and supervision. J. A. Meiser

294. Better accounting for milk plants. FRED MERISH. Milk Plant Monthly, 38, 12: 54–57. Dec., 1949.

Many business failures are due to faulty accounting practices. For maximum efficiency and maximum profit plant operators must keep adequate and accurate records. In general, 4 classes of records must be kept: (a) financial records, (b) production records, (c) auxiliary records and (d) business statements. If these accounts are kept systematically, fewer business failures should result. J. A. Meiser, Jr.

295. Better business management for milk plants. FRED MERISH. Milk Plant Monthly, 39, 1: 34, 36, 50. Jan., 1950.

Business management is a matter of budgeting, cost control, sales control, business analysis and competent financial supervision. This provides the milk plant operator with a clear perspective of his own operations and increases his chances of survival in a competitive market.

J. A. Meiser, Jr.

296. The dairy sales manager's duties. C. H. BEHLE, Breuningers Dairies, Philadelphia, Pa. Milk Plant Monthly, **38**, 12: 50, 52. Dec., 1949.

A sales manager's duties are leading, advising and aiding sales personnel. Rather than force personal decisions on supervisors and foreman, it is advisable to solicit their opinions which should be weighed carefully before reaching decisions. Advance information gained by these group conferences enables personnel to promote sales policies with more enthusiasm, thus insuring better sales returns. J. A. Meiser, Jr.

297. Sales training for routemen pays off. F. FLAGG. Milk Plant Monthly, 38, 11: 77–78. Nov., 1949.

Immediately following a sales training course for sales personnel, a survey of a New Haven, Conn. marketing area showed that a considerable amount of new business could be solicited by enterprising routemen. Allocating 100 qt. of new business/routeman, each driver was given 3 mo. in which to pick up the added business. As an added incentive, routemen received a bonus of \$2.00 for each new customer maintained for a 4-mo. period. J. A. Meiser, Jr.

298. New customer campaign spurs collections and reduces bottle losses. P. L. ANDERS. Milk Plant Monthly, 38, 11: 71-72. Nov., 1949.

According to this plan, routemen receive \$4.00 for each new customer only if their bottle losses did not exceed 3% of their daily load and if their outstanding bills did not increase. The resulting 70% drop in bottle losses and a reduction of one-half in outstanding bills, indicated that the \$4.00 bonus was effective.

J. A. Meiser, Jr.

299. Contest boosts sales of chocolate milk. Anonymous. Milk Plant Monthly, 38, 11: 62-63. Nov., 1949. To increase the sales of chocolate milk, an oldfashioned sales contest was promoted; however, in conjunction with added commissions to the participants, prizes were given to the wives of the men who had obtained the greatest increase in sales during a 4-wk. period. With the added incentive from wives, the contest was highly successful. J. A. Meiser, Jr.

300. Incentives spur sales and collections. R. MILLER. Milk Plant Monthly, **38**, 11: 74–75. Nov., 1949.

In order to establish new delivery routes, customers were taken from established routes and used to form the nucleus of a new route. Regardless of the number of points taken away, the company guaranteed the routeman his previous month's earnings for the next 2 mo. This gave the driver additional time in which to rebuild his route and permitted him to transfer customers that could be better served by other routemen. Although the personnel were paid according to sales volume, a delivery of 350-400 gt. was considered to be an adequate day's work, in that it allowed the routemen sufficient time to solicit business, meanwhile assuring them their regular or even increased earnings. J. A. Meiser, Jr.

301. Self service stores. R. L. STEPHENS. High's Dairy Products Co., Washington, D. C. Ice Cream Trade J., 46, 1: 24, 60. Jan., 1950.

After a pilot store proved successful, 10 counter service retail stores were converted to the selfservice type. All stores are of the "dry stop" variety with 95% of the sales being carry out sales.

Self-service was installed as a means of reducing the waiting time for customers making it possible to serve more customers and to increase the sale of packaged ice cream. The self-service stores require a larger investment, higher power bills and some customers require help; however, these disadvantages are far outweighed by other advantages. Sales of all items increased in the self-service stores, customers were happier because of faster service, employees were happier because of less work and packaged sale was increased, now outselling hand packed (3–1). Sales on the 0.5 gal. bulk family package increased, also.

A hand dipping department for cones and pints is essential but little extra help is needed for it. A standard layout for stores was developed with minimum measurements of 14×50 ft. An exhaust fan was necessary for proper ventilation. If possible, all compressors should be located in the basement. Store equipment investment and electrical bills are about 3 times that of the counter type store. Self service push carts are not used by customers. Small items should be located at the front of the store to prevent pilfering. Some customers need help in locating items. All collections are made at check out counters and skeptical customers could be taught by salesladies that ice cream and milk kept in the open cabinets were in good condition.

