Distribution of Salt and Moisture in Butter as affected by storage

A Thesis

Presented in partial fulfilment

of the requirements for the

Degree of Master of Science

in Agriculture in the

Department of Dairying

of the

University of Idaho

by

Richard D. Canan, B. S.

1917

Distribution of Salt and Moisture in Butter as affected by storage.

During recent years the composition of butter, from a quantitative point of view, has been a subject of considerable interest. Reports of thousands of analyses for water and other constituents have appeared in various publications from time to time, but data, showing the distribution of this moisture and salt throughout the package as affected by storage, is not very abundant. Hence it has seemed desirable to obtain additional data on this subject.

Such a study is deemed all the more advisable since in the past few years many complaints have been received by the Federal Authorities against decisions handed down by the Courts against excess moisture, the objections being based mainly against the method of sampling the butter.

Butter which contains sixteen per cent or more moisture, has been defined by Justice Surton of the United States Supreme Court as Adulterated Butter.

The Treasury Department has ruled that butter suspected of being adulterated shall be sampled in the following manner. "A V-shaped wedge from opposite sides

of the tubs or cubes at a point not lower than one fourth of the depth of the package from the top, nor higher than one half such depth from the bottom, these two portions to total not less than one half pound in weight. However such sampling may be made by a trier, when the manufacturer, owner, or holder so requests in writing and waives any claim for damages to the package so sampled."

Since so much emphasis is laid upon the moisture content of butter it is well that more should be known concerning the distribution of this moisture throughout the package.

History.

During the early nineties we first find our attentions being called to the importance of the moisture content of Butter. A. H. Allen (3) found butter to contain as high as 25 per cent of moisture, which he claims is entirely too high, maintaining that 12 per cent is sufficient so far as the appearance of butter is concerned and when in excess of 16 per cent the keeping qualities of the butter is injured.

Mr. Hehner in the same paper claims that 13 per cent should be the limit and anything above 15 per cent is either culpably added or negligently left in and the excess is not only detrimental to the public but also to the merchants themselves.

At a Danish butter exhibition, (4) of 2,091 samples of export butter better than 85 per cent were found to range between 13 and 16 per cent and F. W. Woll

claims that the quality of the other 15 per cent was materially lowered, whether the moisture was below 13 per cent or above 16 per cent.

At still another exhibit held in Denmark, (5) of 790 tubs of summer butter 109 samples or 14 per cent lost brine on being kept for fourteen days, while 477 samples, out of 1072 tubs or 44 per cent of the tubs of winter butter lost brine. The summer butter losing .05 pound per tub for the two weeks while the winter butter lost .22 pounds per tub. As a rule this loss was not due to a greater water content, there being no apparent connection between the two.

Dr. Vieth and H. D. Richmond (6) in an analysis of 469 samples of London Butter found that the majority of samples ranged between 11 and 15 per cent of moisture, 26 samples containing more than 15 per cent of moisture while 65 contained less than 11 per cent, however only 5 were found to contain more than 16 per cent of moisture and as a result of these investigations the authors recommended for England that adulterated butter should be only that butter which contained more than 16 per cent moisture.

In pursuing these analyses further Richmond found by experiment that the loss of water from salted butter was practically complete after the first week, but it is quite legitimate for this loss to continue in average butter from 10 to 30 days.

From further experiment on English butter by the

same Richmond it is found that the content of the unsalted French butter was 14.46 per cent in summer and 15.09 per cent in winter while with both the salted and the unsalted English butter it was 14.17 per cent in summer and 13.33 per cent in winter. The fresh English butter losing a very small amount of water on keeping while on the contrary the salted butter lost water quite rapidly especially during the first day or two after making, and more slowly during the next week, when the loss nearly ceases. It appears that the loss of water from fresh butter is due chiefly to evaporation, and the loss of water from salt butter chiefly to brine running out. Duplicate analyses of fresh butter taken from the same lump have never been noted to vary over .06 of a per cent while difference of .7 per cent is not uncommon in duplicate analyses made of salted butter from the same lump.

Fidskr (7) in 1041 samples of Swedish butter 82 per cent of these contained from 12 to 15 per cent of moisture and 68 of these samples or 6½ per cent were found to lose on the average of 201 grams or 7 oz. per tub which in the case of a 60 pound tub would mean .71 of a per cent.

From experiments made at the Kleinhof Fapian Experiment Station by R. Eichloff (8) we find the following results recorded, of butter packed in closed tubs and stored in an ordinary cellar.

	Moisture
Fresh butter from churn	13.15 per cent.
Same butter one month old	12.08 per cent.
Same butter four months old	6.69 per cent.

Helsigfois (9) in an analysis of 450 tubs of Finland butter found the average moisture content to be 12.3 per cent with a maximum of 16 per cent and a minimum of 9.2 per cent. 83 of these samples leaked 10 or more grams during storage the average being 181 grams with the maximum showing 985 grams.

At Cornell, Pickerill and Guthrie (10) found that where pound prints are loosely placed in the small store refrigerator they will lose sufficient water in less than ten days, so that they will be below the legal limit for one pound packages.

The California experiment station through L. M. Davis'(11) report that when butter is kept in cold storage for three months it will show on the average, a shrinkage of .6 of a per cent, however no figures were given with regard to ordinary storage.

In an endeavor to more thoroughly prove that butter will lose moisture rather than absorb the same, W. Theopold, (12) tests indicate that when butter is moistened externally or placed in cold water for 70 hours it will not increase in weight as evidenced by the two samples which before treatment contained 22.9 and 18.8 per cent respectively while after treatment the moisture content had dropped to 22.6 and 18.2 per cent.

In attempting to determine the cause for the separation of water from butter, O. Hoffmeister, (13) decided that no definite relationship existed between the separation of water and the consistency and water

content of the butter. In attempting to determine the degree of water separation, it was found that the amount of water was different in the various areas of the same sample and that the sample of butter containing the highest amounts of water had the superficial appearance of being the driest.

The causes for the separation are probably due to various methods of manufacture and possibly the chemical composition and mechanical structure of the fat.

Guthrie and Ross (14) in noting the distribution of moisture in 51 samples shortly after churning found that in some samples the variations were as high as 4½ per cent while in others they were as low as .1 per cent. However these samples were only tested once and no observations were made with regard to the movement or retention of this moisture as might be affected by storage.

At Illinois, Lee, Hepburn and Barnhart, (15) have shown that even different samples of the same butter will show a variation in moisture of content ranging from .1 to 1 per cent, said samples being made up from a number of smaller samples being taken throughout the whole mass.

McKay and Bowen, (16) with 36 samples have proven conclusively that butter at the ends of a churn will contain considerable more moisture than that at the middle and from this data it is easy to assume that different tubs from the same churning will vary considerable and the same is easily seen to be true of samples taken from different parts of the same tub. Carrying their experiment further they averaged

the moisture content of the butter from the two ends and center and compared this with the composite and in most cases the comparison was very close but on sampling the tubs of butter the following day in twelve of the thirteen cases they found the moisture content to have decreased materially in some cases considerably over 1 per cent. Then in sampling the various parts of these tubs they observed in most cases at least that less moisture was found at the top and the bottom of the tub than in the center but this variation in most cases was very slight.

Cohen (16) has shown us that the butter in the churn will vary considerably in moisture content as proven by the great variations in moisture of the different tubs of butter taken from the same churning.

Such is the brief history of the variations of moisture in butter but it is even more difficult to decide on the method of sampling and the system to use in the determination of the moisture because of the seemingly number of different methods, none of which are too strongly recommended.

The average water content of 50 samples of South Australian butter as determined by C. S. Thomson (17) was found to be 11.7 per cent. The butter trier was found unreliable as a practical guide for judging the amount of water in butter.

J. Wanters (18) maintains that an excess of water in butter is an adulteration the same as the addition of fat. In determining the water content of the butter after storage one must take his sample from the central portion as the

exterior has lost much of its moisture by evaporation.

By running the trier the entire length of the tub and then using the entire sample to determine the moisture, by drying in a high pressure oven the interior of which may be close to 250° Fahrenheit or more, is the only way to secure accurate results according to Farrington. (19)

H. H. Dean (20) recommended the determining of moisture by drying samples in small tin pans in a steam oven, and, after two of this method run side by side with both the Gray and the Richmond methods highly recommends the former.

From several Danish analyses we find the following: (21) Chemical analysis of drying 5 gm. in small porcelain dish with about 15 gm. pumice stone at 100° for two hours averaged 14.66 per cent. The English method of drying 10 gm. in porcelain dish over direct flame for 10 minutes, - using glass stirring rod, averaged 14.79 per cent.Im only 6 of the 50 samples were higher results obtained by chemical method. While the Gray method gave lower results than the chemical method by an average of 0.31 per cent.

Thus it is seen that there is considerable variation in the methods used by the different investigators for the determination of salt and moisture in butter.

Purpose.

The purpose of this investigation will be to determine just how much the moisture content of butter will vary in various portions of the same package and to note in what directions the moisture has a tendency to

move and whether or not the salt is carried along with the moisture or deposited in place.

Method of Procedure.

The samples of butter were obtained from the general run of butter as made in the College Creamery during the year. The sample consisted of a five pound tub taken indiscriminately from all parts of the churn. The tub having been soaked in water for at least 12 hours before using. The sample was then placed in the creamery cooler, where the temperature for the past year has ranged from 38 to 65 degrees. At the same time a composite sample was taken from the churn and the moisture and salt content determined. The samples were analyzed for moisture and salt after the following periods of storage; first, twenty-four hours, then seventy-two hours, seven days, fifteen days and finally thirty days. Six samples were taken from each tub at each period, three of which were selected from indiscriminate portions of the top of the package and three from the lower portion. The location of each sample as taken from the tub was carefully noted for future conclusions. After eight, five pound tubs had been experimented with in this way, one sixty pound cube was used in order to note whether or not the results in the case of the cube were similar to those obtained in the small tubs.

The samples consisted of about 5 grams of butter secured by the trier which was then placed in small aluminum pans and placed in a hot water bath oven, and held until all moisture was driven off.

The salt was determined by diluting the residue to 250 cc with hot water and titrating with silver nitrate 17.6 cc of this solution then calculating for the percentage of salt present. Duplicate titrations being made in all instances.

Discussion.

From the data gathered we find that there is considerable variation in the moisture and salt content of different parts of the same package when taken at the same time. The greatest variation of such samples was found to be 2.75 per cent while the lowest variation was .01 per cent in the case of the moisture while the salt showed a variation of .79 per cent in the case of the maximum variation while the minimum variation was only .01 per cent.

Further if we consider an average of all the experiments we will find a gradual decrease in the amount of moisture contained after each different period of storage and this difference for all nine samples is 1.26 per cent in the case of the moisture while it is .26 per cent in the case of the salt. These figures also show that most of this loss of moisture takes place during the first seven days since .88 per cent of the moisture content is lost in this time and .21 per cent of the total amount of the salt lost. However not all the individual samples follow this order but the variations are the exceptions and these may be caused by the exceedingly high moisture or salt content of one single sample, such a sample in all

probability being taken from a water pocket in the tub of butter.

Our data although not so conclusive nevertheless, shows that the lower samples have a tendency to contain more moisture and salt than those from the top of the package. Such results may be due to one of two causes or even both. Either the moisture near the top has evaporated off or else the moisture has a tendency to work towards the bottom and finally out of the sample entirely. The salt variation of the top and bottom samples is also nearly identical with the moisture variation and this would lead one to suppose that the salt in its dissolved form is carried along with the movement of the moisture rather than that the salt solidifies out and is deposited in place.

The data further shows that the samples near the outside contain considerably less moisture than those near the middle and the same is true of the salt content showing as before that the moisture and the salt either leak out or are evaporated off and in any case it is possible to presume that both actions take place.

Conclusions.

All conditions under which the present experiment was conducted, being considered, we may arrive at the following conclusions:

1. The moisture and salt content of butter varies considerably in different portions of the sample.

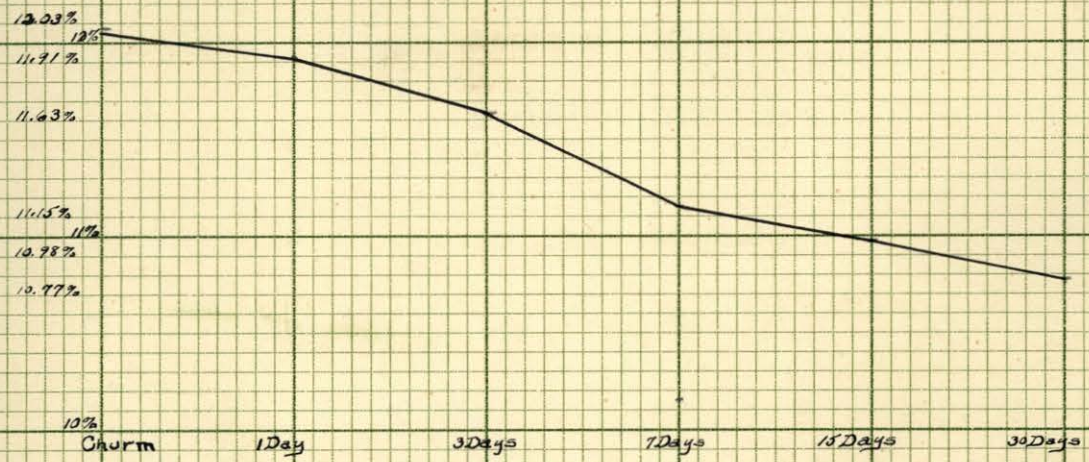
2. Butter will lose both moisture and salt in varied amounts during storage.

