COMPARISON OF VARIOUS INSTRUMENTS FOR ON LINE ASSESSMENT OF THE COLOUR OF VEAL CARCASSES

F. BECHEREL(1), G. EIKELENBOOM (2), M. RENERRE (3), J.R. ANDERSEN(4)

(1) Equipe Qualité des Viandes de l'Institut de l'Elevage, Route d'Epinay, 14310 Villers Bocage, France
(2) DLO Research Institute for Animal Production, P.O. Box 501, 3700 A.M Zeist, The Netherlands
(3)I.N.R.A., Station de Recherche sur la Viande, Theix, 63122 St Genest Champanelle, France
(4) Danish Meat Research Institute, Maglegardsvej 2, P.O. Box 57, DK 4000 Roskilde, Denmark

INTRODUCTION

The colour of veal carcasses is the most important meat quality criteria. Its influence in the price is dominant. Nevertheless the problem of the assessment of the colour in practice is not yet resolved.

At present, in France, a visual judgement in a four points scale (1) white, (2) light pink, (3) pink, (4) red, is used on billions of veal carcasses in the slaughterhouses per year. As this method is subjective, it is a source of disagreement in the trade.

Some apparatus are able to determine objectively the different components of the colour : However, frequently there are limitations to their practical use for on line assessment.

In the experiment, a total of five instruments were tested in order to evaluate their ability to assess the colour of veal carcasses early post mortem (45') and on line. The main reference was the visual judgements supplied by four independant and experienced persons.

I - MATERIAL AND METHOD

The experiment took place in Brittany (Etablissements GUINDE, Montauban De Bretagne, France), and involved a total of 367 carcasses, measured on two consecutive days (respectively 160 and 167 carcasses each day). The calves were 18 weeks old, approximatively 125 kg of cold carcass weight, and consisted partly of friesian, partly of crossed breed animals.

The measurements were realised on line at 45' post mortem, between the legal grading and the weighing of the veal calves.

A total of five instruments were compared.

Three of them were used to measure the colour of the Rectus abdominis (RA), in triplicate, after removal of the fascia : the Chromameter CR 300 (Minolta), the Surface Meat Colour Meter (Sensoptic B.V.) and the Retrolux III.

1 Chromameter CR 300 :

This instrument belongs to a new version of colourmeters perfected by MINOLTA. The Chromameter CR 300 is a tristimulus analyser of the colour on the surface, using a diffused flash and a 0° observation's angle.

The measurements can be made in X,Y,Z coordinates (CIE, 1931), in L,a,b coordinates (CIE 1976) or in the MUNSELL's colour system. In that experiment, the measurements were expressed in HUNTER's system : "L" is the coordinate of lightness, "a" is the redness and "b" the yellowness coordinate. A triplicate measurement was realized on the rectum abdominis of each carcass and the mean value was calculated by an in line computer.

2 Surface Meat Colour Meter :

This instrument, manufactured by SENSOPTIC B.V., uses the principle of light's reflexion. A 560 nm wavelength light flash, coming from the head of the apparatus, is sent on the muscle's surface, reflected by it and analysed in three dimensions.

The mean of two successive measurements was calculated by a portable computer. Data were stored in a portable data logger.

3 Retrolux III :

This instrument, manufactured by I.N.R.A. and made by M^R DAVID, is a reflectometer. A flash, emitted by a small bulb, then filtered in order to obtain a 630 nm wavelength, is sent on the surface of the muscle. The reflected light is analysed by a photoreceptor and converted in a value between 0 (very dark) and 100 (very light). A triplicate measurement was realized on each carcass and the mean value was calculated manually.

Invasive duplicate measurements, using fiber optics, were made in the Muscle Longissimus Lamborum (LL) and the Muscle Biceps femoris (BF) with the Invasive Meat Colour Meter (Sensoptic B.V.) and a prototype of a Danish Probe.

