A COMPARATIVE TEST OF CREAM SEPARATORS.

BY

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Owing to the large number of inquiries received by the Dairy Department of this College in regard to the relative merits of the different makes of separators, Prof. Ed H. Webster planned for a comparative test of a few of the leading makes of machines for the purpose of collecting data for the publication of a bulletin. Although it is not the intention of the Department at the present to publish these results owing to the resignation of Professor Webster which left the Dairy Department without a head, still the work was done with the most exact carefullness although in one or two respects it was not as complete as had at first been planned.

PLAN OF THE TESTS: Six different makes of machines all having nearly the same capacity were kindly loaned by the different manufacturers. The attempt was made to secure machines that were the most used throughout the State but in one or two instances the machines could not be secured. The machines used throughout the test and their capacity per hour were, DeLaval, "Alpha"Baby No.1, 450 pounds; Sharpless Tubular, No.4,500 pounds; National, No. 6, 500 pounds; Empire, No. 2, 400-460 pounds; United States, No. 6, 400-450 pounds; and the Iowa Dairy 450 pounds. The work was commenced the 21st of January, 1903 and continued until the 6th of April, 1903. The test was under the supervision of Professor Webster, who assisted in the laroratory at the beginning, and was worked out by E. W. McCrone and the writer (except the power test which was in charge of the Department of Electrical Engineering.)

The machines were run under four different conditions including the power test. In the first test the conditions were as nearly ideal as possible according to the directions given by the different manufacturers. In the second the speed was decreased

everything else being the same as in number one. In the third cold milk was used, and fourth the amount of power required to run the machines was measured.

Probably the most important quality to consider in any of the above named machines is that of durability and this it is impossible to test in a laboratory experiment of this kind. In the first set of tables given below it will be found 1st a table showing the average of the run and second giving each run in detail but for the second and third trials averages only will be given.

TEST NO. I: The object of this test was to show the actual capacity of the machine and the amount of butter fat lost in both the skim-milk and bowl-wash when the machines were being run as nearly as possible according to the directions given by the different manufacturers. All the machines were flushed with skim-milk. (The directions for operating the Empire Separator advises the use of hot water for flushing and if this had been used the loss of fat in the bowl wash would probably have been less.)

No certain amount of smim-milk was used but in every case it was run through the machine until cream no longer flowed from the cream pan. The bowl-wash consisted of the contents of the bowl, cream pan, and skim-milk can which was left after the flushing. In the case of bowls that emptied at the bottom as the Sharpless, Iowa, and the United States the contents were caught while the machine was stopping.

The milk used was fresh morning's milk from the College herd and was practically the same for every test. The milking was finished at about 7 A. M. and the milk was delivered at the College laboratory at about 7;15 A. M., the separating beginning from 7:30

to 8:00 A. M. In being brought from the barn to the laboratory a distance of less than one-fourth of a mile the milk was cooled much below the separating temperature so that it was always necessary to warm it before separating. The separators in every case were examined and found to be in good running order before the milk was turned on but for any reason the machine did not run as it should the test was thrown out and does not appear below. In taking the time from which to reckon the capacity everything was found to be in good working order and a full stream flowing from both pans, when large cans were placed under the spouts and the cream and milk run into them for ten minutes, they were then removed and the contents weighed, added together, and multiplied by six to find the capacity per hour.

AVERAGE OF ALL RUNS UNDER IDEAL CONDITIONS.

Name of Machine	No of Sep.	Listed Capacity	Actual Capacity	Skimmilk lbs.	oz	Test of Skimmilk
United States	5	400-450	429.5	63	6	.0338
Delaval	6	425-450	469.1	69	14	.048
National	7	500	496.8	74	3	.051
Empire	6	440-460	435	62	9	.038
Sharpless	5	500	518	77	1.5	.0452
Iowa Dairy	7	450	457.9	67	9	.058

(Continuation of foregoing table)

Name of Separator	Fat in Skimmilk	Fat in Bowl Wash	Fat Lost lbs.	Per cent of fat lost	Temperature of milk.
United States	.0216	.0157	.0373	.013	91.4
DeLaval	.0334	.0088	.0422	.0132	90.8
National	.0375	.0316	.0691	.0204	91.1
Empire Sharpless	.0331	.0571	.0902	.0308	90.
Sharpless	.0333	.015	.0483	.0132	90.6
Iowa Dairy	.0424	.0421	.0845	.0272	89.8

Highest test of skim-milk .058 of one per cent.

