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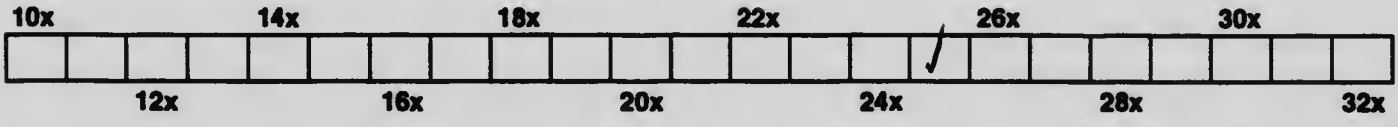

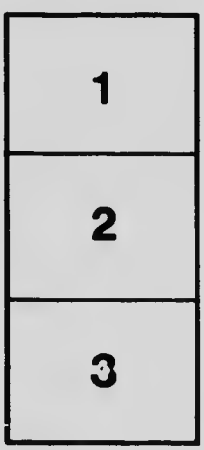

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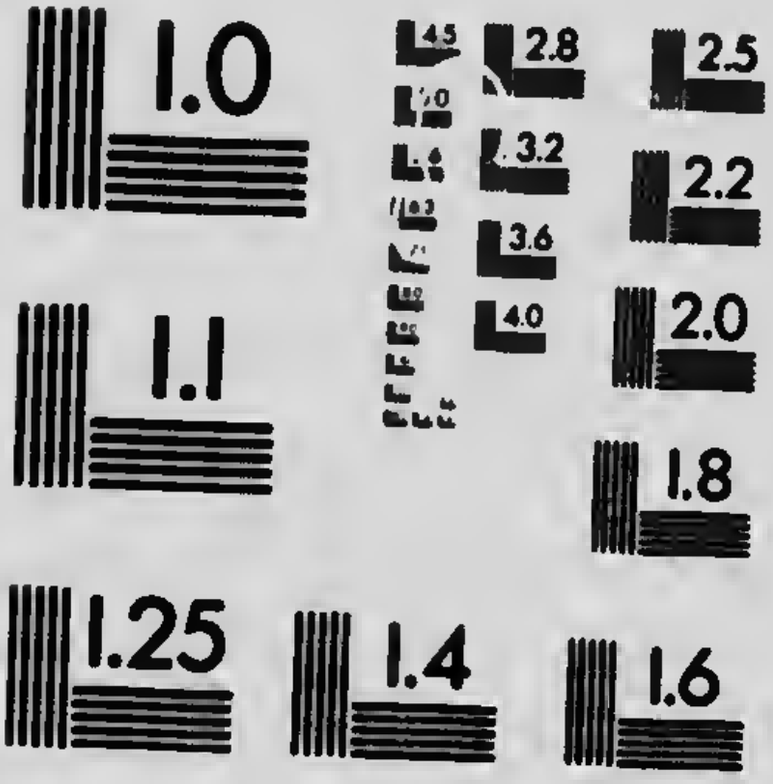

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DEPARTMENT OF AGRICULTURE
DAIRY COMMISSIONER'S BRANCH
OTTAWA, CANADA

SOME OF THE FACTORS

THAT CONTROL

THE WATER-CONTENT OF BUTTER

BY

FRANK T. SHUTT, M.A., F.I.C.,
Chemist, Dominion Experimental Farms

WITH THE ASSISTANCE OF

Mr. C. F. Whitley, B.S.A., and Mr. A. T. Charron, M.A.

BULLETIN No. 8

Published by direction of the Hon. SYDNEY A. FISHER, Minister of Agriculture, Ottawa, Ont.
JANUARY, 1906

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DEPARTMENT OF AGRICULTURE
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OTTAWA, CANADA

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* The Dairy Commissioner gives his personal attention to the Dairy and Cold Storage Divisions.

† Cargo Inspectors are stationed at Liverpool, Manchester, Bristol, London and Glasgow.

LETTER OF TRANSMITTAL.

The Honourable SYDNEY A. FISHER,
Minister of Agriculture,
Ottawa.

SIR,—I have the honour to submit for your approval Bulletin No. 8, of the Dairy Commissioner's Branch series. This bulletin gives the results of a series of experiments undertaken to determine 'Some of the Factors which Control the Water-content of Butter.' I beg to recommend that it be printed for distribution.