W. H. Martin

302. Drug store study. H. H. ROBBINS, Paraffined Carton Research Council, Ice Cream Trade J., **45**, 12: 32, 34, 84. Dec., 1949; *ibid.*, **46**, 1: 26–28, 72. Jan., 1950.

Eight independent drug stores located in the neighborhood shopping areas in Los Angeles, Birmingham, Buffalo, Milwaukee, Philadelphia, St. Louis, Wichita and Springfield, Ohio, with average annual sales of \$103,302/store were surveyed. The fountain alone accounted for 39.2% of the stores' sales transactions and tobacco, candy and magazines accounted for 31.7%. Seven out of 10 sales were made by these 2 departments. The fountains gross profit was 39.9% of sales compared to 53.8% for prescriptions. The average fountains net profit was 1.7%, with 4 stores showing a net of 5.2-17.5% and 4 stores showing a loss of 0.9-14.9%. The 4 profitable fountains averaged 12.4ϕ , while 4 unprofitable ones showed a net loss of 9.1¢ for every dollar sale. At the fountain, factory packed ice cream showed a gross profit of 37.6%, hand packed 33.2% and novelties 28.5%.

Factory packaged ice cream was the only product handled profitably in all test fountains. The rate of turnover was almost 3 times as great as that for hand packed ice cream which was the second most profitable product in the soda fountain. Factors in favor of packaged ice cream are that it needs no training to sell, low labor, rent and inventory costs, high turnover and uniformity of profit. W. H. Martin

GENETICS AND BREEDING

N. L. VAN DEMARK, SECTION EDITOR

303. The examination of bull semen. S. W. J. VAN RENSBURG and N. C. STARKE, Inst. of Onderstepoort, Pretoria, S. Africa. J. So. African Vet. Med. Assoc., 20, 2: 70–79. June, 1949.

This is an outline of the procedure to follow in the collection and evaluation of bull semen. The author lists the following tests which should be run on semen: physical properties, motility, density, pH, methylene blue reduction test and morphology. Each test is discussed in detail as to various abnormal conditions which may be detected. A very good diagram of different types of abnormal sperm is presented.

K. M. Dunn

HERD MANAGEMENT

H. A. HERMAN, SECTION EDITOR

304. Stock watering trough. L. E. MEISNER. U. S. Patent 2,490,824. 1 claim. Dec. 13, 1949. Official Gaz. U. S. Pat. Office, **629**, 2: 408. 1949.

This outdoor stock watering trough consists of 2 troughs, an upper trough for large animals and a lower one for small animals. The device is enclosed in insulated walls. Counter-weighted doors, normally in the closed position, are easily opened by the animal. A small oil lamp and means for circulating warm air is provided for sub-freezing weather. R. Whitaker

305. Vacuum line contamination—Its causes and its cures. I. E. PARKIN, Penn. State College. Milk Plant Monthly, **38**, 12: 68–69. Dec., 1949.

The operating efficiency of a milking machine is greatly reduced by partially clogged vacuum lines, swollen and porous stanchion hoses and loose drive belts. Preventing dust, bedding and other foreign materials from entering the system and periodic flushing of the vacuum lines with a lye solution and successive hot water rinses will improve the efficiency of the machine and also provide better quality milk. I. A. Meiser, Ir.

ICE CREAM

C. D. DAHLE, SECTION EDITOR

306. Emulsifiers and their role in ice cream. H. L. CASLER, Germantown Manufacturing Co., Philadelphia 3., Pa. Ice Cream Trade J., **42**, 12: 48, 77. Dec., 1949.

Emulsifiers classed as "esters" are combinations of long-chain fatty acids such as stearic, palmitic or oleic with one of the higher alcohols, such as glycerol or sorbitol. The esters differ from the fats in that not all the possible linkages of the alcohol are taken up by the fatty acid, thereby producing a compound which has affinity for both fat and water.

Each molecule of the ester may be thought of as a rod, the fatty acid end is soluble in fat and the alcohol end is soluble in water, acting as a link preventing separation. Esters also are powerful surface active agents which move to any interface where fat and water meet and greatly reduce the interfacial tension, which is the force which pulls like globules together to form the largest possible masses. With this force removed, the homogenizer easily can reduce the butterfat to submicroscopic globules of less than 1-10,000th the diameter of a pin. These esters spread over all interfaces, entirely surrounding the tiny fat globules, forming protective films which in conjunction with the stabilizer prevent the globules from clumping.