Lowest " " " .0338 " " " "

Difference .0242

Largest per cent of fat lost .0308

Smallest " " " " " .0130

Difference .0178

DELAVAL "ALPHA" BABY NO.I, LISTED CAPACITY 450 pounds

Actual Capacity	Milk lbs.	oz.	Test of Milk	Fat in Milk	Time Required Minutes	Test of Cream	Skim-milk lbs.	oz.
469.6	78	4.5	***	****	10	34	70	
475.6	79	4.5	3.8	3.013	10	34.2	70	8
467.6	77	15.	4	3.118	10	39.4	70	10.5
479.5	79	14.5	4	3.196	10	38.7	71	5
458.3	76	6	4.2	3.207	10	41.6	68	0
469.	77	6	4.4	3.405	10	39.2	69	0
Average.								
469.1	78	3	4.1	3.188	10	37.8	69	1.4

(DeLaval Table Continued)

Test of Skim-milk	Fat in Skim-milk	Fat in Bowl Wash	Milk	Temperature Cream	of Skim-milk
.06	.042	.0194	94	92	88
.04	.0282	.0076	90	88	84
.033	.0233	.0206	93	88	92
.05	.0357	.0015	90	87	89
.045	.0306	.0029	90	84	88
.06	.0414	.0009	88	85	87
		Average			
.048	.0334	.0088	90.8	87.3	88

NATIONAL NO. 6, LISTED CAPACITY 500 pounds per hour.

Actual Capacity	Milk lbs.	oz.	Test of Milk	Fat in Milk	Time Required Minutes	Test of Cream	Skim-milk lbs.	oz.
494	75	7.75	0	0	18.5	53.7*	70	00
509.1	84	13.75	0	0	10	23.4	71	8
512.3	85	6.5	4	3.415	10	41.8	78	00
500.3	83	6.5	4	3.336	10	50.3	77	2.25
446.7	74	6.5	4.1	3.05	10	49.2	69	00
523.6	87	4.5	4.2	3.665	10	45.4	79	00
492	82	000	4.15	3.404	10	49.8	75	00
				Average.				
496.8	81	13	4.09	3.3739	9.78	44.8	74	3

* Cream screw changed.

(National Table Continued pp5)

Test of Skim-milk	Fat in Skim-milk	Fat in Bowl-wash	Temperature of Milk	Cream	Skim-milk
.035	.0245	.0394	91	91	86
.06	.0429	.0308	96	94	93
.047	.0367	.0191	88	00	00
.04	.0309	.0525	94	90	93
.08	.055	.0420	90	84	89
.03	.0237	.0195	90	84	90
.065	.0488	.0176	89	85	88
		Average.			
.051	.0375	.0316	91.1	88.8	89.8

EMPIRE NO.2, LISTED CAPACITY 440-460 LBS. PER HOUR.

Actual Capacity	Milk lbs.	Milk oz.	Test of Milk	Fat in Milk	Time Required Minutes	Test of Cream	Skim-milk lbs.	Skim-milk oz.
444.3	61	11	4.2	2.8	9	36.8	58	8
448.6	74	12.5	4	2.99	10	30.6	65	8
454.6	75	12.25	4.35	3.29	10	35.2	67	0
434.8	72	7.5	4	2.96	10	34.15	64	5
406.2	67	9	4.2	2.837	10	35.2	59	5
422.	70	5.25	3.2	2.251	10	32.8	61	0
				Average.				
435	71	1.6	3.99	2.854	9.92	34.12	62	9.75

(Empire Table Continued pp 6)

Test of skim-milk	Fat in Skim-milk	Fat in Bowl Wash	Temperature of Milk	Cream	Skim-milk
.03	.0175	.0405	92	92	90
.03	.0197	.062	88	86	87
.059	.0395	.057	89	86	88
.03	.0193	.047	90	86	90
.035	.0208	.054	91	88	91
.045	.0275	.082	90	86	90
		Average.			
.038	.0331	.0571	90	87.3	89.3

SHARPLESS TUBULAR NO.4, LISTED CAPACITY 500 POUNDS PER HOUR.