3. In general, butter after storage contains more salt and moisture at the top of the package than the bottom.

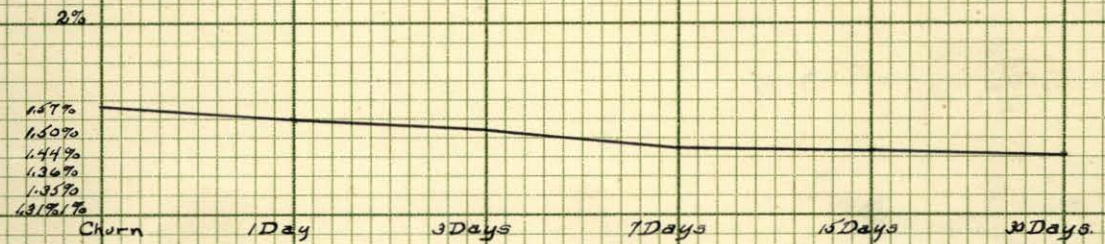
4. Butter, after storage contains more moisture and salt near the center than at the outside.

5. The loss of salt and moisture seem to be in direct proportion, which would indicate that the brine oozes out rather than that the water evaporates.

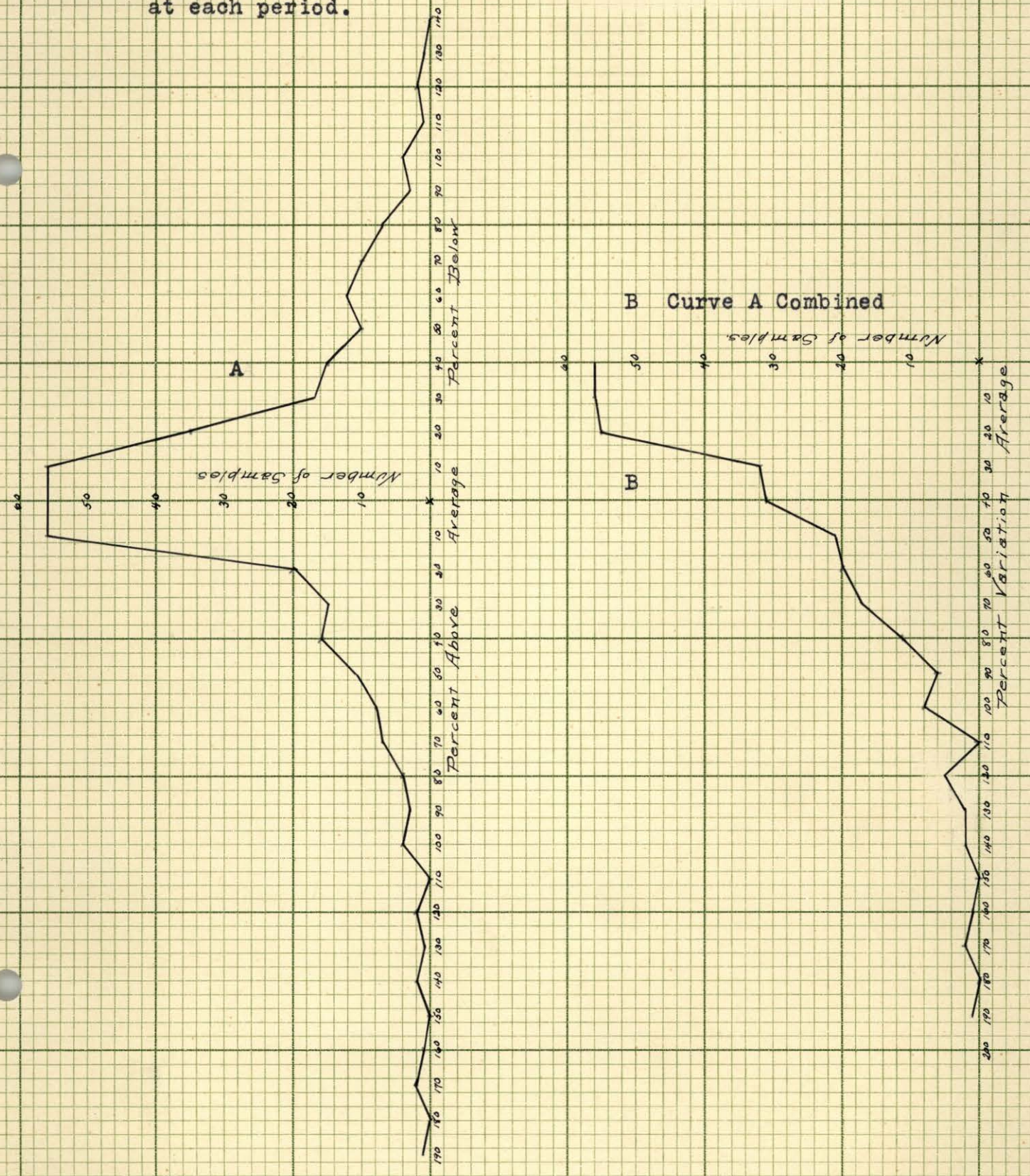
A Curve showing the average loss of moisture at the different periods of storage.



B Curve showing the average loss of salt at the different periods of storage.

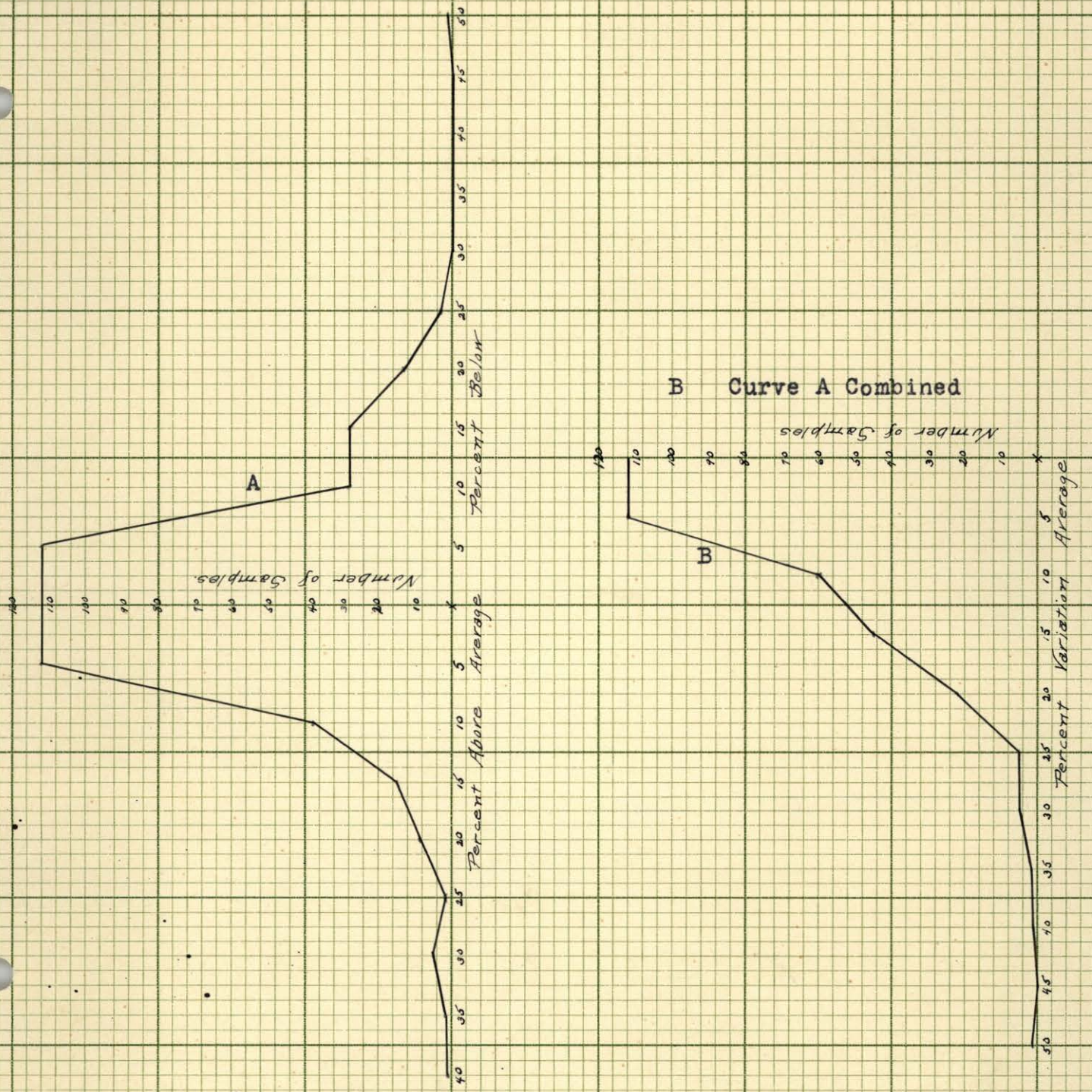


A Curve showing the variation in moisture of the separate samples as compared with the average of the six samples at each period.

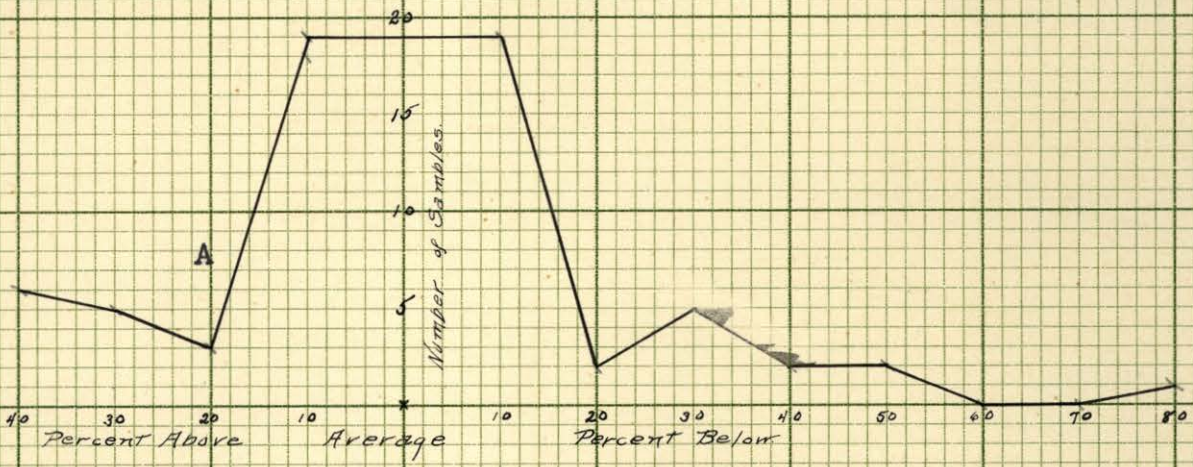


B Curve A Combined

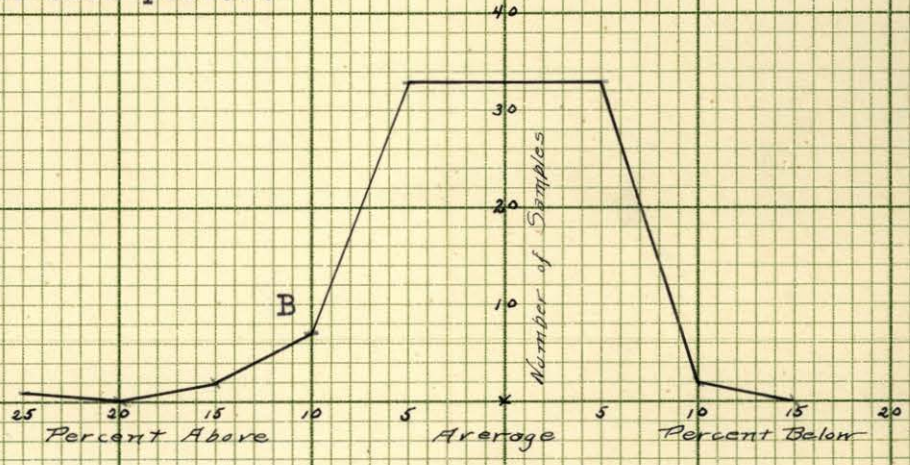
A Curve showing the variation in salt of the separate samples as compared with the average of the six samples at each period.



