Milk falsification

The content and the properties of the normal milk vary, depending on many and different factors. This gives the possibility in the practice the milk to be adulterated in different ways and sometimes without some of its characteristics (density, fat, solids, and solids-non-fat) to go out of the boundaries of the so-called "normal milk". Different substances can be added to the normal milk or a part of its fat to be taken away (detracted). The milk is accepted as adulterated, if there are unusual substances added to it or a part of its fat is detracted. They differ in dependence of the falsification's character – what is the quantity of added unusual substances. All possible falsifications of milk can be divided in 3 groups:

1. **Falsifications** - aiming increasing the volume of the milk – added water, fat detraction, double falsification (simultaneously added water and fat detraction), adding whey, or other liquids.
   - **Added water** – the most commonly used falsification. All characteristics are decreased and the quality control parameters of the milk (density, fat, solids, solids-non-fat). For more details, please read paragraph **Proving added water** below.
   - **Fat detraction** – most often when the evening milk is skimmed or non-fat-milk is added towards whole milk. Milk characteristics are changed as follows: density is increased, as when skim is 20%, density is increased with 1 Den degree; fat is decreased proportionally to the degree of skim; solids also are decreased, SNF is left unchanged or insignificantly increases. For more details, please read paragraph **Proving a skim** below.
   - **Mixed or double**. Simultaneously added water and fat detraction. The control characteristics of the milk are changed as follows: density remains unchanged or is slightly increased or decreased in dependence of the correlation between the degree of added water and skim; fat is sharply decreased and is in a dependence on the degree of added water and skim; solids are significantly decreased; SNF decreases proportionally to the degree of added water, but is not influenced on the degree of skim **Proving double falsification.**
2. **Falsifications, when unusual substances are added**. The aim of this is to cover another kind of falsification or to stop turning the milk foxy. For this purpose are used flour or farina when there is added water to the milk, and soda bicarbonate when the milk is with increased acidity and different aseptic substances.
   - **Added water and addition of farina and flour**. The aim is to increase the milk's density. Can be proved by using tincture of iodine.
   - **Added water and addition of salt and sugar**. The taste of the milk is not changed, while the refraction number of only 1% from them is increased by 2,5, which allows 15 % added water, and this could not be detected by the refractometer. The rest of the control characteristics – density, fat, solids, SNF are decreased.
   - **Added water and addition of urea**. Increases density and refraction, decreases the titer acidity, but suppress milk fermentation. For proving this kind of falsification is used enzyme method with ready to use test of Boringer.
   - **Added water and addition of powder skimmed milk**. Increases density and covers added water. The rest of the control characteristics are changed as follows: solids and SNF are decreased, but in a smaller degree than when added water; fat decreases proportionally to the added water. The most positive indicator for this kind of falsification is the fat of falsified milk compared to the fat of the milk from "cowshed" sample. The formula presented for **Proving added water in the milk** could be used. Proving can be done by using spectro-photometric method in a licensed laboratory
   - **Addition of whey in the milk**. When falsified with these waste products, the milk's density is not significantly changed and could not be detected by the milk measuring devices. The control characteristics are changed as follows: solids and SNF are decreased, but not significantly; fat is decreased proportionally to the added whey. The most reliable indicator in this kind of falsification is the fat of the falsified milk, compared to the fat of the milk from "cowshed" sample. In the table below are pointed out the content, some of the milk's

characteristics and changes in its quality characteristics when added 10 % water, whey etc. (data based on Inihov and Brio)

Table 1.

	Falsification type	Density	Fat	Proteins	Solids	SNF
1	Normal milk	1,0310	3,5	3,4	12,70	9,20
2	Milk and water	1,0279	3,15	3,06	11,43	8,28
3	Milk and skim-milk	1,0315	3,16	3,42	12,36	9,20
4	Milk and butter-milk	1,0313	3,19	3,37	12,35	9,16
5	Milk and whey	1,0307	3,2	3,16	12,15	8,95
6	Milk, water and skim-milk	1,031	2,84	3,18	11,09	8,25
7	Milk, water and butter-milk	1,0303	2,84	3,03	11,08	8,24
8	Milk, water and whey	1,0276	2,85	2,82	10,88	8,03
9	milk, butter-milk and skim-milk	1,0318	2,85	3,49	12,01	9,16
10	Milk, skim-milk and whey	1,0291	2,86	3,28	11,81	8,95
11	Milk, butter-milk and whey	1,0289	2,89	3,13	11,80	8,91

3. Mixing different kinds of milk and offering it as more valuable kind. Mixing goat and sheep's milk and offering it as a sheep's, have skimmed cow milk with whole buffalo for whole sheep's etc.