Actual Capacity	Milk lbs.	oz.	Test of Milk	Fat in Milk	Time Required Minutes	Test of Cream	Skim-milk lbs.	oz.
518.3	86	6.25	3.8	3.2828	10	20.6*	77	00
515.1	85	13.75	4	3.4343	10	34.6	76	7.25
514.8	94	6.25	4.2	3.964	11	39.2	85	00
520.6	86	12.25	4.35	3.7754	10	32	75	8
521.3	86	14.5	4.5	3.9108	10	32.4	77	8
				Average.				
518	88	.6	4.17	3.6704	10.2	31.7	77	1.5

* Cream screw changed to skim thicker cream.

(Sharpless Tubular Table Continued pp 7)

Test of Skim-milk	Fat in Skim-milk	Fat in Bowl Wash	Temperature of Milk	Cream	Skim-milk
.04	.0284	.0188	90	89	88
.05	.0382	.0087	92	90	88
.04	.034	.0175	90	86	88
.049	.037	.011	90	86	88
.037	.0286	.0192	91	88	90
		Average.			
.045	.0333	.015	90.6	87.8	88.5

UNITED STATES NO.6, LISTED CAPACITY 400-450 LBS. PER HOUR.

Actual Capacity	Milk lbs.	Milk oz.	Test of MIlk	Fat in Milk	Time Required Minutes	Test of Cream	Skim-milk lbs.	Skim-milk oz.
416.9	767	7.75	4.2	2.918	10	44.3	63	8
433.8	772	5	4.15	3.001	10	34.4	63	8
445.2	774	3	3.6	2.6707	10	30.9	65	5.75
426.5	770	6.5	4.2	2.957	10	35	62	0
425.25	770	14.	4	2.83	10	36.1	63	5
			Average					
429.5	71	7.0	4.04	2.875	10	36.1	63	6

(United States Table Continued pp 8)

Test of Skim-milk	Fat in Skim-milk	Fat in Bowl Wash	Milk	Temperature of Cream	Skim-milk
.035	.0222	.0278	90	84	89
.042	.0267	.0181	93	90	88
.04	.026	.0208	91	85	90
.012	.0078	.004	93	86	91
.04	.0253	.0077	90	85	85
		Average.			
.0338	.0216	.0157	91.4	86	88.6

IOWA DAIRY, LISTED CAPACITY 450 POUNDS PER HOUR.

Actual Capacity	Milk lbs.	oz.	Test of Milk	Fat in Milk	Time Required Minutes	Test Cream	Skim-milk lbs.	oz.
451.6	75	4.25	4	2.971	10	38.4	68	
457.7	76	4.25	4.5	3.468	10	33.6	67	
463	77	7.25	4.1	3.175	10	38.8	70	
438.3	73	14.25	4.4	3.251	9 5/6	39.6	65	8
482	80	5.25	4.2	3.373	10	33.8	70	
450	73	5.25	3.2	2.346	10	39.2	66	
461	76	13.25	4.15	3.188	10	32.8	66	8
			Average.					
457.9	76	3	4.08	3.11	9.58	36.6	67	9

(Iowa Dairy Table Continued pp 9)

Test of Skim-milk	Fat in Skim-milk	Fat in Bowl Wash	Temperature of Milk	Cream	Skim-milk
.03	.0204	.045	89	88	84
.115	.0771	.0959	90	87	89
.045	.0315	.0592	90	84	89
.0525	.0344	.0036	90	84	88
.0675	.0472	.0313	90	89	90
.05	.033	.0322	90	85	89
.08	.0532	.0278	90	84.	88
		Avarage.			
.058	.0424	.0421	89.6	86	88