A Curve showing the average of the moisture content of the three top samples as they varied from the average of the six samples at each period.

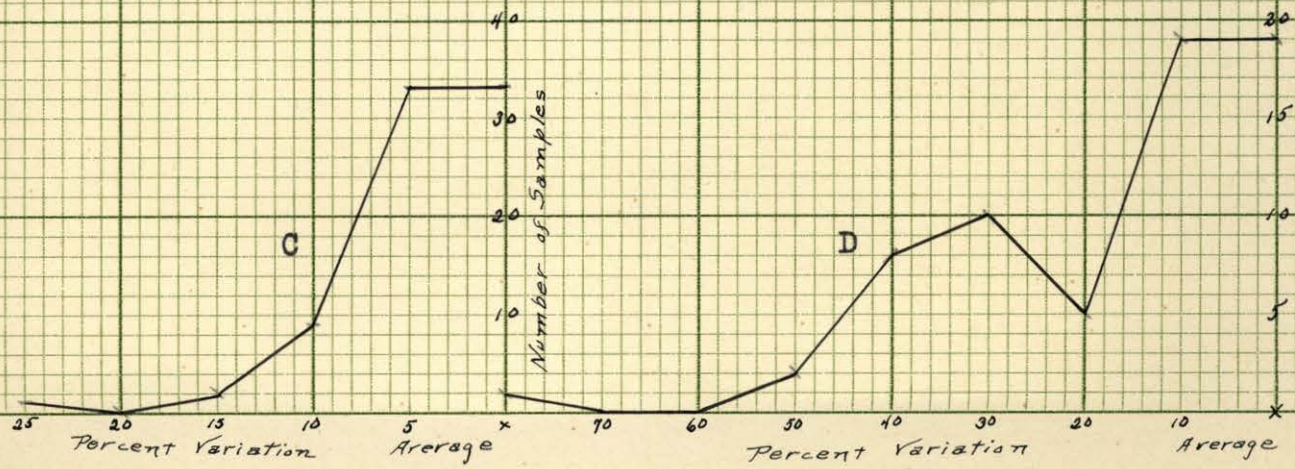


B Curve showing the average of the salt content of the three top samples as they varied from the average of the six samples at each period.

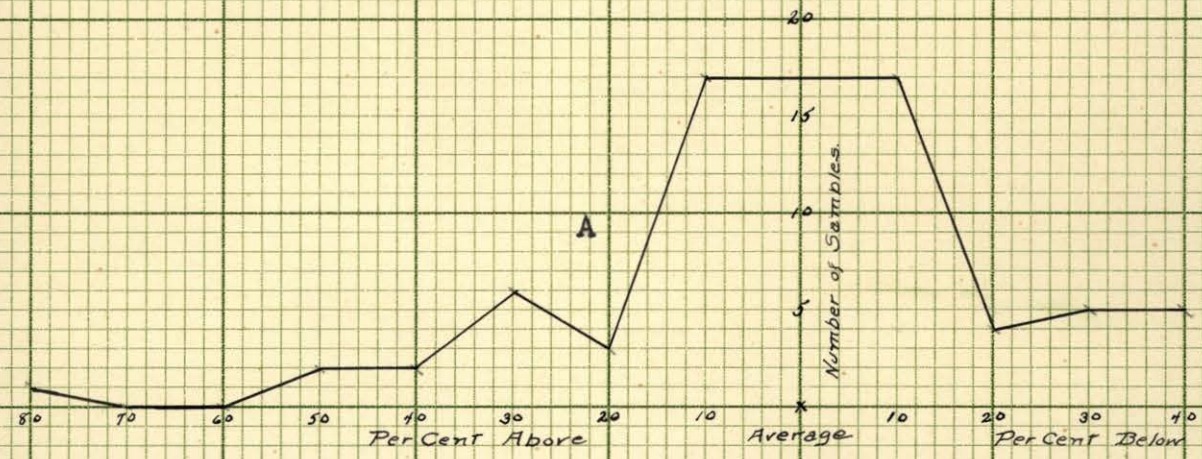


C is B Curve Combined

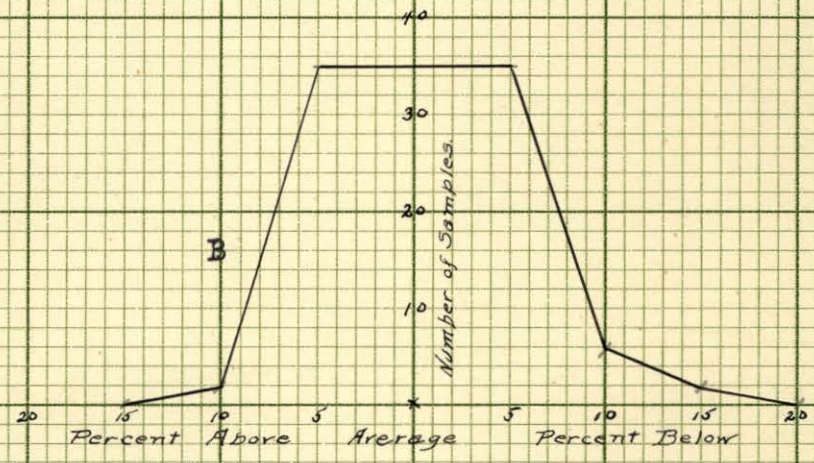
D is A Curve Combined



A Curve showing the average of the moisture content of the three bottom samples as they varied from the average of the six samples at each period.

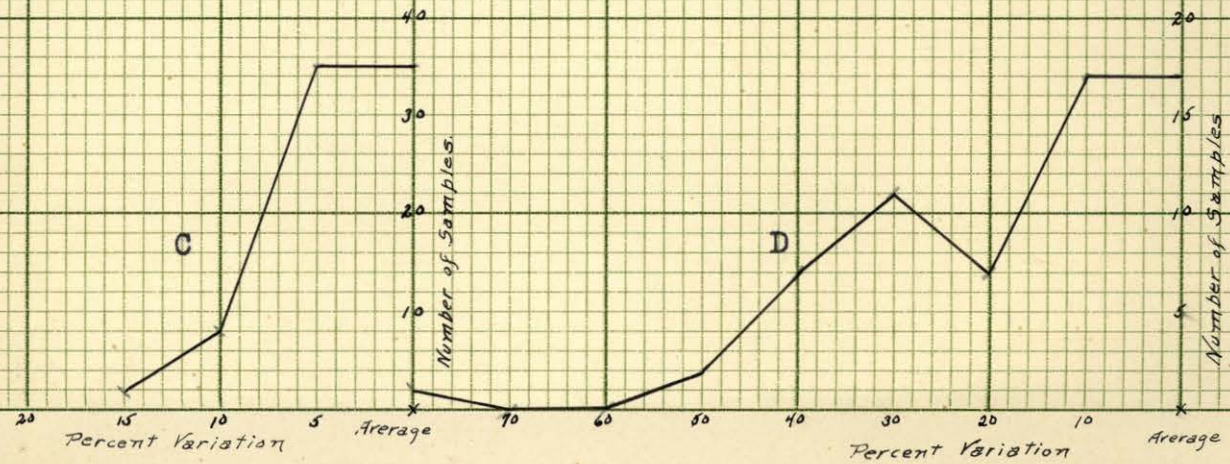


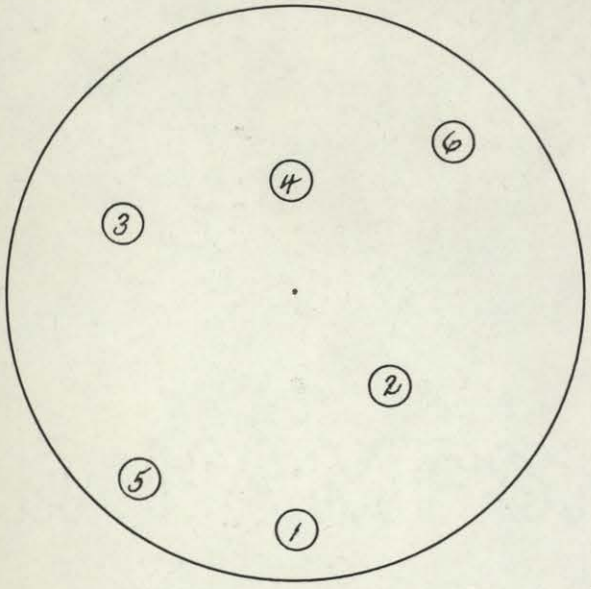
B Curve showing the average of the salt content of the three bottom samples as they varied from the average of the six samples at each period.



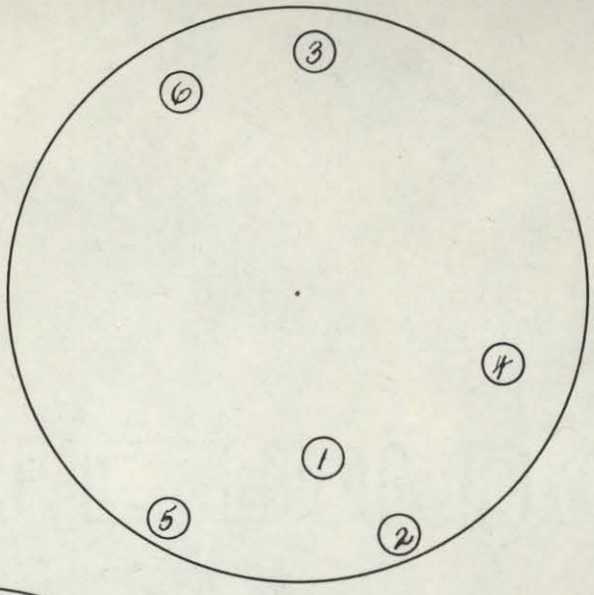
C is B Curve Combined

D is A Curve Combined

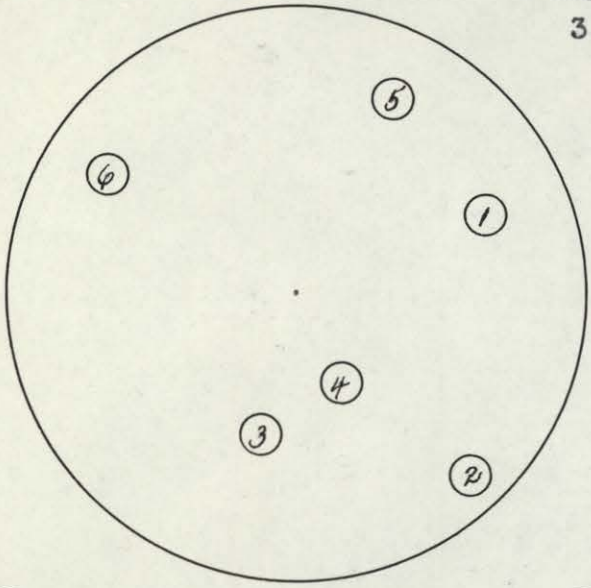




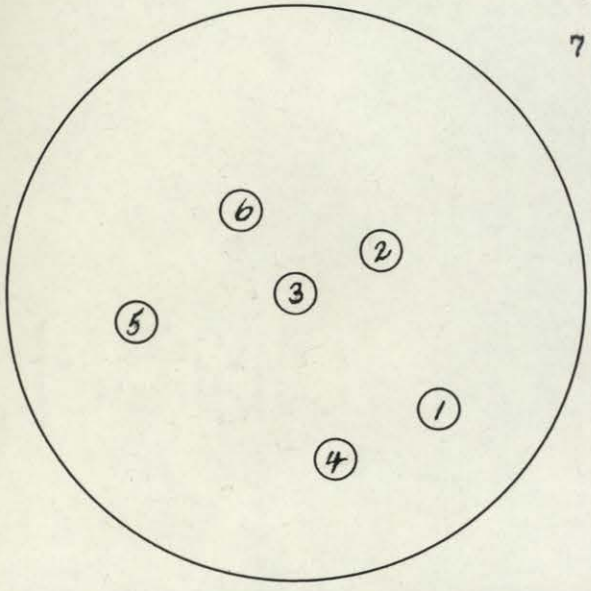
1 day



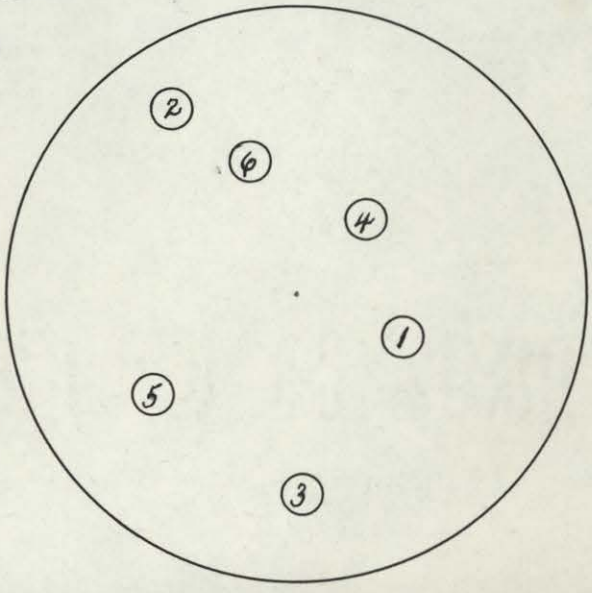
3 days



7 days



15 days



30 days

Tub I after 1 day

Sample Number	Moisture	Salt
1	12.26	1.38
2	12.91	1.41
3	12.48	1.28
4	12.52	1.25
5	12.13	1.33
6	12.58	1.26
Average	12.48	1.32

