A Revised Standard, Reflecting Lactation Conditions, for Per Cent Solids-Not-Fat Values of Cow Milk in Kanagawa Prefecture

By SHIRO ANDO, MASAZUMI YOSHINO and HIROSHI HAMADA

Department of Animal Products, National Institute of Animal Industry
(Kukizaki, Inashiki, Ibaraki, 305 Japan)

In relation to compositional quality improvement of cow milk, it is not rational to qualify individual milk taken from cows under various different conditions by using a single standard per cent SNF value such as 8.0 or 8.5, because SNF content of individual milk varies with lactation number, lactation stage of cow and season of milking, etc. To rationalize screening of low SNF milk, the authors propose a revised standard, reflecting lactation conditions, for per cent SNF values of individual milk (hereafter referred to "conditioned standard"), in which standard values are prepared in accordance with various combination of each level of the three factors: lactation number, lactation stage, and season of milking. With the establishment of the conditioned sandard values, screening of low SNF milk, and of cows and farms producing such milk in a district will become easy in a short term and by season-randomized SNF test of milk.

The method by which the standard values were derived

The SNF data of milk samples used for calculation of the conditioned standard values were those of 1,296 samples randomly selected from a set of 8,400 samples which were obtained in testing milk performance of milking cows (Holstein) under the Dairy Herd Improvement Program of Kanagawa Prefecture* in 1979, but did not include more than 4 data from an individual cow.

* Adjacently southwest to Tokyo

The conditioned standard values were calculated by the mathematical model used in the least squares analysis of three-way classified data with unequal subclass numbers after Yokouchi[5] and Harvey[3].

$$X_{ijkl}=\mu+A_i+B_j+C_k+E_{ijkl}$$

where X: Datum observed
μ: the least squares overall mean,
A_i: effect of lactation number, i th
B_j: effect of season of milking, j
C_k: effect of lactation stage, k
E_{ijkl}: errors associated to each measurement, for which zero was substituted in the calculation

By the way, total solids and fat content of milk samples were determined by the TMS-Checker[2,6] and the Milk-Checker, respectively.

Analytical aspect of the standard values

1) From the F-test in the variance analysis, no significant interaction was observed with the three factors. Essentially, the mathematical model in the least squares analysis has been postulated with no interaction. Therefore, the test result shows the adequate applicability of the mathematical model.

As to the effects of lactation number, lactation stage of cow and season of milking on SNF content of milk, Endou[1] suggested that these three factors were acting independently each other. Therefore, it may be generally agreed that there is no significant interaction of effects of the three factors on SNF con-

Table 1. The conditioned standard per cent SNF values of cow milk in Kanagawa Prefecture (1979)

Lactation no.	Lactation stage (mons.)	Season of milking												Least squares mean & effect estimates
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	
1+2	1+≧8	8.87	.78	.81	.80	.72	.66	.65	.65	.74	.76	.79	.86	
	2+3+4	.60	.52	.55	.54	.46	.40	.39	.39	.47	.50	.53	.60	8.62
	5+6+7	.72	.64	.67	.66	.58	.52	.51	.51	.59	.62	.65	.72	0.111
3+4	1+≧8	.71	.63	.65	.64	.57	.50	.49	.49	.58	.61	.64	.71	
	2+3+4	.45	.36	.39	.38	.30	.24	.23	.23	.32	.35	.37	.45	8.47
	5+6+7	.57	.48	.51	.50	.42	.36	.35	.35	.44	.47	.49	.57	−0.039
≧5	1+≧8	.68	.60	.62	.61	.54	.47	.46	.46	.55	.58	.61	.68	
	2+3+4	.42	.33	.36	.35	.27	.21	.20	.20	.29	.32	.34	.42	8.44
	5+6+7	.54	.45	.48	.47	.39	.33	.32	.32	.41	.44	.46	.54	−0.069
Least squares mean & effect estimates		8.62	8.53	8.56	8.55	8.47	8.41	8.40	8.40	8.49	8.52	8.54	8.62	8.509
		0.111	0.021	0.051	0.041	−0.039	−0.099	−0.109	−0.109	−0.019	0.011	0.031	0.111	

