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Colour parameters for evaluation of udder cleanliness

The investigation of colour parameters for the evaluation of udder and teat cleaning has shown that after manual cleaning the reflection degree of the surfaces is the main aspect that changes. On white surfaces the parameters red/green or yellow/green are not suitable for evaluation of the cleaning results. Only where teats had black surfaces was a significant reduction of the yellow factor established as a sign of cleaning success. Bloodied surfaces were best highlighted by the parameter red/green. A practically oriented evaluation of visual cleanliness can be expected from photograph processing systems which evaluate the structural characteristics of surfaces through different optical aspects.

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Keywords

Udder cleanliness, teat injuries, optical parameters, AMS

Literature

Literature details are available under LT02607e at <http://www.landwirtschaftsverlag.com/landtech/lo-cal/fliteratur.htm>

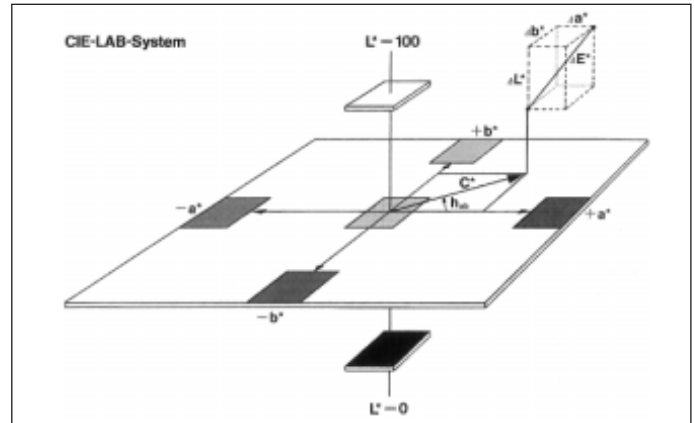


Fig. 1: CIE-lab-system for colour analysis (source: Dr. Lange GmbH & CoKG, Düsseldorf)

Up until now automatic milking systems have not been capable of successfully carrying out required udder and teat cleaning nor of identify injuries on teats before the beginning the milking process.

As a first step in the technical solving of this requirement, fundamental investigations were made by [1] over the application of optical parameters. This proved problematical, especially with pigmented teat surfaces.

[2] used photographs from a CCD colour camera for assessing the cleanliness of teat surfaces. The relationship between colour and colour intensity of all pixels enabled correct recognition of teats smeared with dung. Only a few clean teats were identified wrongly.

[3] classified different variants of dirtiness on the teat surfaces. Through this, the clean-

liness of the cow housing and type of dung were revealed as important influences on the teats' degree of dirtiness.

Building on the experiences through assessment of premilking [4] it was investigated at the FAL experimental station to what extent industrial standards for the technical evaluation of teat and udder cleaning before milking could be useful analogue to visual evaluation by the milkers.

Material and methods

In the first investigation series udder and teats of 76 cows before and after thorough manual cleaning at three milkings were inspected according to DIN 6174 by spectroscope (Dr. Lange GmbH) using the CIE-Lab colour measurement system (fig. 1).

Table 1: Reflectivity (L) of evaluated surfaces

	Udder white		Teats white		Teats black	
	uncleaned	cleaned	uncleaned	cleaned	uncleaned	cleaned
n	23	23	34	34	19	19
average value	46.99	60.44	40.24	55.04	31.84	24.29
s	9.92	6.06	7.30	3.68	4.56	3.89
significant		1%		1%		1%

Table 2: Relationship red/green (a) of evaluated surfaces

	Udder white		Teats white		Teats black	
	uncleaned	cleaned	uncleaned	cleaned	uncleaned	cleaned
n	23	23	34	34	19	19
average value	3.66	3.45	4.27	4.3	2.04	1.93
s	1.39	1.40	1.34	2.12	1.05	0.67
significant		n.s.		n.s.		n.s.

Table 3: Relationship yellow/blue (b) of evaluated surfaces

	Udder white		Teats white		Teats black	
	uncleaned	cleaned	uncleaned	cleaned	uncleaned	cleaned
n	23	23	34	34	19	19
average value	14.63	14.58	13.60	14.27	7.47	3.11
s	3.30	3.31	4.04	2.84	3.16	1.29
significant		n.s.		n.s.		1%