Tub I after 3 days

Sample Number	Moisture	Salt
1	12.91	1.47
2	12.44	1.20
3	12.20	1.52
4	12.05	1.26
5	12.01	1.59
6	12.17	1.47
Average	12.29	1.42

Tub I after 7 days

Sample Number	Moisture	Salt
1	10.57	1.12
2	12.48	1.40
3	12.79	1.33
4	11.88	1.21
5	11.54	1.20
6	10.79	1.38
Average	11.67	1.27

Tub I after 15 days

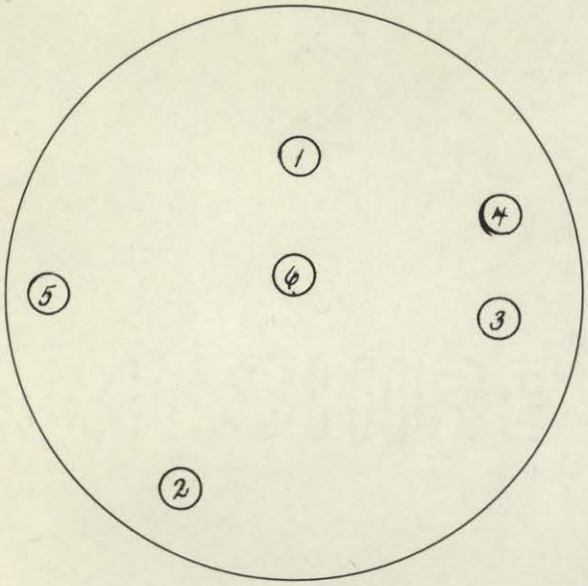
Sample Number	Moisture	Salt
1	12.86	1.40
2	12.25	1.36
3	11.68	1.26
4	11.84	1.36
5	11.20	1.17
6	11.89	1.39
Average	11.95	1.32

Tub I after 30 days

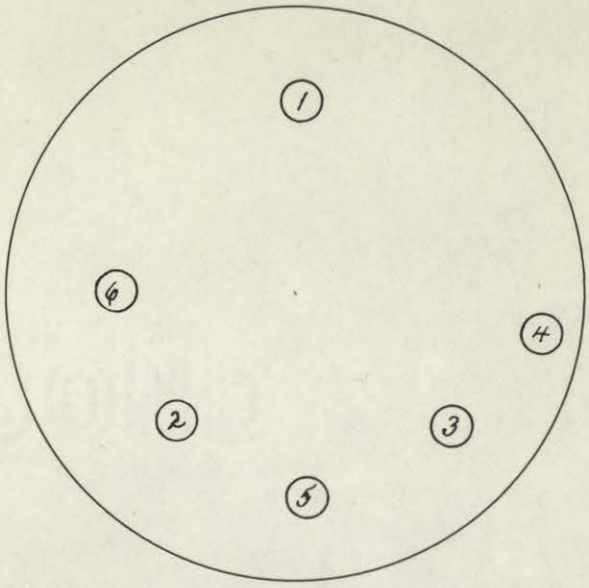
Sample Number	Moisture	Salt
1	12.52	1.49
2	11.83	1.27
3	12.13	1.32
4	11.45	1.23
5	11.42	1.22
6	12.74	1.34
Average	12.02	1.31

Summary Tub I

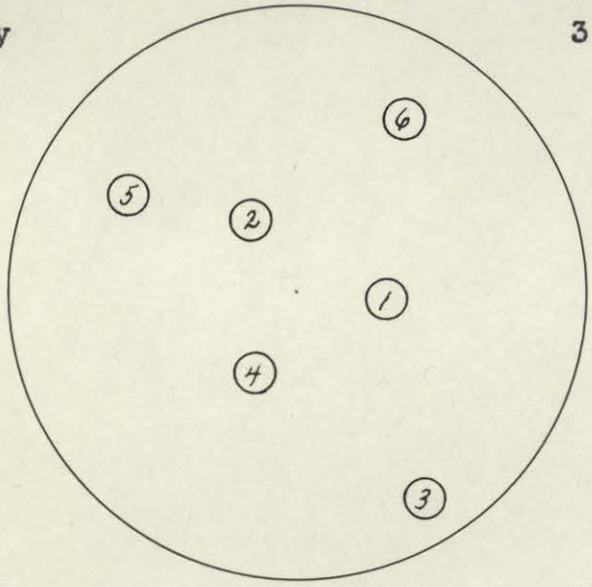
Averages	Moisture	Salt
After 1 day	12.48	1.32
After 3 days	12.29	1.42
After 7 days	11.67	1.27
After 15 days	11.95	1.32
After 30 days	12.02	1.31
Churn Sample	12.99	1.30



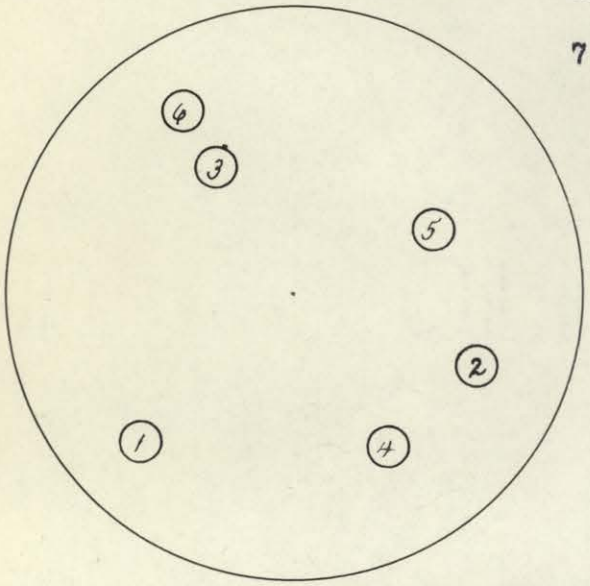
1 day



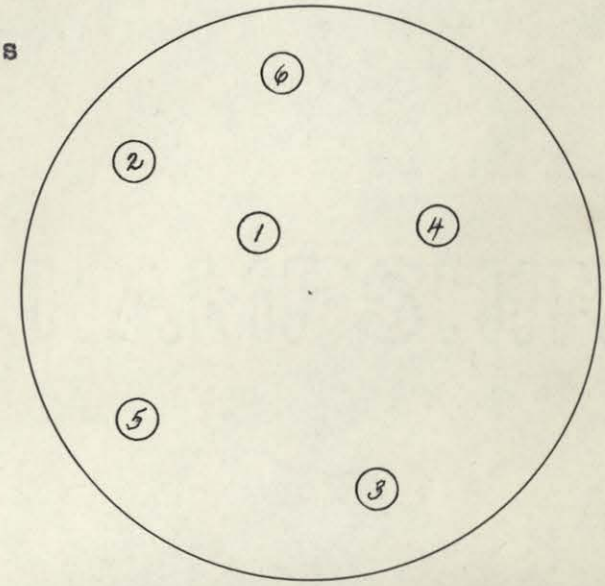
3 days



7 days



15 days



30 days

Tub II after 1 day

Sample Number	Moisture	Salt
1	13.32	1.66
2	11.62	1.31
3	11.43	1.36
4	13.21	1.32
5	11.39	1.30
6	11.36	1.25
Average	12.05	1.36

Tub II after 3 days

Sample Number	Moisture	Salt
1	12.37	1.41
2	12.46	1.27
3	11.95	1.54
4	11.74	1.44
5	11.63	1.43
6	11.50	1.41
Average	11.94	1.41

Tub II after 7 days

Sample Number	Moisture	Salt
1	11.02	1.27
2	11.60	1.35
3	11.85	1.26
4	10.99	1.34
5	10.97	1.36
6	10.54	1.36
Average	11.16	1.31

Tub II after 15 days

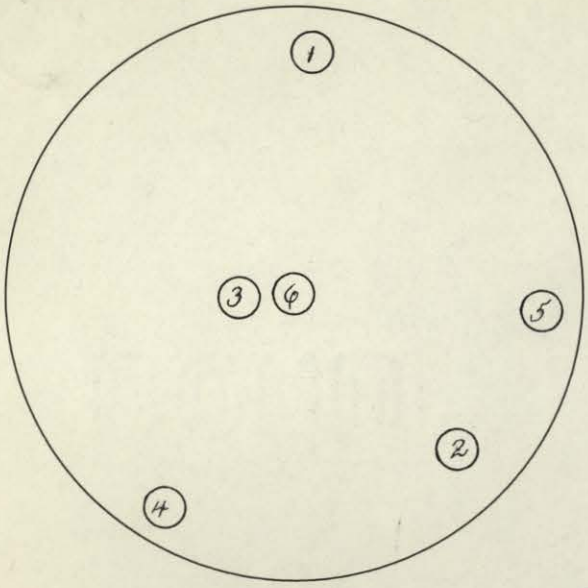
Sample Number	Moisture	Salt
1	10.76	1.07
2	9.66	1.10
3	12.29	1.53
4	11.68	1.33
5	10.50	1.19
6	10.58	1.19
Average	10.91	1.23

Tub II after 30 days

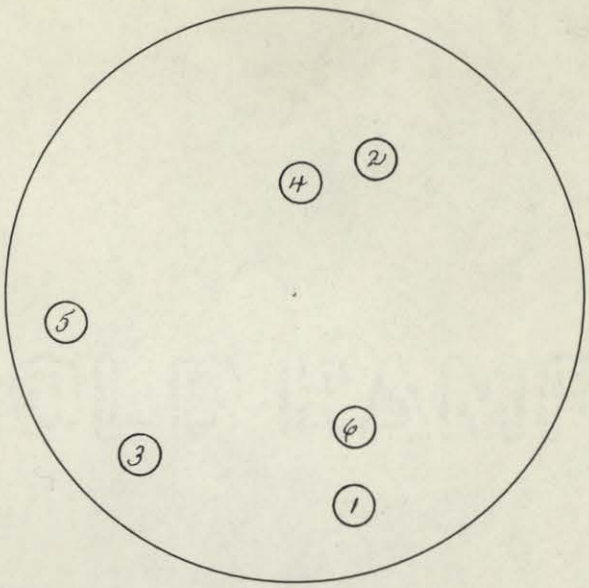
Sample Number	Moisture	Salt
1	10.38	1.02
2	11.18	1.43
3	10.56	1.29
4	11.31	1.07
5	10.83	1.30
6	11.61	1.19
Average	10.97	1.22

Summary Tub II

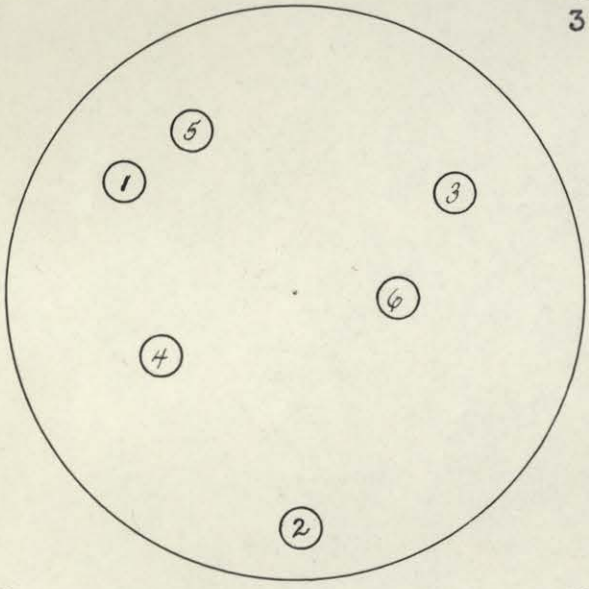
Averages	Moisture	Salt
After 1 day	12.05	1.36
After 3 days	11.94	1.41
After 7 days	11.16	1.31
After 15 days	10.91	1.23
After 30 days	10.97	1.22
Churn Sample	11.34	1.39