Proving falsifications

Proving added water:

Water, added to the milk dilutes it and decreases the value of its control characteristics – density, fat, solids, SNF. Due to these characteristic's fluctuations in a broad spectrum during the lactation period and influenced by other factors, when there is a small quantity of added water they do not cross the boundaries of the normal fluctuations. In order to be proved added water and its percentage to be determined, the control characteristics of the problematic and "cowshed" sample have to be compared. When making the comparison between the control characteristics of both samples can be seen how the characteristics of the falsified or problematic sample are changed towards the characteristics of the "cowshed" sample. If they decrease, there is a doubt for added water in the milk. After that the decrease % of the density measuring degrees is determined. As a basis is taken the practical rule, that the density decreases at about 3°Den when there is 10 % added water towards cow, sheep and buffalo milk.

Fat decrease could be checked by equalization of the "cowshed" sample to 100 and then the difference between the FAT of the problematic and "cowshed" milk is calculated as a %. On the same way the decrease % of the solids and SNF is determined. But these characteristics could also be calculated by using fat and density as a basis.

When there is one and the same decrease % (with a difference up to 3-5) there is ONLY added water in the milk. When the difference is more than 5% the milk is NOT only with added water. When there is added water in the milk its density, fat, solids, SNF are decreased proportionally to the quantity of the added water.

After we establish that the problematic milk is with only added water, the % of the added water can be determined by using one of the two formulas:

$$Water\% = \frac{SNF_1 - SNF_2}{SNF_1} * 100[\%] \qquad Water\ \% = \frac{F_1 - F_2}{F_1} * 100\ [\%]$$

Where:
SNF_1 is the SNF of the "cowshed" sample %
SNF_2 is the SNF of the problematic milk
F_1 is the fat of the "cowshed" sample %
F_2 is the fat of the problematic milk %
More precise results can be received by using the second formula, where decrease of the fat is taken into account. Using Gerber method (± 0,1%) could do more precise determination of fat. When calculating SNF the density also have to be taken into account, which determination may lead to bigger mistakes. These mistakes will influence SNF and then the % of the added water.
Example: When analyzing a doubtful cow milk the following results are received: for density 1,027, for FAT 3,5%, for solids (by formula Solids=1,2.M+?/4+0,76).11,71 and SNF 8,21%. The "cowshed" sample of the same milk has shown density 1,0302, fat 3,9%, solids 12,99 and SNF 9,09%. The data could be presented on the following way:

	Characteristics	"cowshed" sample	Doubtful	Difference ±	%
1	Density	1.030[2]	1,027	3,2	10,7
2	Fat %	3,9	3,5	0,4	10,2
3	Solids %	12,99	11,71	1,28	9,9
4	SNF %	9,09	8,21	0,88	9,7

It is seen that all the results are decreased. We have doubts for added water.
In order to establish in what percentage is the density decrease, you have to find out the difference in Den degrees of the cowshed and doubtful sample. In the example, the difference is 3,2°Den, which corresponds to 10,7% added water. After that you have to check what is the percentage decrease of the fat ($x = \frac{0,4.100}{3,9} = 10,2\%$), of solids ($x = \frac{1,28.100}{12,99} = 9,9\%$) and SNF ($x = \frac{0,88.100}{9,09} = 9,7\%$).
As it could be seen, the basic characteristics decrease is proportionally (the difference is only 0,5% between the characteristics Fat and SNF). Therefore the milk is only with added water – at about 10%.