These tables show that the highest average test of the skim-milk was .058 of 1 per cent, while the lowest test was .0338 of 1 per cent, the difference being .0242 of 1 per cent. This shows that as far as closeness of skimming is concerned there is very little difference between the machines used. It is also probable that if the machines were to be run over again they would not rank exactly the same in the respect of the amount of butter fat left in the skim-milk. There is however a greater difference in the amount of fat left in the bowl wash, the largest amount lost being .0571 pounds and the least being .0088 pounds. Tha amount of milk separated makes practically no difference in the amount of fat left in the bowl, as much probably being lost in separating 100 pounds as when separating 1000 pounds and hence the importance to be placed upon this point depends on whether there is a large or small quantity of

milk to be separated. For example suppose a machine lost .1 pounds of fat in the bowl wash. Now if only 40 or 50 pounds were separated the percent of loss would be very large while if 500 or 1000 pounds were used the per cent lost would be so small as to probably not be worth considering. It will be further seen that the Sharpless, De-Laval and Iowa overran the listed capacities while the National and Empire fell slightly below, the United States coming within its range of variation.

TEST NO. 2 LOW SPEED: It seems to be a very general opinion among farmers that a cream separator is closely related to the grindstone and corn sheller and will work just as well if turned at much less than its rated speed. The following test was made not in order to compare the different machines but to show just what is lost by running the machine at low speed. All the machines in the test were run at three-fourths their maximum speed, Otherwise everything is the same as in test No. 1.

AVERAGE OR TWO RUNS AT THREE-FOURTHS LISTED SPEED.

Name of Separator	Turns of Crank per Minute	Listed Capacity	Actual Capacity	Test of Skim-milk	Fat in Skim-milk
National	45	400-450	479	.25	.1689
DeLaval	34	450	467	.177	.1304
Iowa Dairy	45	450	428	.18	.1064
Sharpless	34	500	483	.2	.1367
United States	45	400-450	418.7	.19	.0857
Empire	42	440-460	416.2	.2	.1224

(Average Speed Test Continued)

Name of Separator	Fat in Bowl wash	Fat Lost	Per cent of Fat lost	Temperature of milk.
National	.0322	.2011	.066	91.5
DeLaval	.0059	.1362	.0399	90.5
Iowa Dairy	.0247	.1049	.068	89.5
Sharpless	.0125	.1430	.045	88.5
United States	.0159	.1016	.037	92.
Empire	.0669	.1888	.056	91.

Average amount of butter fat lost in 100 pounds milk .1646

" " " Bowl Wash lost .0263

" Total Amount Lost .1909

" " " Running at full speed .1804

" " " by " " low speed .1105

In this case the average loss of all the runs of all the machines is.1909 pounds for 100 pounds of milk or.1105 less than was lost when running at full speed. Figuring the fat at 20¢ per pound there is a loss of .022¢ for every 100# of milk. All of the machines fell below their listed capacity except the DeLaval and the United States.

TEST NO. 3 SEPARATING COLD MILK: The separator on the farm will vary often during the winter having to separate milk at a much lower temperature than 80 degrees. In fact unless each cow's milk is separated as soon as milked the temperature as a rule will be less than 80 degrees rather than 80 degrees or more. It is not

practical on the ordinary farm to warm the milk before separating and therefore the machine that will separate milk at a low temperature has advantages over other makes.

In this test the milk was at a temperature of 75°. Morning's milk being used with enough old milk (12 hours old) to cool it down to 75°. Up to this time the United States machine had not shown up as great a capacity as it was supposed to have but the supply can was raised by one of the Company's agents greatly increasing its capacity as is show in the following tables. It might be well to remark however that if the machine had been placed on a farm the supply can would undoubtedly not have been changed and for that reason the capacity of the machine should be taken from the tables of test NO. I.

AVERAGE OF TWO RUNS WITH COLD MILK.