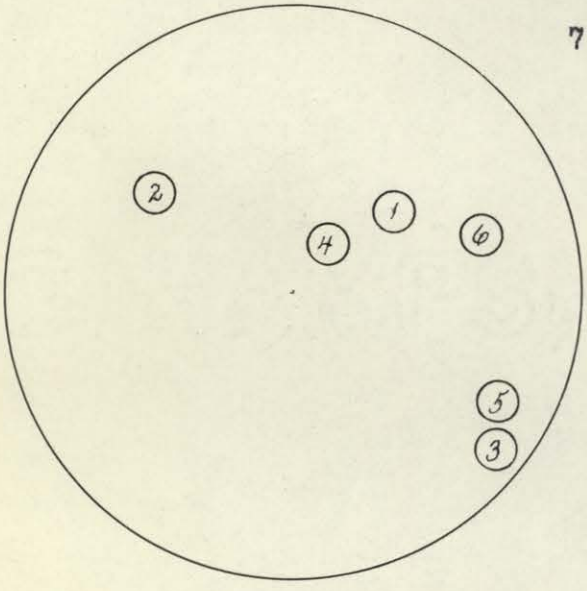
1 day



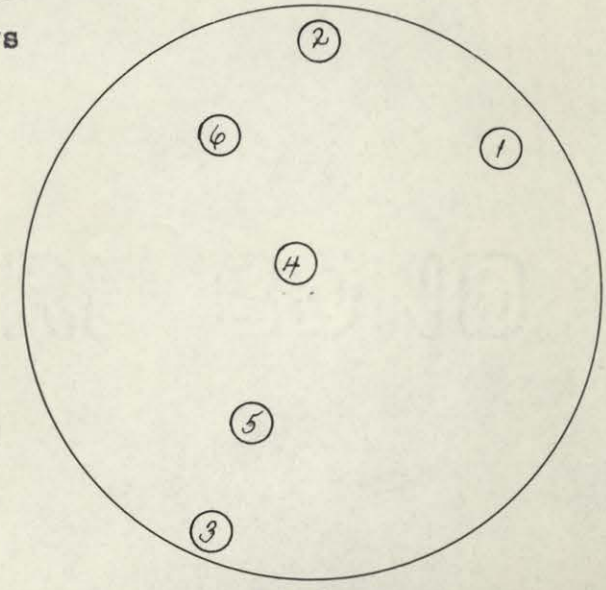
3 days



7 days



15 days



30 days

Tub III after 1 day

Sample Number	Moisture	Salt
1	11.08	1.90
2	10.70	1.89
3	11.10	1.80
4	10.99	1.93
5	10.67	1.93
6	11.80	1.97
Average	11.06	1.90

Tub III after 3 days

Sample Number	Moisture	Salt
1	11.80	2.08
2	11.52	1.97
3	11.30	1.94
4	11.39	1.89
5	11.68	1.80
6	11.08	1.92
Average	11.49	1.93

Tub III after 7 days

Sample Number	Moisture	Salt
1	10.34	1.84
2	10.69	1.71
3	10.71	1.72
4	11.43	1.87
5	10.90	1.73
6	11.31	1.85
Average	10.89	1.78

Tub III after 15 days

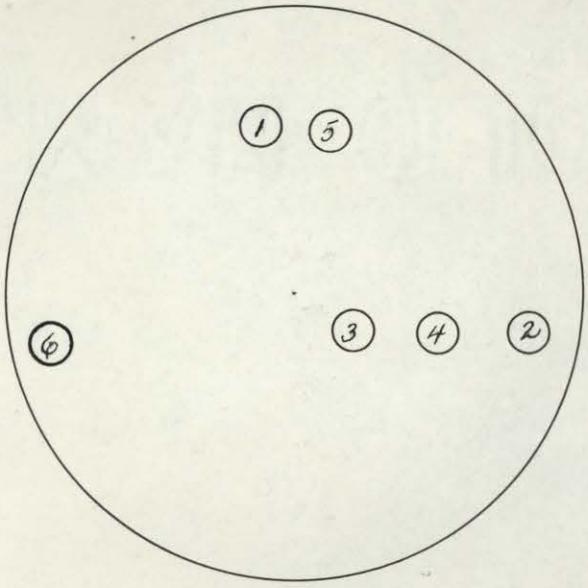
Sample Number	Moisture	Salt
1	10.75	1.70
2	11.01	1.98
3	10.46	1.61
4	10.66	1.70
5	11.18	1.76
6	9.76	1.59
Average	10.64	1.72

Tub III after 30 days

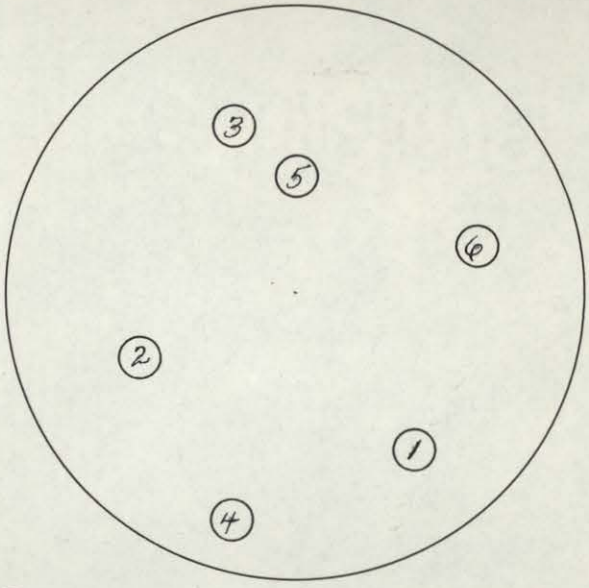
Sample Number	Moisture	Salt
1	10.31	1.58
2	9.85	1.52
3	11.07	1.56
4	9.82	1.77
5	9.85	1.62
6	9.81	1.70
Average	10.12	1.63

Summary Tub III

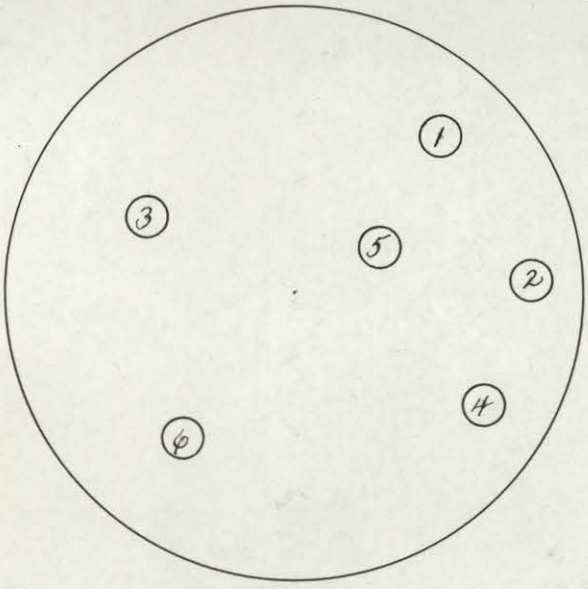
Averages	Moisture	Salt
After 1 day	11.06	1.90
After 3 days	11.49	1.93
After 7 days	10.89	1.78
After 15 days	10.64	1.72
After 30 days	10.12	1.63
Churn Sample	11.09	1.99



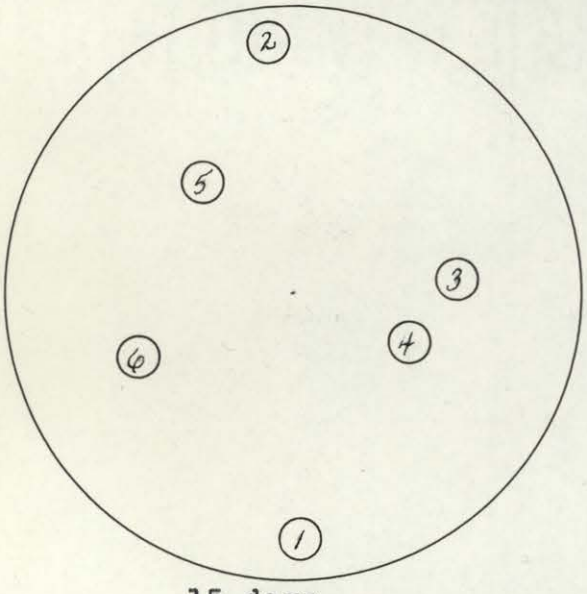
1 day



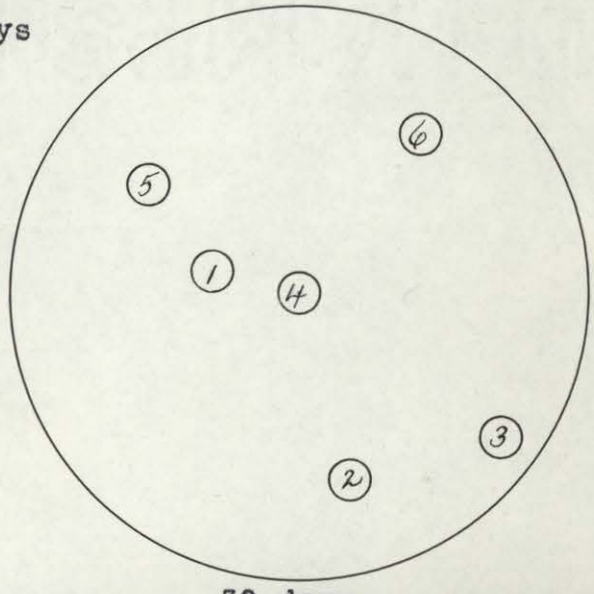
3 days



7 days



15 days



30 days

Tub IV after 1 day

Sample Number	Moisture	Salt
1	13.27	1.76
2	12.97	1.69
3	13.13	1.75
4	13.33	1.67
5	12.94	1.68
6	13.15	1.73
Average	13.48	1.71

Tub IV after 3 days

Sample Number	Moisture	Salt
1	14.36	1.92
2	14.45	1.97
3	13.50	1.99
4	13.79	1.76
5	13.99	1.81
6	13.99	1.70
Average	14.01	1.86

Tub IV after 7 days

Sample Number	Moisture	Salt
1	12.33	1.54
2	12.23	1.53
3	12.20	1.56
4	11.73	1.40
5	12.45	1.47
6	12.41	1.45
Average	12.22	1.50

Tub IV after 15 days

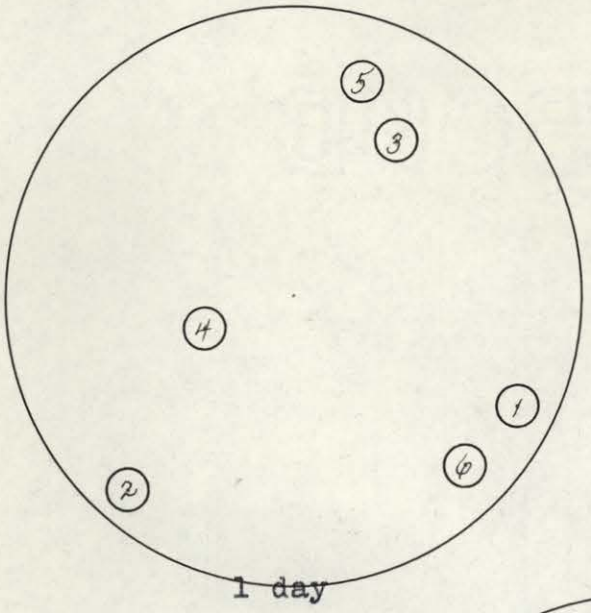
Sample Number	Moisture	Salt
1	12.64	1.71
2	12.35	1.50
3	12.48	1.68
4	12.23	1.44
5	12.58	1.55
6	12.94	1.59
	12.54	1.58

Tub IV after 30 days

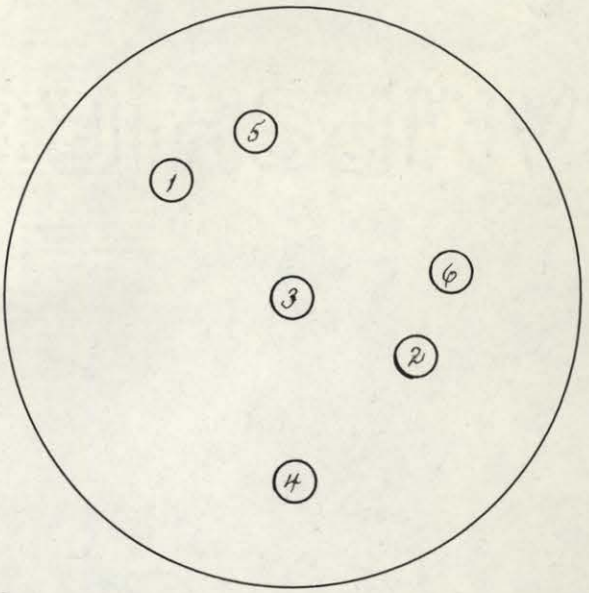
Sample Number	Moisture	Salt
1	11.47	1.22
2	11.73	1.37
3	11.60	1.43
4	11.57	1.31
5	11.67	1.34
6	11.99	1.34
Average	11.67	1.33