Lactation stage		
	1+≧8	8.64 0.131
	2+3+4	8.38 −0.129
	5+6+7	8.50 −0.009

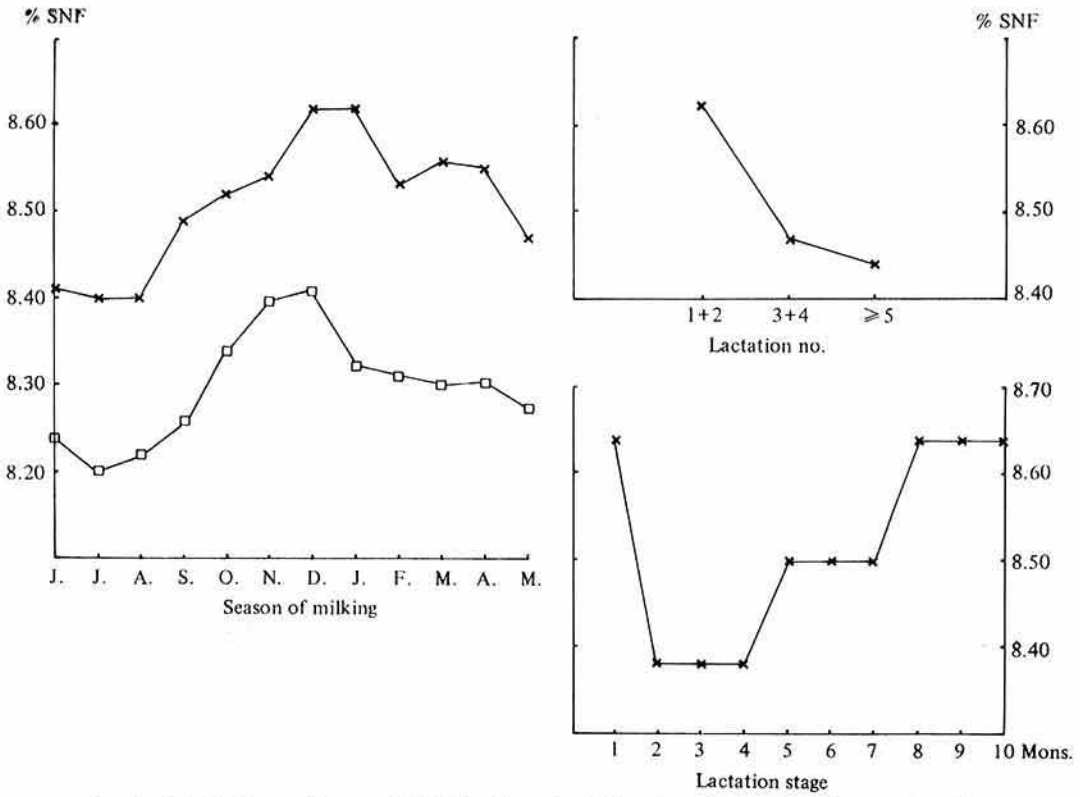

Fig. 1. Variation patterns of SNF values in Table 1 and of seasonal one of milk in Kanto District
Note —×—: Values in Table 1
—□—: Values of milk in Kanto District

tent of individual milk.

2) The percent variance estimates of lactation number, lactation stage of cow, season of milking and errors to the overall estimates were 5, 5, 10 and 80, respectively. This means that SNF content of cow milk is more influenced by such other factors as nutrition, subclinical mastitis, genetic milk performance of individual cow etc. than the above three factors.

3) The least squares estimates of overall mean and effects of levels in each factor were 8.509, and A_1: 0.111, A_2: −0.039, A_3: −0.069, B_1: 0.111, B_2: 0.021, B_3: 0.051, B_4: 0.041, B_5: −0.039, B_6: −0.099, B_7: −0.109, B_8: −0.109, B_9: −0.019, B_{10}: 0.011, B_{11}: 0.031, B_{12}: 0.111, C_1: 0.131, C_2: −0.129 and C_3: −0.009 (%), respectively (Table 1). The conditioned standard percent values of SNF content calculated from the mathematical model are shown in Table 1.