Emulsifiers have been in use in the margarine and shortening industry and by bakers for years. They are non-toxic and have about the same nutritional value as true fats. W. H. Martin

307. Polyoxyethylene esters for improving frozen confections. A. B. STEINER and A. MILLER. (Assignors to Kelco Co.) U. S. Patent 2,493,324. 12 claims. Jan. 3, 1950. Official Gaz. U. S. Pat. Office, 630, 1: 176. 1950.

An ice cream improver consisting of a hydrophilic colloid and a polyoxyethylene ester of stearic acid as an emulsifying agent is described. R. Whitaker

308. Storing cream for use in ice cream. J. W. STULL, Univ. of Arizona, Tucson. Ice Cream Trade J., **46**, 1: 46, 86. Jan., 1950.

Cream for storage should not come in contact with Cu or Fe during processing and should be separated from high quality milk. A product containing either 40 or 80% fat may be stored. In the case of 40% cream, 10% sugar may be added before pasteurization to prevent destabilization during freezing. The pasteurization temperature should be 170° F, for 15 min. and the cream cooled to 40° F. and stored at $-10-20^\circ$ F.

Antioxidants, such as nordihydroguaiaretic acid (NDGA) in concentrations as low as 0.005%of the fat content of the cream, may be used to prevent oxidation. When NDGA is used, pasteurization temperature may be reduced to 150° F. for 30 min. The frozen product may be thawed by placing in a 40° F. room or it may be crushed in a sanitary type ice crusher and incorporated directly into the mix. W. H. Martin

309. Detecting foreign fats in ice cream. W. H. MARTIN, W. D. RUTZ and C. H. WHITNAH, Kansas State College, Manhattan. Ice Cream Trade J., 45, 12: 40, 78. Dec., 1949.

Reichert-Meissl numbers of butter fat used in 4 ice cream mixes averaged 29.24. This value was almost identical with the 29.15 number for fat extracted by the Minnesota reagent churning method from the ice cream. The Polenske number for the control fat was 2.17, compared to 2.19 for the fat extracted from ice cream. The Kirschner number for the control fat was 24.44 compared to 24.63 for the extracted fat.

Determinations were made on fat extracted from 5 experimental samples of ice cream which contained foreign fats. When one-third of the fat was supplied by coconut oil and cottonseed oil, the Reichert-Meissl numbers were reduced from 28.70 to 23.59 and 21.14, respectively. Kirschner

numbers likewise were about one-third lower than the Kirschner number of the butterfat. About 5% adulteration with foreign fats could be detected by the Reichert-Meissl numbers, provided a sample of the butterfat used in the ice cream or a similar sample is available for analysis.

W. H. Martin

310. Ice cream container. A. H. BARASCH. U. S. Patent 2,492,832. 5 claims. Dec. 27, 1949. Official Gaz. U. S. Pat. Office, **629**, 4: 1126. 1949.

An edible container for ice cream consisting of 2 parts, bottom and top, is described. The container is expansible to permit maintaining a seal where the top and bottom meet.

R. Whitaker

311. Ice cream maker and dispenser. D. A. ELWELL. U. S. Patent 2,493,395. 3 claims. Jan. 3. 1950. Official Gaz. U. S. Pat. Office, **630**, 1: 195. 1950.

A vertical ice cream freezer having a rotating agitator and a pusher blade, the latter so designed as to eject the finished product through an outlet in the bottom of the cylindrical freezing chamber is described. R. Whitaker

312. Method of manufacturing frozen confections. C. L. and R. and P. BERNARDS. (Assignors to John M. Bernards and Sons, Inc.) U. S. Patent 2,495,403. 3 claims. Jan. 24, 1950. Official Gaz. U. S. Pat. Office, 630, 4: 991. 1950.

A stick is inserted into a solid core of fruit, covered with ice cream, quick hardened and finally coated in the usual manner to form a frozen novelty on a stick. R. Whitaker

313. Soft ice cream. G. PRINCE, Alexandria Dairy Products Co., Alexandria, Va. Ice Cream Rev., 33, 7: 50. Feb., 1950.

Freezer fresh ice cream, frozen with a continuous freezer and offered in a variety of flavors will attract customers and increase sales. Soft ice cream combines freshness, flavor appeal and correct serving temperature all in the same product.

Other suggestions offered for increasing the sale of ice cream during the winter months are: (a) Produce higher butterfat (warmer) ice cream in winter, (b) offer a greater variety of flavors, (c) concentrate on the sale of factory filled packaged ice cream with an overrun of from 65– 75%, thereby eliminating hand packed ice cream, and (d) provide an insulated bag with sufficient dry ice for the specific holding time necessary for carry-out trade. This service should be provided at no extra cost to the customer and appropriately may be charged to advertising.