Summary Tub IV

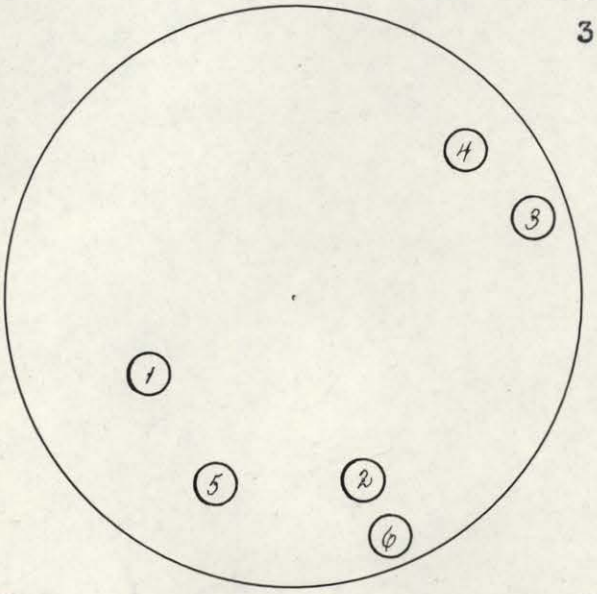
Averages	Moisture	Salt
After 1 day	13.48	1.71
After 3 days	14.01	1.86
After 7 days	12.22	1.50
After 15 days	12.54	1.58
After 30 days	11.67	1.33
Churn Sample	13.98	1.86



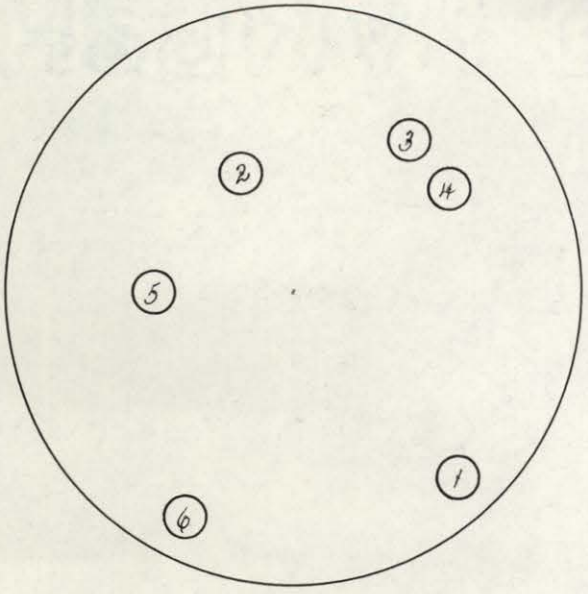
1 day



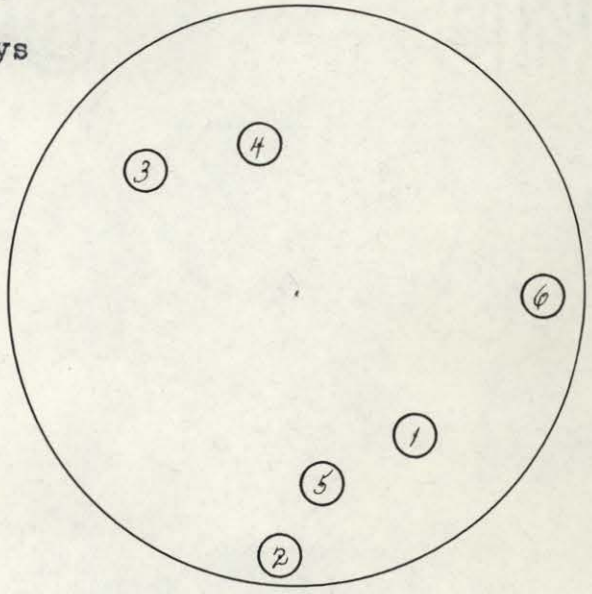
3 days



7 days



15 days



30 days

Tub V after 1 day

Sample Number	Moisture	Salt
1	11.24	1.89
2	11.29	2.06
3	11.18	2.10
4	11.96	2.08
5	13.93	1.87
6	12.59	2.24
Average	12.03	2.04

Tub V after 3 days

Sample Number	Moisture	Salt
1	11.36	1.72
2	10.77	1.75
3	10.38	1.68
4	9.92	1.56
5	10.38	1.78
6	10.53	1.64
Average	10.56	1.69

Tub V after 7 days

Sample Number	Moisture	Salt
1	11.57	1.92
2	11.06	1.76
3	11.43	1.57
4	11.72	1.17
5	10.41	1.55
6	11.76	1.96
Average	11.33	1.65

Tub V after 15 days

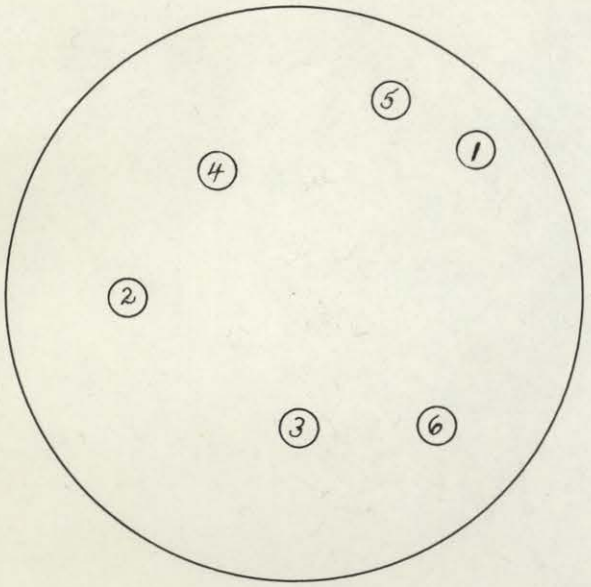
Sample Number	Moisture	Salt
1	9.86	1.44
2	10.29	1.67
3	10.81	1.72
4	10.82	1.56
5	10.29	1.61
6	9.27	1.41
Average	10.22	1.57

Tub V after 30 days

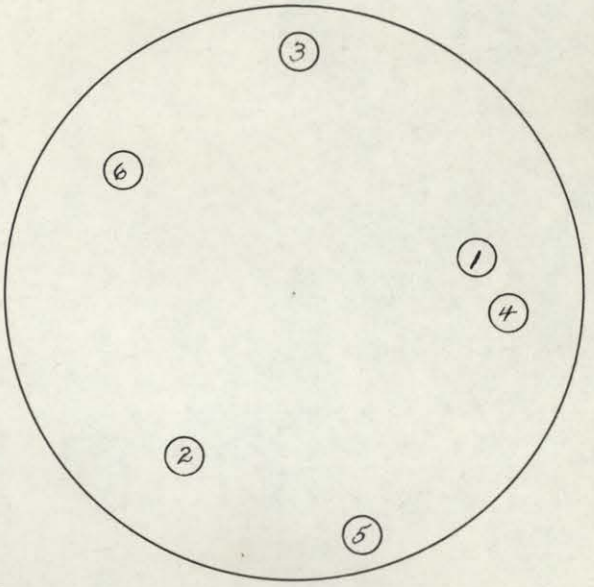
Sample Number	Moisture	Salt
1	9.22	1.59
2	9.00	1.70
3	9.88	1.64
4	9.66	1.30
5	9.29	1.59
6	9.35	1.68
Average	9.40	1.59

Summary Tub V

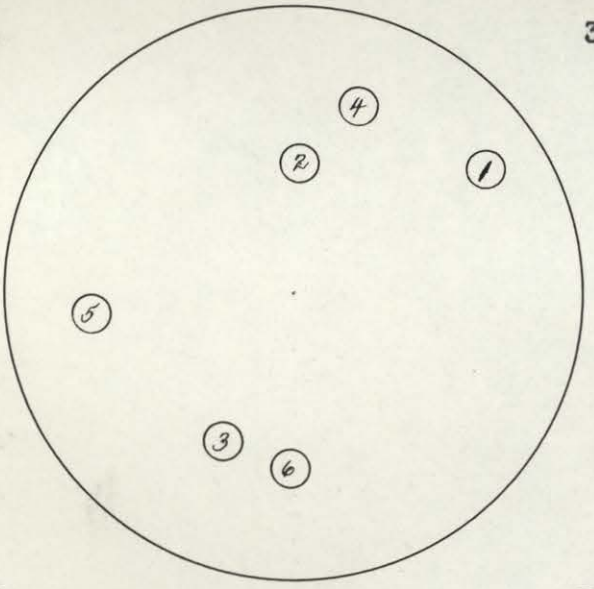
Averages	Moisture	Salt
After 1 day	12.03	2.04
After 3 days	11.33	1.65
After 7 days	10.56	1.69
After 15 days	10.22	1.57
After 30 days	9.40	1.59
Churn Sample	12.17	2.32



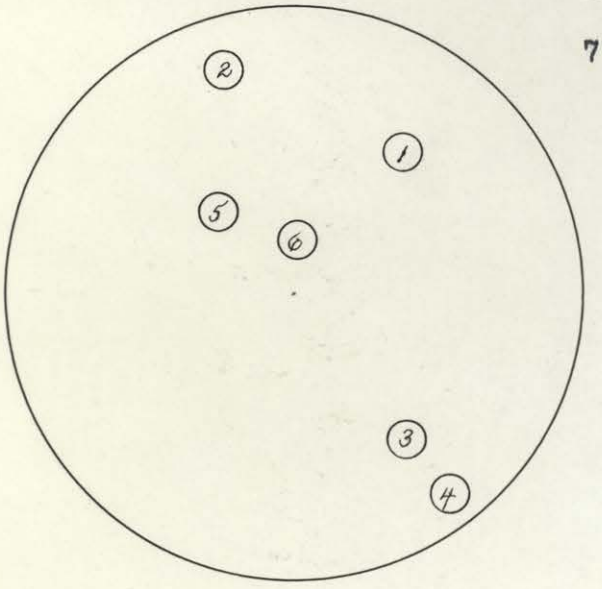
1 day



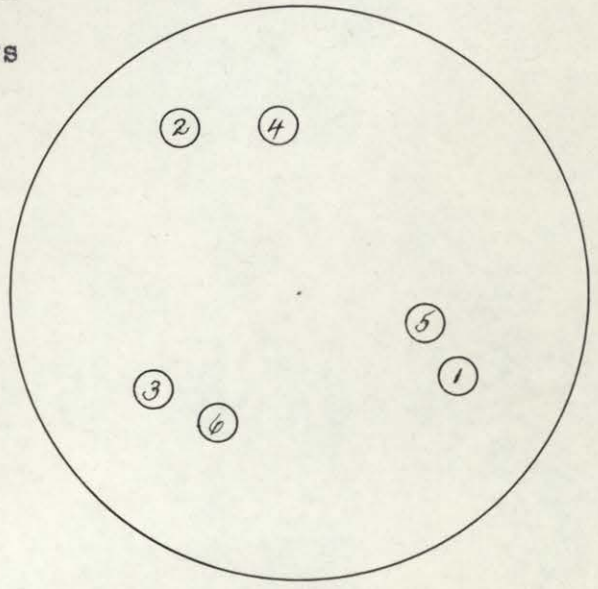
3 days



7 days



15 days



30 days

Tub VI after 1 day

Sample Number	Moisture	Salt
1	11.69	1.39
2	11.89	1.49
3	11.46	1.36
4	12.30	1.53
5	11.52	1.53
6	12.14	1.77
Average	11.83	1.51

Tub VI after 3 days

Sample Number	Moisture	Salt
1	11.84	1.45
2	11.96	1.47
3	11.81	1.46
4	11.76	1.43
5	12.08	1.48
6	11.87	1.51
Average	11.89	1.47

Tub VI after 7 days

Sample Number	Moisture	Salt
1	10.31	1.27
2	12.18	1.37
3	11.66	1.55
4	11.99	1.45
5	11.51	1.28
6	11.35	1.58
	11.50	1.42

Tub VI after 15 days

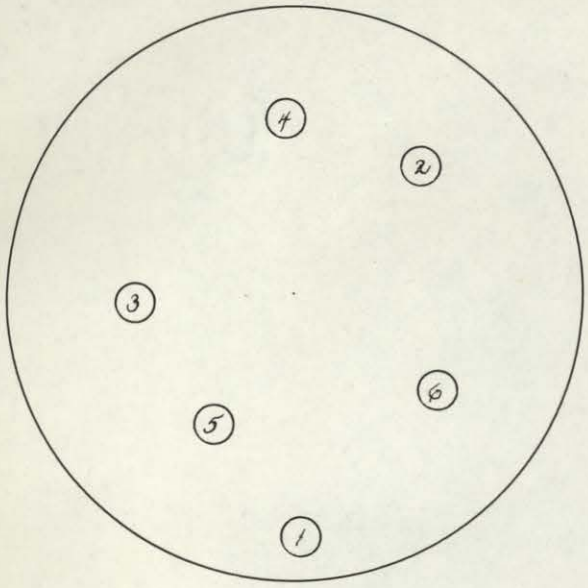
Sample Number	Moisture	Salt
1	12.22	1.64
2	11.82	1.34
3	11.99	1.47
4	11.05	1.47
5	11.03	1.51
6	12.03	1.44
Average	11.69	1.48