Proving skim-milk
Milk is most frequently skimmed by collecting the cream from the evening's milk when a big part of the fat is collected on the milk's surface or by adding of skimmed milk to the normal milk. As a result of this falsification the butter content is decreased, bad qualities and feeding characteristics of the dairy products also.
For proving skimmed milk, as it is in case of added water, you have to have the results from "cowshed" sample for comparison. When skimmed, the milk's characteristics change as follows: density is proportionally increased, because the lightest part of the milk is taken away; the fat decreases proportionally to the degree of skim; Solids decrease, but not so significantly as is when added water; SNF remains unchanged or is slightly increased:

Example

	Characteristics	Sample		Difference	
1	Density	1.029[4]	1.030[3]	+0,9	18,0
2	Fat %	4,1	3,3	-0,8	19,5
3	Solids %	13,03	12,30	-0,73	
4	SNF %	8,93	9,00	+0,07	

When comparing the control characteristics it is seen that the density of the doubtful sample is increasing, and the fat is decreasing. Therefore the sample is doubtful for being skimmed. You have to

search what is the density increase in percentage, having in mind the practical rule, that each 20% skimmed, the density is increased with 1°Den, from which follows that in this case, there is at about 18% fat decrease. You have to find out what is the percentage of fat decrease as it is when **proving added water in the milk.**
When calculating is seen that the decrease is 19,5%. In this case, density is increasing and the fat of the doubtful sample is increasing with almost same percentage and SNF is insignificantly increasing, the sample is only skimmed.
In order to understand what is the quantity of the detracted fat (degree of skim), the same formula is used as when establishing the added water percentage:

Detracted fat $$\% = \frac{F_1 - F_2}{F_1} * 100$$

Proving double falsification
We call combined (double) falsification in milk when at one and the same time two kinds of milk falsification are used - added water and fat detraction. The aim of this falsification is to remain the density unchanged. The milk's control characteristics are changed as follows: density may be decreased, to remain the same or to be slightly increased in dependence of the correlation between the degree of added water and of detracted fat. In correlation under 1:6 (for example 10% water and 30% fat detraction) density is decreasing. When the correlation is 1:6 (5% water and 30% fat detraction) is remaining the same. When the correlation is above 1:6 (5% water and 45% fat detraction) is slightly increasing; fat is significantly decreasing, proportionally to the total degree of falsification; solids decrease; SNF decrease only proportionally to the quantity of the added water.

Examples:Determination of type double falsification

Characte-ristics		"cowshed" sample	Doubtful samples								
			A			B			C		
			Values	difference		Values	difference		Values	difference	
				±	%		±	%		±	%
1	Density	1.029[6]	1.027[8]	-1,8	6,0	1.029[5]	-0,1	0,3	1.030[4]	+0,8	16,0
2	Fat	4,0	2,8	-1,2	30,0	2,6	-1,4	35,0	2,0	-2,0	50,0
3	Solids	12,96	11,07	-1,89	14,6	11,26	-1,7	13,1	10,76	-2,2	17,0
4	SNF	8,96	8,27	-0,69	7,7	8,66	-0,3	3,3	8,76	-0,2	2,2

When comparing the control characteristics of the doubtful sample A with the "cowshed" sample, is seen that the density and fat values are lower, but not proportionally one to another and as a result the sample is not only with added water. The sample is double falsified in correlation below 1:6. In doubtful sample B the density remains the same and the fat is decreased. The sample is double falsified in correlation between water and fat detraction at about 1:6. In doubtful sample C the density is increased and the rest of the characteristics are with lower values. The sample is doubtful for being fat detracted. But the missing proportionality in density increase (16%) and fat decrease (50%) it could be accepted as double falsified sample in correlation above 1:6. It is also confirmed by the slightly decreased SNF.
The total degree of falsification in case of proven double falsification is established by the fat decrease.

Total falsification $$\% = \frac{F_1 - F_2}{F_1} * 100$$

Added water quantity is determined by the decreased SNF content

$$Water\% = \frac{SNF_1 - SNF_2}{SNF_1} * 100[\%]$$

the degree of fat detraction is determined by the difference between the total degree of falsification and the percentage of the added water.
Fat detraction % =% of the total falsification -% of the water.