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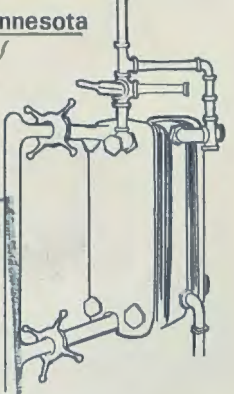
MINNESOTA DAIRY PRODUCTS PROCESSOR



By V. S. Packard
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COMPOSITION CONTROL IN CONTINUOUS BUTTERMAKING

We have finished a survey of several continuous buttermaking operations and have some data that may interest you. We sampled at both churn and printer at 10-minute intervals. All samples were analyzed in triplicate using a modified Kohman analysis in which samples were weighed on a balance sensitive to ± 1 mg on a 10-gram sample.

DIFFERENCE BETWEEN CHURN AND PRINT BUTTER COMPOSITION

Table 1 summarizes differences in churn and print butter composition. In all cases some moisture loss occurred during printing, resulting in higher butterfat. Extent of moisture loss varied from 0.06% to 0.21% and averaged, for the four operations, 0.11%. Curd values appear to be lower than the assumed value of 1.4%, but it must be remembered that these values were obtained by difference and are of questionable validity. In any event, some accounting of composition at the printer would seem to have merit.

MACHINE CAPABILITY

In deriving a statistically valid sampling and testing program it is necessary to segregate process variability from test variability. Data in table 2 indicate the difference in these two variables. In moisture regulation, using the best Kohman procedure possible, the test method is nearly as variable as the continuous buttermaking machine itself. Two-thirds of the time the machines were able to control moisture to within ± 0.087%. For the test method, this same statistic was 0.074%, hardly any better. If you are using a Kohman balance, this latter value climbs to about 0.14%. Since the test is no more sensitive than the machine, only the average of duplicate moisture analyses should be used as a basis for making machine adjustments. A single test is not enough.

For salt analysis the data indicate that a single test would suffice. The test itself is quite a bit more precise than the machine. However, when potassium dichromate is used as the indicator, results can be expected to average about 0.1% higher than those obtained by conventional Kohman analysis.

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STRESS PERIODS

Another factor in setting up a sound composition control program is an understanding of frequency and extent of stress periods in the process. In continuous buttermaking, stress periods occur during conversion to a fresh tankful of cream, or immediately following any shutdown. We found that stress periods caused abnormally high butterfat tests (as high as 81%) and involved an adjustment period of about one hour.

WHAT CAN WE DO?

While we have not been able to provide you with all the details of this study, we can highlight the conclusions that seem to evolve.

1. First, a balance more sensitive than the Kohman balance should provide better precision (better repeatability) in both moisture and salt analyses.

2. Because test error is nearly as great, if not greater (depending upon the balance used) than machine variability in moisture control, you should make duplicate moisture determinations, average the results, and adjust the machine only when averages indicate the necessity to do so.

3. On salt analysis a single direct titration of a 5-gram sample appears to be adequate, so adjustments could be based on one test result.

4. Testing should be concentrated around known stress periods. Appropriate machine adjustments could help reduce excessive butterfat overages when new cream is introduced, when flow is interrupted, or when duplicate moisture analyses indicate a problem. Moreover, don't consider the machine properly adjusted until at least two series of moisture tests indicate the desired moisture level.

   You might find some advantage in running single moisture analyses on two different samples taken at the same time and averaging these results.

5. Machines are capable of holding reasonably uniform composition for at least ½ hour, if not 1 hour, depending upon oil temperature changes after initial start-up. After systems are brought into control, routine testing should continue, preferably at ½-hour intervals and certainly at hourly intervals. Routine testing, at a minimum, should include duplicate moisture analyses and single direct salt titrations.

6. Lastly, after machines are brought into adjustment, tighter control appears possible when sampling involves a proportionate number of print samples and churn samples.

Table 1. Grand means[1] of moisture, butterfat, salt, and curd[2] analyses of churn and print butter samples from four continuous churning operations

Plant	Moisture			Butterfat			Salt			Curd		
	Churn	Print	(Diff.)	Churn	Print	(Diff.)	Churn	Print	(Diff.)	Churn	Print	(Diff.)
A	16.35	16.29	(-0.06)	80.38	80.47	(+0.09)	2.06	2.01	(-0.05)	1.24	1.18	(-0.06)
B	16.33	16.21	(-0.12)	80.22	80.48	(+0.26)	2.07	2.05	(-0.02)	1.45	1.26	(-0.19)
C	16.45	16.24	(-0.21)	80.56	80.80	(+0.24)	1.92	1.90	(-0.02)	1.07	1.08	(+0.01)
D	16.11	16.04	(-0.07)	80.58	80.71	(+0.13)	2.10	2.07	(-0.03)	1.20	1.17	(-0.03)
Grand avg.	16.31	16.19	(-0.11)	80.43	80.61	(+0.18)	2.03	2.00	(-0.03)	1.24	1.17	(-0.06)

[1] Means were calculated from triplicate analyses of samples taken at 10-minute intervals. The total number of samples analyzed, including both churn and print samples, were: plant A (60), plant B (70), plant C (30), plant D (14).

[2] Curd values were obtained by difference.

Table 2. Mean square values of an analysis of variance of continuous buttermaking machine variability and analytical error[1]

Butter component	Machine variability (mean square)	Standard deviation	Method variability (mean square)	Standard deviation
Moisture	0.0077	0.087	0.0055	0.074
Butterfat	0.0268		0.0083	
Salt[2]	0.0034	0.058	0.00023	0.015
Salt[3]			0.00017	0.013
Curd	0.0164		0.0058	

[1] A total of 45 samples taken from four commercial butter plants were analyzed in triplicate.

[2] Salt determinations were made by the conventional USDA modified Kohman procedure.

[3] Salt determinations were made by direct titration, in butter-water mixture, using potassium dichromate as indicator.

Agricultural Extension Service
Institute of Agriculture
University of Minnesota
St. Paul, Minnesota 55101
Roland H. Abraham, Director
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