If the consumer can get what he wants and if the product reaches his table at the most favorable serving temperature, summer volume of sales may be approached during the winter months by the ice cream industry, in the opinion of the author.

W. J. Caulfield

314. Soft ice cream. P. H. TRACY and D. MOOR, Univ. of Ill., Urbana. Ice Cream Trade J., 46, 1: 30. Jan., 1950.

Soft ice cream has grown in popularity. Today thousands of gallons are manufactured in batch and continuous freezers. In some states the composition of the soft ice cream is the same as for the regular product; in other states 3-6% fat is permitted and the serum solids are usually about 14-16%, with 15-16% sugar.

Machines have been made to break down hard ice cream. The product made by one of these machines (the Sof-Tee) has been studied at the Univ. of Illinois. The product should be from $6-8^{\circ}$ F. when placed in the machine, if too warm, the finished product is too thin and if too cold, the motor will be overworked. The cup should be cold at the start of the operation and the final temperature of the product should be about 17– 18° F. A 12% product is too rich and filling for some customers. The lower fat product has proven to be popular. Fruits, syrups and crisp breakfast foods can be added to the machine along with the frozen product.

The final over run usually is 50–55% regardless of the over run of the original product. The amount of emulsifier used in the frozen product has no relation to the over run in the final product.

For low fat products (5-6%), the serum solids should be about 15-16% and sweetening agents containing monosaccharides should not be used. For ice milk type of products, about 2 times as much emulsifier and about one-third more stabilizer should be used than for regular ice cream. W. H. Martin

315. Sandwiches, mass production. V. M. RABUFFO. Ice Cream Trade J., **46**, 1: 36. Jan., 1950.

Automatic equipment for mass production of ice cream sandwiches has been developed by the General Ice Cream Co., Schenectady, N. Y. A wafer dispensing unit is synchronized with the flow of ice cream from the extruder attachment to the freezer and both are synchronized with the speed of a slowly moving conveyor belt.

From a sloping tray, wafers are fed contin-

uously one at a time on to the conveyor belt as it moves along. At the next station, ice cream is extruded in a continuous flow in ribbon-like form over the wafers. Next, wafers are fed from a second sloping tray to the top of the layers of ice cream. The entire string of sandwiches moves along the conveyor belt; at the end of the belt a girl "breaks off" the individual sanwiches and places them in a tray. The tray moves to the hardening room and after 1 hr. the sandwiches are bagged and boxed.

The sandwich conveyor setup weighs 290 lb. The dispensing unit weighs 130 lb. and is set on casters so it can be moved readily when not in use. W. H. Martin

316. Apparatus for serving ice cream. H. W. PROTZELLER. (Assignor of one half to A. W. Nelson.) U. S. Patent 2,495,077. 3 claims. Jan. 17, 1950. Official Gaz. U. S. Pat. Office, **630**, 3: 823. 1950.

Ice cream is hardened in the shape of rods or cylinders and dropped into this device end to end in a vertical position. The chamber holding the ice cream is separated from a refrigerated cylinder by a small air space. A sliding valve in the bottom cuts off a segment of ice cream when depressed and releases same through an opening in the bottom when the valve is returned to its normal position. R. Whitaker

MILK AND CREAM

P. H. TRACY, SECTION EDITOR

317. Quality improvement programs. C. J. BABCOCK, PMA, USDA. Milk Plant Monthly, 39, 1: 44-46. Jan., 1950.

The ineffectiveness of quality improvement programs is due to buyers who will purchase low quality raw materials, lack of sincerity in setting up programs and improper approaches to producers. Effective programs must be set up on an area basis and, following improvement, the area should be used as a demonstration area to instigate future programs. Cooperation of plants and uniform grading also are essential to improved quality. Although competent fieldmen can do much to improve quality, leadership cannot be delegated but must be retained by the manufacturers of dairy products. J. A. Meiser, Jr.

318. The shifting emphasis in quality control of milk supplies. A. C. FAY, H. P. Hood and Sons, Boston, Mass. Milk Plant Monthly, **39**, 1: 26–30. Jan., 1950.

The author traces the history of quality control of the nation's milk supply during the past decades and presents a discussion of the 3 factors generally credited with promoting this progress, namely, (a) development, perfection and application of new quality tests, (b) advancements in dairy engineering and processing methods and (c) more rigid inspection of production and processing facilities. These changes have been affected by the succeeding generations of new thinkers in the dairy industry. J. A. Meiser, Jr.