Name of Machine	Listed Capacity	Actual Capacity	Temp. of milk	Tem of Cream	Temp of Skim-milk
National	500	495	75	74	75
DeLaval	450	471	75	73	74
Iowa Dairy	450	423	74.5	72	74.5
Sharpless	500	488.5	74.5	73.5	74
United States	400-450	495	74.5	73.5	74.5

(Average Cold Milk Test Table Continued)

Name of Separator	Test of Cream	Test of Skim-milk	Fat in Skim-milk	Fat in Bowl Wash	Total Fat Lost	Percent of fat lost
National	42.9	.125	.093	.021	.114	.032
DeLaval	42.4	.065	.0459	.016	.0619	.0192
Iowa Dairy	38.2	.125	.0787	.0465	.1252	.0453
Sharpless	38.1	.0624	.0454	.0399	.0853	.026
United States	52.3	.0401	.0318	.0304*	.054	.015

* One Run.

Average amount of fat lost per 100 pounds milk in skim-milk.0712

" " " " " in the Bowl Wash .0308

Total " " " " per 100 pounds milk .102

Here the average of all the runs of allnthe machines show a loss of .102 pounds of fat for each 100 pounds of milk. This does not include the bowl wash of the first run made with the United States machine as the cream tested so high that it would probably be unfair to consider the bowl wash. In all of these runs the fat lost in the bowl wash would have been much less if hot water had been used for flushing the bowls instead of skim-milk. It is probable that any machine will skim cold milk but the difficulty is that in many bowls the cream opening is so small that it will not allow the cream to pass out. Hence the machine that has the largest cream opening will undoubtedly handle the coldest milk. From these tables the amount lost by any one machine may be figured and from this each one must figure for himself whether or not it will pay him to warm the milk as the expense varies greatly with different farms.

However if the skim-milk is desired warm for calves or young pigs it is of course for the better to warm before separating.

POWER TEST: This test was entirely in charge of Professor Eyer and Professor Webster. The work was done in the Electrical Laboratory and because of the inconvenience of handling milk at that place water was run through instead. The machines were run at their listed speeds, 1st without a load, and 2nd with water running through it.

The amount of Electric Current required to run the machines under these two conditions was measured and from this the horse-power was calculated. The pull on the crank which is given in the following table was worked out from the formula $\frac{2\ R \times Rev. \times P}{33,000} = H.\ P.$ where R. equals the length of crank, Rev. the number of revolutions of crank per minute, and P the pounds pull on the crank. Having the horse-power given P is easily found. A glance at this formula will show that the pull on the crank will vary with the length of the crank but this should not be misunderstood; the actual work required to operate a machine is the horse power required, not the pounds pull on the crank.

POWER TEST MADE BY DEPARTMENT OF ELECTRICAL ENGINEERING.

Name of Separator	No of Sep.	Turns of Crank per minute	Revolutions of bowl per minute	Weight of Bowl. lbs.	oz.
DeLaval	1	45	7065	12	10 1/4
Sharpless	4	45	16515	6	7 3/4
Empire	2	55	9973	8	12
Iowa Dairy	0	60	10680	7	14 1/2
National	6	60	10200	9	8 3/4
United States	6	60	10200	11	6 1/2

(Power test continued)

Name of Separator	Length of Crank	H.P.no Load	Pounds pull on crank	H. P. Full Load	Pounds pull on Crank Full Load.
DeLaval	10 1/2	.085	11.3	.101	13.7
Sharpless	13	.061	6.5	.104	11.2
Empire	9 1/2	.093	11.2	.114	13.7
Iowa Dairy	9 1/4	.134	15.3	.151	17.6
National	9 1/2	.119	13.1	.134	14.8
United States	10 3/4	.183	17.8	.193	18.9

It is not to be supposed that these tests are by any means exhaustive for in the short time allowed for the work only a beginning could be made and in some cases this incompleteness may have worked to the disadvantage of the separators used, as for instance, in the test with cold milk only two runs were made on each machine and the work of no machine can be ascertained by less than six or more runs.

Also in this case the milk was always at a temperature of about 75° and a test with milk colder than 75° should have been made as a few degrees difference in the temperature of the milk has been found to make an undue variation in the test.

No matter how good a machine is or how many advantages it has over other makes if expected to do good work it must have good treatment. The high speed at which they are run requiring a far more delicate mechanism than is found in an ordinary farm implement, and the farmer should study his machine and become an expert in its management thus securing perhaps better results than were secured in this test.