In addition, the variation patterns of SNF values appearing in the conditioned standard values in Table 1 and also of corresponding seasonal SNF contents[4] in raw milk collected by dairy factories in Kanto District in which Kanagawa Prefecture is located are shown in Fig. 1, in which the least squares means of each level in Table 1 are plotted.

As shown in Fig. 1, these patterns are familiar to us all, and, this fact offers an evidence for the reliability of the conditioned SNF standard values obtained in Kanagawa Prefecture, though the level of SNF values differs considerably each other. This difference might be attributed to nature of both milk samples,

Table 2. An example of calculation of a standard SNF value for a farm bulk milk using the conditioned SNF values in Table 1, assuming that the season of milking is October

Cow's no.	Lactation no.	Lactation stage	Milk yield (kg/day)	Conditioned st. SNF values in Table 1
1	1	5	30	8.62 (%)
2	5	7	25	8.44
3	3	2	20	8.35
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
n	4	6	25	8.47

$8.62 \times 30 = 258.60$
$8.44 \times 25 = 211.00$
$8.35 \times 20 = 167.00$
. . .
. . .
$8.47 \times 25 = 211.75$

Total 100 848.35

Thus, standard SNF value of the bulk milk is 848.35/100=8.48 (%).

i.e. individual cow milk and dairy factory raw milk.

Application of the standard values

1) A standard per cent SNF value for a farm bulk milk can be calculated using the conditioned standard values in Table 1 as shown in Table 2, provided that milk yield per day, lactation number and lactation stage of all individual cows in the farm on a testing day are known.

Accordingly, the farm bulk milk can be qualified using the calculated standard SNF value.

2) The screening of low SNF milk, and of such milk-producing cows and farms in a district would become easy in a short term and by season-randomized SNF test of raw milk, e.g. in case of judging milk performance of cows at dairy shows.

3) Variation pattern of SNF content in individual or herd milk caused by season of milking differs considerably with calving month of cow as shown in Fig. 2. Therefore, month of service can be planned using the conditioned standard SNF values in order not to lower the SNF of milk in a specific month of the year.

4) When low SNF milk-producing cow or cows are found, we should seek the cause

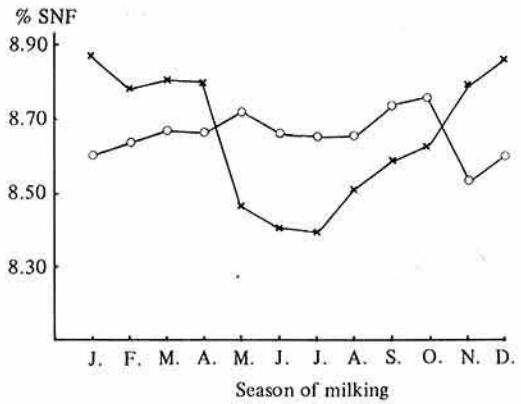

Fig. 2. Seasonal variation of standard SNF values of milk taken from two cows with different calving month, calculated using the conditioned standard values in Table 1 assuming that lactation number is the 1st for both cows
Note —×—: Milk from cow which calved in April
—○—: Milk from cow which calved in October

firstly in subclinical mastitis and nutritional condition of the cow, and subsequently in the genetic milk performance of the cow.

By the way, SNF content of raw milk is generally said to be correlated negatively to milk yield of cow. However, in considering the relationship between SNF content of milk and milk yield under the concept of conditioned SNF values, we should distinguish the relationship between SNF and milk yield of the cow tested for SNF from the relationship which exists between SNF and milk yield among different cows. In the former case, milk yield of the cow is affected by lactation number, lactation stage and season of milking, so that the effect of milk yield of the cow on SNF content can be thought to be reflected already in the conditioned standard SNF values. On the contrary, the latter relationship is not reflected directly in the conditioned standard SNF values but is included in the errors. Then, such defined milk yield of different cows must be taken into account as a factor affecting SNF content of milk.

At present, however, we don't know a standard milk yield of cows as clearly as in the cases of normal condition of health and feeding standards of cows both of which are well known. Therefore, we are obliged to neglect milk yield of different cows as a factor limiting SNF content of milk.

Future problems

The above concept of conditioned standard values might be extended to milk fat content and milk yield respectively, and would be useful for improving milk quality and increasing milk yield of cows.

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