Tub VI after 30 days

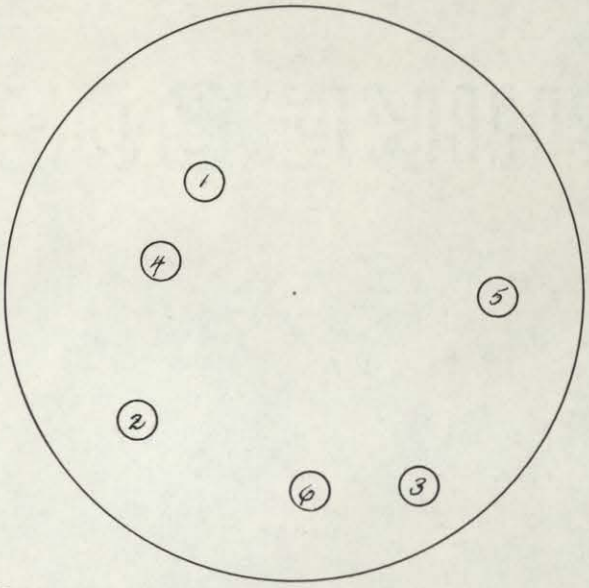
Sample Number	Moisture	Salt
1	10.61	1.52
2	10.09	1.54
3	12.24	1.64
4	12.88	1.64
5	11.09	1.41
6	10.79	1.35
Average	11.29	1.51

Summary Tub VI

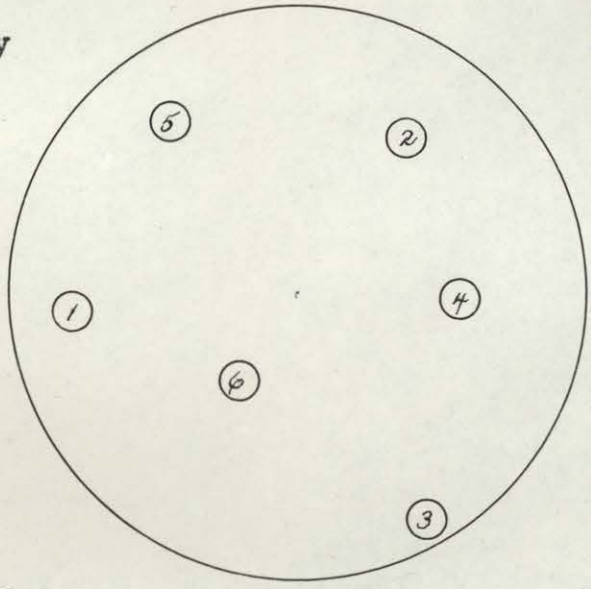
Averages	Moisture	Salt
After 1 day	11.83	1.51
After 3 days	11.89	1.47
After 7 days	11.50	1.42
After 15 days	11.69	1.48
After 30 days	11.29	1.51
Churn Sample	11.84	1.55



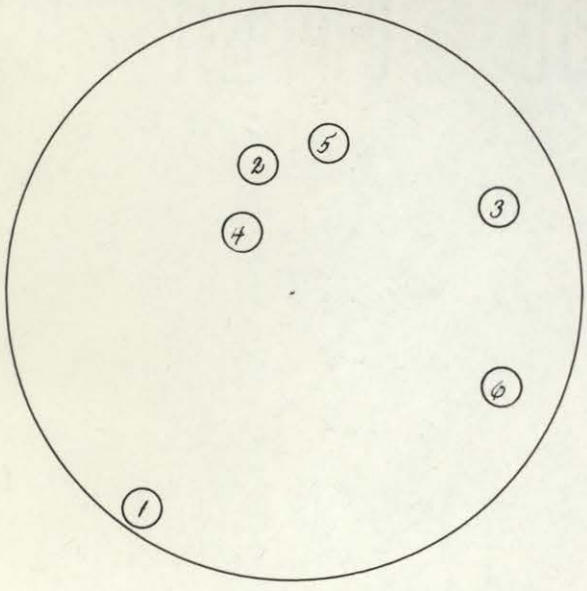
1 day



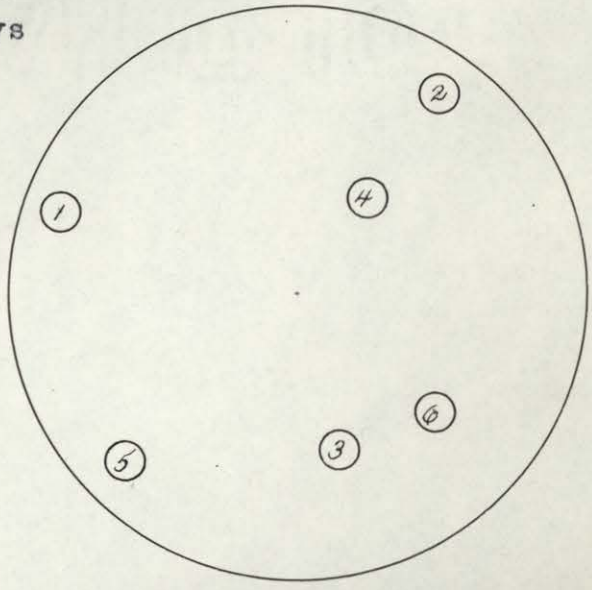
3 days



7 days



15 days



30 days

Tub VII after 1 day

Sample Number	Moisture	Salt.
1	10.94	1.38
2	12.33	1.62
3	11.84	1.43
4	11.97	1.51
5	11.80	1.43
6	11.10	1.17
Average	11.66	1.42

Tub VII after 3 days

Sample Number	Moisture	Salt
1	10.06	1.24
2	9.81	1.25
3	9.13	1.50
4	10.75	1.31
5	10.41	1.49
6	10.49	1.24
Average	10.11	1.34

Tub VII after 7 days

Sample Number	Moisture	Salt
1	10.59	1.29
2	10.52	1.35
3	10.19	1.38
4	10.94	1.50
5	10.01	1.42
6	9.53	1.16
Average	10.30	1.35

Tub VII after 15 days

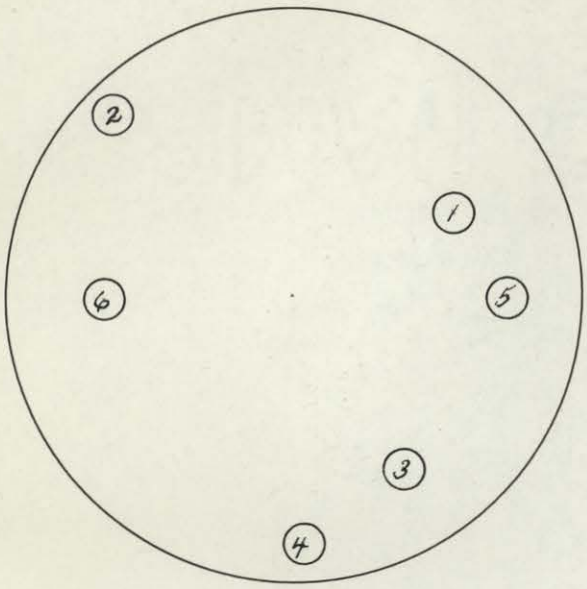
Sample Number	Moisture	Salt
1	10.63	1.52
2	10.05	1.38
3	11.48	1.79
4	10.61	1.23
5	10.68	1.51
6	9.53	1.26
Average	10.50	1.45

Tub VII after 30 days

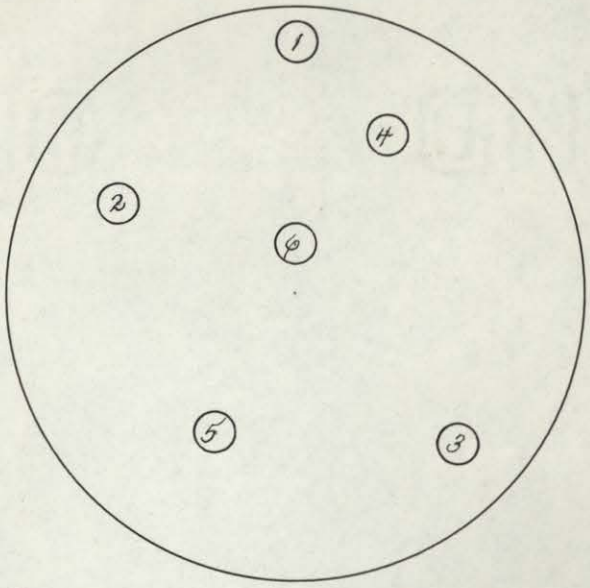
Sample Number	Moisture	Salt
1	9.70	1.19
2	9.96	1.35
3	10.35	1.29
4	9.93	1.28
5	10.22	1.27
6	10.49	1.38
Average	10.11	1.29

Summary Tub VII

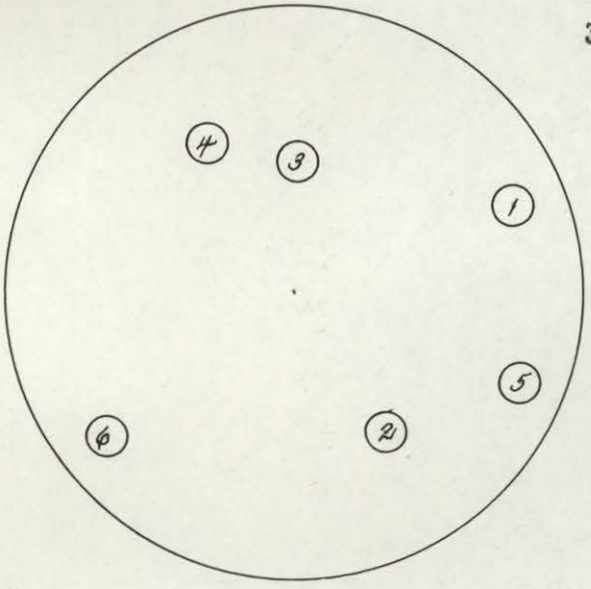
Averages	Moisture	Salt
After 1 day	11.66	1.42
After 3 days	10.11	1.34
After 7 days	10.30	1.35
After 15 days	10.50	1.45
After 30 days	10.11	1.29
Churn Sample	11.80	1.64



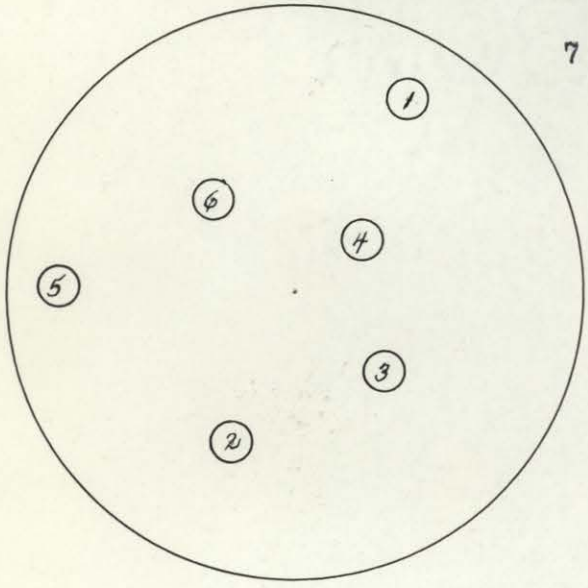
1 day



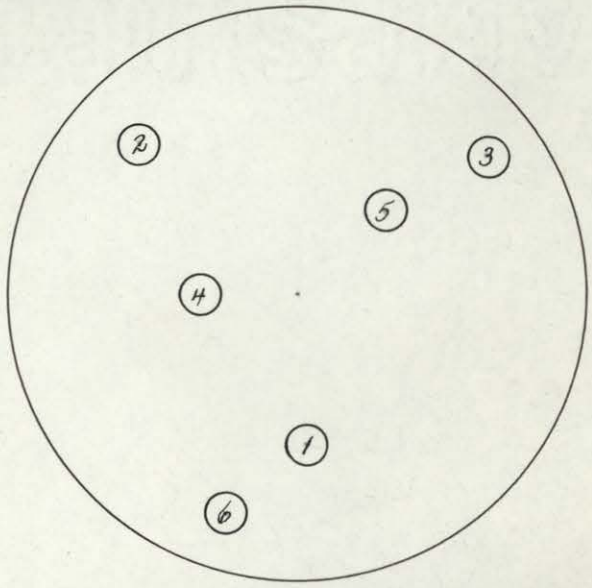
3 days



7 days



15 days



30 days

Tub VIII after 1 day

Sample Number	Moisture	Salt
1	10.90	1.04
2	10.82	1.09
3	10.83	1.10
4	11.56	1.05
5	11.27	1.13
6	11.04	1.04
Average	11.07	1.07