I have the honour to be, sir,

Your obedient servant,

J. A. RUDDICK,
Dairy Commissioner.

SOME OF THE FACTORS THAT CONTROL THE WATER-CONTENT OF BUTTER.

BY

FRANK T. SHUTT, M.A., F.I.C.,
Chemist, Dominion Experimental Farms.

WITH THE ASSISTANCE OF

MR. C. F. WHITLEY, B.S.A., AND MR. A. T. CHARRON, M.A.

Water is a normal constituent of butter. Butter-fat, pure and simple, could never become an article of diet; it would be unpalatable and disagreeable, and also—a matter of considerable importance—it would be uninviting in appearance.

Further, butter without salt or other preservative could not be held good for any length of time at ordinary temperatures. These preservatives do not dissolve in butter-fat; mechanically mixed with pure butter-fat they could not act in keeping the butter. It is these saline materials in solution (brine) that preserve the butter. The keeping qualities of butter, therefore, are in a certain sense dependent upon the water-content.

There is also, no doubt, a relationship between 'body' or texture and water-content. There are no data, unfortunately, that can be presented to prove this point, or rather to show the exact proportion of water that should be present for the best results, but of this fact there is ample evidence—that an excessive amount of water, no matter how well incorporated, tends to destroy this desirable property, and this is especially true when obtained by means of a high churning or washing temperature.

'Quality' in butter includes flavour, body or texture, appearance and similar attributes; it is a comprehensive term and may be said to result from several causes, beginning with the nature of the feed the cow receives, and ending with the various details of fermentation of the cream and manufacture of the butter. Nevertheless, the probabilities are that in controlling the water-content we have at least one means of controlling the quality of butter, and this, apart from 'keeping quality,' a distinct property from quality as usually understood, is one which undoubtedly is injuriously affected by a high water content. For quality as judged immediately after the butter is made, much depends upon the thorough incorporation of the water and the temperatures at which it is incorporated, but it is very doubtful if there is not in all cases a distnct falling off in value when the water exceeds 41 per cent, no matter how skilfully the butter is made.

Though, as we have seen, water is a necessary and legitimate constituent of butter, there is no recognized normal water-content, unless one so regards the legal limits fixed in some countries, as, for instance, 16 per cent in Canada as a maximum. As butter comes from the churn and before working it may contain between 16 per cent and 22 per cent. After working and draining, unless the conditions are exceedingly abnormal, it may contain between 7 per cent and 16 per cent, according to certain factors to be discussed later in this bulletin. According to the concensus of European authorities, well made butter of the best quality should not contain more than 15 per cent water, and as far as the writers can gather, most experts favour a water-content between 13 per cent and 14 per cent. In this latter deduction, the analytical data of

butters made in England, Denmark, Sweden, Holland, and other European countries, have been consulted.

It has been stated that water is a necessary and legitimate constituent of butter; nevertheless, when present in excessive or unusual amounts it is accounted an adulterant. Water in undue proportions results from fraud or lack of skill in the manufacture of the butter, but in either case the butter so characterized is held to be adulterated. As we have already stated, the legal limit of water-content in Canada is 16 per cent. It is, therefore, evident that as regards the desirability or possibility of making butter in Canada having a moisture content of 16 per cent or over, there is no room for discussion. But we go further than this and say that it would be highly injudicious to approach this percentage.

Two years ago we submitted to analysis a large number of samples of creamery butter made in various parts of the Dominion, and we found that this butter contained an average of 12·3 per cent water*. We considered this, from all points of view, a very satisfactory amount, though very possibly it might be brought up to 13·5 per cent without injury to the butter. A higher percentage would mean a larger 'overrun,' which, of course, implies a larger return, but the probabilities are that the benefit would not be a lasting one, for the quality of the butter would suffer, and the butter trade—and particularly the export trade—would be correspondingly injured. It seems undesirable, therefore, we believe, to adopt any modification in manufacture that would result in a butter with a water-content above 13·5 per cent. As an illustration of the relation between keeping quality and water-content, we may instance the New Zealand butter. This butter is in excellent repute in the British market, and the analysis of a number of samples made last year gave an average water-content of 10·59 per cent.