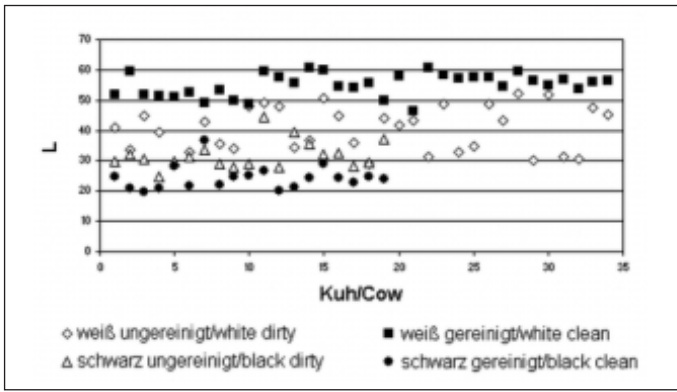


Fig. 2: Reflectivity (L) of evaluated teat surfaces

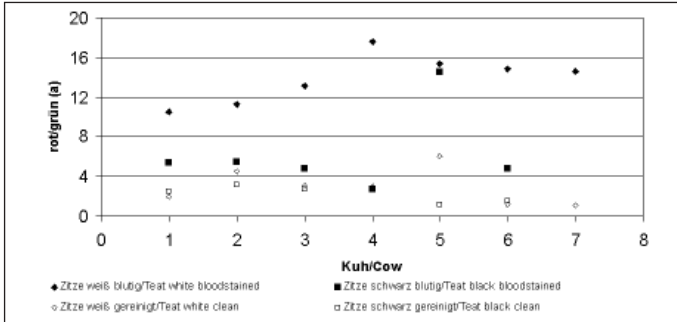


Fig. 3: Relationship red/green (a) of bloodstained teat surfaces

Given here was the brightness (parameter L) in a dimensionless number between 0 and 100. The red/green colours (parameter a) or yellow/blue (parameter b) were also described here as dimensionless numbers. Their result applied the value „0“ to the deviation from neutral areas. The preliminary sign characterised the colour determined in each case through the colour „stich“. In a further series of recordings it was investigated to what extent it was possible with the described measurement methods to identify surfaces with blood on them. For this reason udder and teats of 13 cows had freshly-collected blood applies in dots. Six teats had a black surface. Subsequently the colour parameters of the affected surfaces were measured. A further recording was conducted following manual cleaning. Recording was done through applying the measuring equipment to the surfaces to be examined. The results were separated according to measured object and the applied parameters and evaluated in simple variance analyses (F-test and range test according to Newman-Keuls), also described by [5].

Results and discussion

Dirtied surfaces

The measurement point on white udder and teat surfaces after cleaning always showed a higher degree of reflection as before the cleaning (table 1). This parameter altered for teats with black surfaces with, in total, lower measurement values in the opposite direction. The differences through cleaning were significant in all variants ($P < 1\%$).

The parameter red/green (table 2) remained almost unchanged through the cleaning with all investigated variants with in total do-

minating red proportion (positive measurement value).

The reactions of the parameters yellow/blue (table 3) as a result of the cleaning were not uniform. The yellow proportion (measurement value in the positive area) dominated with all investigated surfaces. While the measurement values in the case of measurement points with white surfaces hardly changed, there was a significant drop in the yellow proportion on the surfaces of black teats.

The degree of reflection proved to be the most suitable measure for evaluating the cleanliness of udder and teats analogue to visual evaluation by milkers. Figure 2 shows the division of these parameters on the teat surfaces. Between the clearly divided „clean“ areas on the white and black teat surfaces there was a zone wherein the measurement values of the dir-

Table 4: Reflectivity (L) of bloodstained surfaces

	Udder white		Teats white		Teats black	
	bloodied	cleaned	bloodied	cleaned	bloodied	cleaned
n	13	13	7	7	6	6
average value	36.28	61.95	45.01	57.44	19.80	22.75
s	5.29	4.10	4.14	2.48	3.98	3.41
significant		1%		1%		n.s.

Table 5: Relation red/green (a) of bloodstained surfaces

	Udder white		Teats white		Teats black	
	bloodied	cleaned	bloodied	cleaned	bloodied	cleaned
n	13	13	7	7	6	6
average value	29.50	4.44	13.93	3.00	6.28	2.30
s	6.11	2.36	2.28	1.68	3.79	0.71
significant		1%		1%		5%

Table 6: Relation yellow/blue (b) of bloodstained surfaces

	Udder white		Teats white		Teats black	
	bloodied	cleaned	bloodied	cleaned	bloodied	cleaned
n	13	13	7	7	6	6
average value	24.02	15.95	18.46	11.79	6.78	3.47
s	4.55	5.66	1.58	2.06	3.40	0.67
significant		1%		1%		n.s.

tied surfaces of both groups were included. From this non-linear methods can be deduced for evaluating cleaning efficacy. As with other comparable data structures there are possibilities here too of wrong evaluations of the measurement results.

With bloodied surfaces

The results of measurements on bloodied surfaces are collected in tables 4 to 6. With white surfaces on udder and teats there were significant differences between the measurement values of the bloodied and cleaned surfaces using all parameters. As expected, the parameter red/green proved most suitable for determining the presence of blood. This proved to be the only one which could determine blood on black teat surfaces with any degree of certainty.

Figure 3 shows that when a measurement value of 4 is exceeded for these parameters, the presence of blood can be expected with a high degree of certainty on the inspected teat surfaces independent of pigmentation.

Evaluation

Analogue to the results known from the literature [1, 2] this investigation showed that colour parameters established in the industrial standards can be suitable for evaluating the cleanliness of udder and teats and for the presence of blood in these areas. In that the measurement equipment used in the fundamental investigations described require mechanical contact with the surfaces to be evaluated, it is not suitable for automated application under practical conditions. As described by [2] a photograph processing system adjusted to suit the non-homogeneous surfaces if the udder area could be applied here.