Tub VIII after 3 days

Sample Number	Moisture	Salt
1	10.51	.91
2	9.70	.84
3	10.59	.82
4	10.68	.82
5	10.44	.77
6	11.07	1.04
Average	10.50	.87

Tub VIII after 7 days

Sample Number	Moisture	Salt
1	10.51	.94
2	10.56	.95
3	10.71	1.09
4	10.61	.87
5	11.00	.96
6	10.34	1.14
Average	10.62	.99

Tub VIII after 15 days

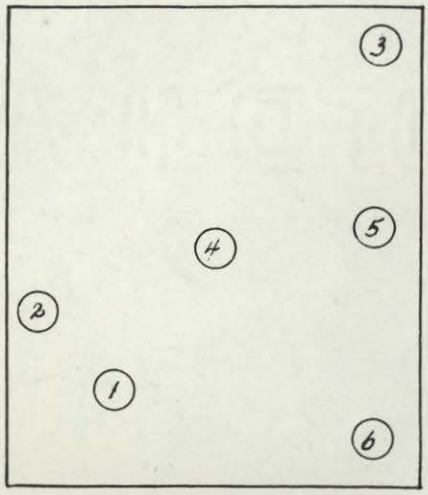
Sample Number	Moisture	Salt
1	10.05	.86
2	10.44	.89
3	10.17	.90
4	10.70	.81
5	10.85	.88
6	10.84	.84
Average	10.51	.86

Tub VIII after 30 days

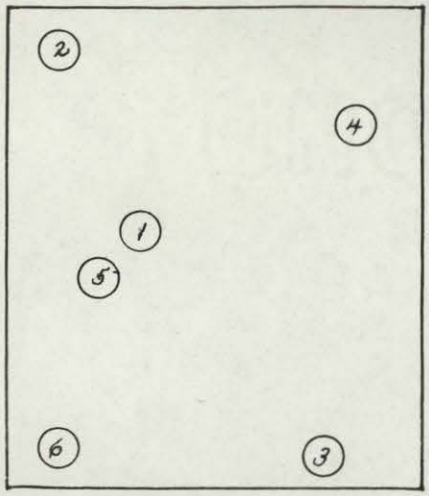
Sample Number	Moisture	Salt
1	9.88	.80
2	9.77	.82
3	10.02	1.04
4	10.85	.99
5	10.14	.94
6	10.02	.97
Average	10.11	.93

Summary Tub VIII

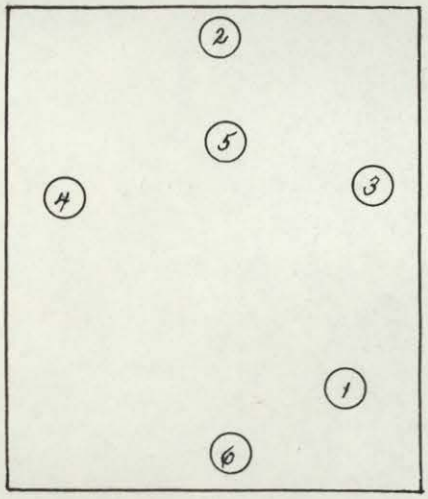
Averages	Moisture	Salt
After 1 day	11.07	1.07
After 3 days	10.50	.87
After 7 days	10.62	.99
After 15 days	10.51	.86
After 30 days	10.11	.93
Churn Sample	11.52	1.03



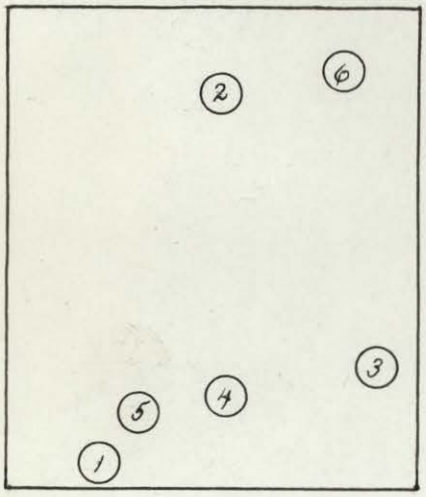
1 day



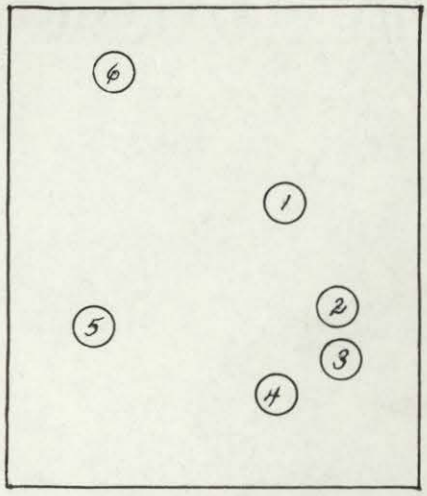
3 days



7 days



15 days



30 days

Cube I after 1 day

Sample Number	Moisture	Salt
1	12.39	1.19
2	11.78	1.51
3	10.79	1.07
4	11.30	.98
5	11.14	.97
6	11.86	1.04
Average	11.54	1.13

Cube I after 3 days

Sample Number	Moisture	Salt
1	10.86	1.01
2	10.94	.80
3	11.36	1.18
4	13.18	1.13
5	11.08	.86
6	11.58	.87
Average	11.50	.98

Cube I after 7 days

Sample Number	Moisture	Salt
1	11.19	1.00
2	11.23	.94
3	10.88	.84
4	12.76	1.01
5	11.49	1.00
6	10.73	.82
Average	11.38	.93

Cube I after 15 days

Sample Number	Moisture	Salt
1	10.76	1.24
2	10.79	.83
3	11.11	1.11
4	10.73	.92
5	10.77	.85
6	10.98	.98
Average	10.86	.99

Cube I after 30 days

Sample Number	Moisture	Salt
1	10.90	.96
2	10.75	.95
3	10.95	.93
4	10.91	.97
5	11.00	.94
6	11.38	.94
Average	10.95	.95

Averages	Moisture	Salt
After 1 day	11.54	1.13
After 3 days	11.50	.98
After 7 days	11.38	.93
After 15 days	10.86	.99
After 30 days	10.95	.95
Churn Sample	11.52	1.03

Table showing the averages of all samples taken at the definite periods of storage.

Tub	Churn		After 1 day	
	Moisture	Salt	Moisture	Salt
1	12.99	1.30	12.48	1.32
2	11.34	1.39	12.05	1.36
3	11.09	1.99	11.06	1.90
4	13.98	1.86	13.48	1.71
5	12.17	2.32	12.03	2.04
6	11.84	1.55	11.83	1.51
7	11.80	1.64	11.66	1.42
8	11.52	1.03	11.07	1.07
Cube 1	11.52	1.03	11.54	1.13
Average	12.03	1.57	11.91	1.49

	After 3 days		After 7 days	
Tub	Moisture	Salt	Moisture	Salt
1	12.29	1.42	11.67	1.27
2	11.94	1.41	11.16	1.31
3	11.49	1.93	10.89	1.78
4	14.01	1.86	12.22	1.50
5	11.33	1.65	10.56	1.69
6	11.89	1.47	11.50	1.42
7	10.11	1.34	10.52	1.35
8	10.50	.87	10.62	.99
Cube 1	11.50	.98	11.38	.93
Average	11.67	1.44	11.15	1.36

	After 15 days		After 30 days	
Tub	Moisture	Salt	Moisture	Salt
1	11.95	1.32	13.02	1.31
2	10.91	1.23	10.97	1.22
3	10.64	1.72	10.12	1.63
4	12.54	1.58	11.67	1.33
5	10.22	1.57	9.40	1.59
6	11.69	1.48	11.29	1.51
7	10.50	1.45	10.11	1.29
8	10.51	.86	10.11	.93
Cube 1	10.86	.99	10.95	.95
Average	10.98	1.35	10.77	1.31

Summary

	Moisture	Salt
Churn	12.03	1.57
After 1 day	11.91	1.49
After 3 days	11.67	1.44
After 7 days	11.15	1.36
After 15 days	10.98	1.35
After 30 days	10.77	1.31

Table showing the average moisture and salt content of the three top samples as compared with the three bottom samples.

	Top Samples		Bottom Samples	
		Tub I		
	Moisture	Salt	Moisture	Salt
After 1 day	12.55	1.36	12.41	1.28
After 3 days	12.52	1.40	12.08	1.44
After 7 days	11.95	1.28	11.40	1.26
After 15 days	12.26	1.34	11.64	1.31
After 30 days	12.16	1.36	11.87	1.26
		Tub II		
	Moisture	Salt	Moisture	Salt
After 1 day	12.12	1.44	11.92	1.29
After 3 days	12.26	1.42	11.62	1.43
After 7 days	11.49	1.29	10.83	1.35
After 15 days	10.90	1.23	10.92	1.24
After 30 days	10.71	1.25	11.25	1.19
		Tub III		
	Moisture	Salt	Moisture	Salt
After 1 day	10.96	1.86	11.15	1.94
After 3 days	11.54	2.00	11.38	1.87
After 7 days	10.58	1.76	11.21	1.82
After 15 days	10.74	1.76	10.53	1.68
After 30 days	10.41	1.55	9.83	1.70

	Top Samples		Bottom Samples	
		Tub IV		
	Moisture	Salt	Moisture	Salt
After 1 day	13.79	1.73	13.14	1.69
After 3 days	14.10	1.96	13.92	1.76
After 7 days	12.25	1.54	12.20	1.44
After 15 days	12.49	1.63	12.58	1.53
After 30 days	11.60	1.34	11.74	1.33
		Tub V		
	Moisture	Salt	Moisture	Salt
After 1 day	11.24	2.02	12.83	2.06
After 3 days	10.84	1.72	10.28	1.66
After 7 days	11.35	1.75	11.30	1.56
After 15 days	10.32	1.61	10.13	1.53
After 30 days	9.37	1.64	9.43	1.55
		Tub VI		
	Moisture	Salt	Moisture	Salt
After 1 day	11.68	1.41	11.99	1.61
After 3 days	11.87	1.46	11.90	1.47
After 7 days	11.38	1.40	11.62	1.44
After 15 days	12.01	1.48	11.37	1.47
After 30 days	10.98	1.57	11.59	1.47
		Tub VII		
	Moisture	Salt	Moisture	Salt
After 1 day	11.70	1.48	11.62	1.37
After 3 days	9.67	1.33	10.55	1.35
After 7 days	10.43	1.34	10.16	1.36
After 15 days	10.72	1.56	10.27	1.33
After 30 days	10.01	1.28	10.21	1.31

	Top Samples		Bottom Samples	
		Tub VIII		
	Moisture	Salt	Moisture	Salt
After 1 day	10.85	1.08	11.29	1.07
After 3 days	10.27	.86	10.75	.88
After 7 days	10.59	.99	10.68	.99
After 15 days	10.22	.88	10.80	.84
After 30 days	9.89	.89	10.34	.97
		Cube I		
	Moisture	Salt	Moisture	Salt
After 1 day	11.65	1.26	11.43	1.00
After 3 days	11.05	1.00	11.95	.95
After 7 days	11.10	.99	11.66	.94
After 15 days	10.89	1.06	10.83	.92
After 30 days	10.87	.95	11.10	.95
		Summary		
	Moisture	Salt	Moisture	Salt
After 1 day	11.84	1.52	11.98	1.48
After 3 days	11.62	1.46	11.60	1.42
After 7 days	11.24	1.37	11.23	1.35
After 15 days	11.17	1.39	11.01	1.32
After 30 days	10.70	1.31	10.82	1.30

Bibliography

1. (T. D. 1871) Office of Commissioner of Internal Revenue.
2. (T. D. 1810) Office of Commissioner of Internal Revenue.
3. Analysist 1892 pp. 107-109.
4. Forsog Circular Mar. 12, 1893, pp. 4.
5. Forsog 28th Report Copenhagen 1893 pp. 217.
6. Analysist 1894, Jan. pp. 16-18.
7. Landtman 16 (1895) pp. 900-905.
8. Milch Ztg. 23 (1894) No. 46 pp. 733, 734.
9. Finland 1899 pp. 04.
10. Cornell Bulletin 355.
11. California Report 1916.
12. Ber Nahrmth Untersuch, amt Bromberg, 1913 p. 16.
13. Hildesheim 25 (1911) No. 16 pp. 271.
14. Cornell Bulletin 336.
15. Illinois Bulletin 137.
16. Chicago Dairy Produce, October 1916.
17. Journal Agr. & Ind. South Australia 1902 No. 6, pp. 544.
18. Bul. Soc. Chem. Beld 20 (1906) No. 11 pp. 365.
19. Wisconsin Bulletin No. 154.
20. Annual Report Ontario Agr. Col. & Expt. Farm, 33 1907 pp. 97.
21. Forsog Copenhagen 62 (1907) pp 30.