319. Housewife complaints on milk flavors. J. A. NELSON, Montana State College, Bozeman. Milk Plant Monthly, **38**, 12: 46–47. Dec., 1949.

Flavor defects in milk are classified as those resulting from faulty production and faulty processing techniques. A third class of off-flavors are those due to circumstances outside the control of the producer or processor. The author then presents a discussion of these 3 classes of off-flavors and lists methods for preventing their occurrence in milk. J. A. Meiser, Jr.

320. Supplementing fluid cream with frozen cream. H. V. ATHERTON, Univ. of Vermont, Burlington. Milk Plant Monthly, **39**, 1: 22, 24–25. Jan., 1950.

In an attempt to add the maximum amount of frozen cream to fluid cream and still produce a product suitable for commercial use, the following manufacturing procedure resulted in a product nearest to that of normal fresh cream. Frozen cream combined with fresh cream on a 50-50 basis was heated to 140° F., homogenized at 100 lb. pressure, cooled and stored for 24 hr. at 40° F. The resulting product when examined for feathering, oiling-off, viscosity, blendability, plug formation and whipability was not superior to normal fresh cream but did present a usable product that may allow a more economical usage of surplus cream than is possible at present.

J. A. Meiser, Jr.

321. Tie-in boosts cream sales. F. FLAGG. Milk Plant Monthly, 38, 11: 52–53. Nov., 1949.

To offset drops in cream sales during winter months, combination packages which included 1 lb. of frozen strawberries and 0.5 pt. of cream were made up. Offered at their regular retail prices, this item was featured as a week-end special and resulted in cream sales increasing 100%. Although local retail grocers complained that this sales promotion idea was detrimental to their sales, it was later proven by an accurate check that their retail sales of berries and cream also had increased. J. A. Meiser, Jr.

322. Container for milk and the like. M. O. KUHN. (Assignor to The Firestone Tire and Rubber Co.) U. S. Patent 2,495,110. 2 claims. Jan. 17, 1950. Official Gaz. U. S. Pat. Office, 630, 3: 831. 1950.

Structural details are given covering the Firestone milk can recently placed on the market.

R. Whitaker

Also see abs. no. 272, 273, 285, 286, 293, 294, 295.

NUTRITIVE VALUE OF DAIRY PRODUCTS

R. JENNESS, SECTION EDITOR

323. The food value of milk and dairy products for human consumption and means of increasing their consumption. ETHEL A. MARTIN, National Dairy Council, Chicago. Milk Plant Monthly, 38, 11: 42-44, 46, 48, 78. Nov., 1949.

Based on the findings of the nutrition research, the author presents a summary of currently accepted nutritional facts about milk, butter, ice cream and cheese. With this knowledge at hand, the National Dairy Council attempts to increase the consumption of dairy products by radio, research, literature, motion pictures, exhibits and leader contacts. J. A. Meiser, Jr.

SANITATION AND CLEANSING

K. G. WECKEL, SECTION EDITOR

324. Substantial savings by a planned equipment cleaning program. K. L. Fowler. Milk Plant Monthly, **39**, 1: 54–56. Jan., 1950.

A planned equipment cleaning program that has provided substantial savings includes: (a) dispensing of cleaning compounds in paper bags from a centralized point, (b) preparation of cleaning solutions in a centralized tank from which they may be dispersed through pipe lines to the cleaning operations, (c) maintaining hot water at 115–120° F. and dispensing at 25–40 lb. pressure, (d) phosphoric acid in preference to abrasives for milkstone and stain removal, (e) chlorine sterilization of vats by means of an air pressure spray gun and (f) use of nylon brushes and specialized cleaning aids for small-parts washing. J. A. Meiser, Jr.

Also see abs. no. 291, 305.



FARMER AND FIELDMAN COOPERATE. Robert L. Fortenberry (left) gets bigger checks for bis milk-thanks to Fieldman E. C. Bullick and the B-K PR Plan. Both men are from Hammond, La.

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JOURNAL OF DAIRY SCIENCE







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for Cultivation of Lactobacilli

BACTO-TOMATO JUICE AGAR

BACTO-TRYPSIN DIGEST AGAR support luxuriant and characteristic growth of *Lactobacillus acidophilus*, and are well adapted for use in establishing the number of viable organisms in acidophilus products. These media are also widely used for estimation of the degree of implantation by *L. acidophilus*.

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS In the Research and Development of Bacto-Peptone and Dehydrated Culture Media.

DIFCO LABORATORIES DETROIT 1, MICHIGAN