This is a matter which is receiving considerable attention at the present time, and we, consequently, take this opportunity of impressing upon those in authority in Canadian creâmeries that it would be extremely unwise for a present benefit to hazard the loss of our reputation. We can make first class butter with good keeping qualities, and the output from the majority of our creameries is, and has been, of this character; any deviation in the direction of a butter containing more water would, as we have said, lead eventually to loss and possibly injury to the butter industry that it would take years to recover from.

EXPERIMENTAL WORK.

For the better guidance of butter makers we have endeavoured to ascertain some of the factors that influence the water-content of butter. This investigation was undertaken at the suggestion of and with the co-operation of the Dairy Commissioner, Mr. J. A. Ruddick, who personally supervised the manufacture of the butter, and otherwise assisted in carrying on the work. The butter was made by an expert butter maker, with special apparatus and accommodation for prosecuting the research. Two 50-gallon 'Simplex' combined churns were used. This enabled us to divide the ripened cream and carry on, side by side, the making of the butters under the varying conditions as noted in the discussion of the experimental work. Every precaution was taken to eliminate in each trial all the factors save the one under examination, and thus obtain data that would be strictly comparable. Accurate and complete records were kept of the temperatures throughout the various processes, of the richness and ripeness of the cream, and of all the other factors to be noted in the manufacture of butter, but only such data as directly bear upon the results obtained will be here inserted. Unless otherwise specified in the text, the cream was churned at a temperature of about 57° F. until granules of the size of small wheat were obtained. The resulting butters, in all 105 samples, were carefully and completely analysed in the laboratories of the experimental farms. The percentages given in the following tables are averages

* The percentage of water in Canadian Creamery Butter, Bulletin No. 4, new series, Branch of the Commissioner of Agriculture and Dairying.

and frequently represent the analysis of eight or ten butters. Most of the trials were quadruplicated.

The chief factors investigated were: temperature of churning, temperature of wash water, size of granules when churning was stopped, the length of the time between salting and final working, and the effect of varying amounts of salt. The results show very clearly that there is a very distinct relation between the process of manufacture and the percentage of water the butter will contain.

Table I.—High and Low Churning Temperatures.

Also showing effect on resulting butter of wash water at high and low temperatures. (Including the results of twelve trials).

High Churning Temperature. 70° F.		Low Churning Temperature. 46° F.—51° F.	
Temperature of Wash Water.		Temperature of Wash Water.	
High, 66° F.	Low, 46° F.	High, 66° F.	Low 49° F.
Water. % 17·11	Water. % 15·32	Water. % 14.88	Water. % 14·02

With the high churning temperatures the average fat-content of the butter-milk was 0·6 per cent, and with the low churning temperatures, 0·1 per cent.

As far as was practicable, the churning in these tests was stopped when the granules attained the size of small wheat grains, but this could not always be effected with accuracy when churning at high temperatures. The times of working and the rate of salting were alike in all the trials.

The following deductions may be made from the results: –

1. That the higher the churning temperature, within reasonable limits, the higher the water-content.

2. That a low temperature wash water reduces, in a certain degree, the water-content of a butter from a high churning temperature. The converse of this is also true—that a high temperature wash water increases the water-content of a butter churned at a low temperature.

It is very plain from this series that the results of a high churning temperature cannot be sufficiently corrected by a low temperature wash water to reduce the water in the butter to a safe percentage.

3. That the greater loss of butter-fat in the butter-milk ensues from the higher churning temperatures.

Table II.—Size of Granules.

Size of Clover Seed, 2 trials.	Size of Corn Grains, 2 trials.	Overchurned: Size of Walnuts and over, 2 trials.
Water. % 13·59	Water. % 14·75	Water. % 20·23

In this series the churning temperatures and temperature of the wash waters were practically the same throughout, as were also the manner and times of working and the rate of salting.

These data need no explanation; it is very evident that the larger the granules to which the butter is churned, the more water will the butter contain, other things being equal.

Table III.—The Length of Time Between Salting and Working.

(The butter was salted immediately after churning, in granular form).

Worked 2 Hours after Salting.	Worked 24 Hours after Salting.
Water. % 13·42	Water. % 11·78

The temperature of the storage room in which the butters were kept when working was delayed, was 45° F.

