Control of the water content of dairy products - definition of limits, consideration of process variation, official use of autocontrol data

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Water content of dairy products

Legislation - a simple task ?

Aspects to be considered :

Specify a limit

Define a reference method

Take samples using approved techniques

Perform the analysis in laboratories with proven competence

compliance with the legal requirement

Check compliance by comparing the result obtained with the limit

Is it really so simple ?

Water content of dairy products
Aspects usually neglected

- Measurement error
- Sampling error
- Definition of limits
- Compliance of large products quantities produced over an extended period of time.

NOT discussed

Is the reference method appropriate for water determination ?

Special case : **Added** water in drinking milk

Drinking milk production results in "unavoidable" water addition

Control Conventional approach :

- Freezing point determination - Comparison with a limit

Problem

- Variation of the freezing point of raw milk => variation of the freezing point of drinking milk.

Adequate control procedure

- Comparison (freezing point of raw milk - freezing point of drinking milk).

Definition of limits

Should "100 % compliance" be required ?

Problem :

- Control not possible in practice

Consequence :

- A certain percentage (1%, 5%, 10%) of non-complying units (increments) in the quantity submitted to control should be accepted.

Table 1 : Definition of limits

Compliance with an upper limit (U) for the water content

$$\mu \leq U - 1.645\ \sigma_p$$

μ : *true arithmetic mean of the water content*

σ_p *long - term process standard deviation of the water content*

1.645 : *factor to be used if "95% compliance " is required (probability to obtain a complying result : 95 %)*

Table 2 : Upper limit for the arithmetic mean - a function of the compliance criterion

- *Example* : Butter, water content
  Process s.d. : 0.20%

Accepted percentage of non-complying results	Upper limit for x (%)
10%	**15.74**
5%	**15.67**
1%	**15.53**
0.10%	**15.38**
0.01%	**15.26**

Table 3 : Calculation of the "true" process standard deviation

$$\sigma_p = \sqrt{\sigma^2 - \sigma_r^2}$$

σ : *process standard deviation including the repeatabil ity*

stan dard deviation σ_r

Remark :

For practical reasons it may be preferable that the producer uses σ when controlling the production process. σ_p is used by the control authority.

Official control

Ideal situation

- Control of arithmetic mean and standard deviation.

Reality

- Control of arithmetic mean, use of composite samples.

  Information on standard deviation provided by the producer.

Table 4 : Official control

Interpretation of control results taking sampling error and analytical error into consideration

$\bar{x} \leq \mu \quad \Rightarrow$ Compliance

$\bar{x} > \mu \quad \Rightarrow$ Further investigation

$\bar{x}$: arithmetic mean of the official control results

$$\bar{x} \leq \mu + 1.645\ \sigma_{\bar{x}}$$

$$\sigma_{\bar{x}} = \sqrt{\frac{\sigma_p^2}{n} + \sigma_L^2 + \frac{\sigma_r^2}{n_1}}$$

σ_L = Between-laboratory standard deviation

$\sigma_L = \sqrt{\sigma_R^2 - \sigma_r^2}$

σ_R = reproducibility standard deviation

σ_r = repeatability standard deviation

n_1 = number of composite samples

n = sample size

Use of auto-control data

Determination of the process standard deviation σ_p( ) :

Required sample sizes unacceptable for control authorities. Consequences :

- σ_p is determined by the producer.
- auto control data are made available to the control authority on request.
- auto-control data must be reliable.

Reliability of auto-control results

- Capability to produce reliable data.
- Data must reflect reality.

Reliability control

- Comparison with results obtained by dairies producing under similar conditions.
- Analysis of a large representative sample in the dairy laboratory under supervision.
- Comparison with results obtained by the official control laboratory. Application of special statistical techniques (comparison of the arithmetic means of 2 composite samples).

Principle

1. Definition of "unavoidable" water addition.
2. Control procedure based on a comparison of raw milk and drinking milk composition.
3. Selection on an appropriate parameter, e.g., freezing point, protein, lactose.

Criteria :

- Natural variation of the analyte,
- precision of the control method,
- effect of processing on the results obtained,
- manipulation possibilities.

Conclusions (1)

Control of the water content

Advantages the new approach :

Limits in legislation would be easily defined,

comprehensive information on product composition,

adequate decision on compliance possible,

no increased workload,

transparency for both sides.

Conclusions (2)

Control of the added water content of drinking milk

The new approach :

Provides an adequete answer to a control need,

reduces the risk of manipulations / fraud,

requires a "new way of thinking" (statistical approach).