By delaying the final working of the butter after salting 24 hours a very appreciable reduction in the water-content is effected. These butters at salting were identical, being part of the same churning. The data include results from eight trials.

Supplementary to the data presented in the foregoing table, results may now be given which were obtained to ascertain the reduction in water-content by working the butter at various periods within the 24 hours after salting.

Table IV.—The Length of Time Between Salting and Working.

(Butter salted in granular form).

Worked at Once.	After 2 Hours.	After 4 Hours.	After 24 Hours.
Water. % 14·10	Water. % 12·54	Water. % 12·44	Water. % 11·10

Each average represents four butters. In each of the four trials the butter was salted, divided and the portions worked as indicated.

These analyses add further proof that delaying the final working lowers the water-content; that is, the longer the period between salting and working, when the butter is kept at the same temperature, the drier will be the butter.

In the next series of experiments it was sought to learn the effect on the water-content by salting after 24 hours, as compared with the method usually adopted of salting immediately after churning.

Table V.—Salting at Once and Salting After 24 Hours.

Salted at once and Worked after 24 Hours.	Slightly Worked: Salted after 24 Hours and Worked at once.
Water. % 11·91	Water. % 12·51

This series included seven trials, in each case the butter being divided and the portions treated as indicated in the table.

The results confirm those of Tables III. and IV., and show that the length of time between salting and working is an important factor in reducing the water-content.

The explanation of the lower water-content in the butter 'Salted at Once' is undoubtedly that the salt tends to attract the water into larger globules, which are then more readily expelled, both in the draining and final working of the butter.

Table VI.—Length of Time Allowed to Drip After Washing.

10 Minutes.	15 Minutes.	30 Minutes.	30 Minutes: Slightly worked before Salting.
Water. %	Water. %	Water. %	Water. %
13·77	14·37	14·33	14·03

There appears, therefore, to be little effect on the water-content by varying the length of time from 10 to 30 minutes during which the butter is allowed to drip after washing.

Table VII.—Light and Heavy Salting.

Rate of Salting.	Worked 2 Hours after Salting.		Worked 24 Hours after Salting	
	Water. %	Salt. %	Water. %	Salt. %
½ oz. per lb.	13·42	1·25	11·78	1·29
1 oz. per lb.	13·18	3·34	11·74	2·32

When the final working is made two hours after salting, the lower rate of salting furnishes a butter containing slightly more water; but if a period of 24 hours is allowed to elapse between the salting and final working, there does not appear to be any practical difference in the water-content of the butters salted by ½-oz and 1-oz. per lb.

In both series of tests the percentage of water was very appreciably decreased by the postponement of the final working.

As regards the salt-content, it will be observed that the heavier the salting the more salt is retained in the finished product. This is true whether the butter is worked 2 or 24 hours after salting, though there is a reduction of practically 1 per cent salt in the heavier salted butter by delaying the final working for 24 hours.

Table VIII.—Salted and Saltless Butter.

Salted 1 oz. per lb. Worked 2 Hours after Salting.	Not Salted. Worked 2 Hours after Churning.
Water. %	Water. %
13·48	14·14

These results were obtained from a series of 10 churnings. They show that saltless butter, under similar conditions of manufacture, contains slightly more water than salted butter.

Regarding the relative yields of salt and saltless butter from a given weight of cream, the following data obtained from the above 10 churnings will be of interest. A total weight of cream (representing 5 churnings) of 719 pounds yielded of salted butter 208 pounds 7 ounces, while a similar weight of the same cream furnished 199 pounds 13 ounces of saltless butter. In other words, the yield of finished salted butter from cream was 28·9 per cent, while that of the finished saltless butter was 27·7 per cent.

Table IX.—Slightly Working before Salting—Salting without Previous Working.

When Worked.	Slightly worked before Salting.	Salted and then Worked.
	Water. %	Water. %
At once	14·02	14·10
After 2 hours	13·66	13·54
After 4 hours	12·55	11·91

A slight working before salting does not appear to materially affect the percentage of water.

In bringing together the results of this investigation the writer has consulted the Dairy Commissioner, Mr. J. A. Ruddick, who by his experience and larger knowledge of the butter industry has materially assisted in the consideration of the data and in the deductions therefrom that are here presented.