4 Invasive Meat Colour Meter :

This apparatus operates on the same principle as the Surface Meat Colour Meter, with the difference that the light is transfered through lfiber optics. A duplicate measurement was realised on each carcass and a portable computer calculated the mean value. Data were stored in a data logger.

5 Prototype of a Danish Probe :

This instrument, as the previous does, uses fiber optics to conduct, inside the muscle, light flash including the entire wavelength spectrum.

The spectrum of absorbtion so obtained is compared to a reference by computer.

A duplicate measurement was made on each carcass. First, a pigment value was calculated for each muscle, and then a synthetic one was computed.

The prototype of Danish Probe, produced by the Danish Meat Research Institute, had been previously utilized to measure the colour on pork carcasses. In contrast to the other instruments, it was used for the first time on veal carcasses.

Three standard measurements were used as a reference.

1 The independant visual assessment :

Four experienced and independant persons gave a visual assessment of veal colour at 45'post mortem, with reference to the four classes classification. The colour was mainly assessed on the Rectus abdominis. The mean value was calculated, after checking the coherence between the different assessments.

2 Ultimate colour :

This reference was determined on samples of the M. RA by spectrophotometer (Philips), at 24 h post mortem, after storage at 0/+2°C. The "L", "a" and "b" values were calculated from the analysis of the spectra of reflexion (from 400 to 700 nm).

3 Haem content :

The haem content of the M. RA was determined later by the HORNSEY Method (1968) on samples stored at 0/+2°C for 24 h, then frozen at -20°C for a week.

The **data** were processed by program S.A.S. MICRO.

A first comparison with the five instruments was realized by calculating the Pearson correlation coefficients between the instrumental measurements and the references, by linear regression.

A sample of 253 carcasses was selected to study the ability of both the Chromameter CR 300 ("L" and "a" values combined) and the Surface Meat Colour Meter to correctly predict the colour classes as determined by visual assessment (mean value). The 253 carcasses were choosen among those whose visual judgements were unequivocal.

The linear regression model and the Logistic model were used to calculate the prediction of the colour class system, from the measurements provided by both the instruments.

Each predicted colour class was then compared to the mean value of the visual assessments corresponding to the same carcass, in order to obtain the rate of well predicted colours.

A second test, realized on 367 carcasses, compared the proportion of well predicted values by the Chromameter CR 300 to the rate of well predicted colour class by each of the visual judgements, always with reference to the mean value.

II - RESULTS AND DISCUSSION :

1 Table 1 presents the mean values and the standard-errors of the measurements by the experimental instruments and by the reference measurements. Two sets of measurements were distinguished, the first one for the first day (160 carcasses), the second one for the second day (167 carcasses).. Except for the Retrolux III, all the instruments operated with a connected computer. Some data may have been lost during the measurements (Chromameter CR 300), others during the processing (Surface Meat Colour Meter).

2 Pearson correlation coefficients between the reference measurements :

The reference measurements are good related to each other ($r>0.70$).The Pearson correlation coefficients between one visual assessment and the mean value of the three others. They ranged from 0.77 to 0.87.

3 Pearson correlation coefficients between the instrumental measurements and the reference measurements : Surface measurements were best related to the visual judgement of carcass colour, on the same muscle (RA). The Pearson correlation coefficients between this reference and the Chromameter ("L" and "a" values combined), the Surface Meat Colour Meter and the Retrolux III were -0.85,- 0.81 and -0.76, respectively (cf **table2**).

The results obtained with the Surface Meat Colour Meter confirmed the conclusions published by EIKELENBOOM and Al (1990), who considered that instrument as very promising.

On the other hand, the results provided by the Chromameter were much better in the experiment, than in the experiment by EIKELENBOOM and al (1990). In that experiment, the correlations between the visual judgement and the "a" and "L" values ranged from -0.32 to -0.38 and from -0.68 to -0.75 respectively . However, it was not exactly the same apparatus (there are several differences between the CR 200 and the CR 300). Moreover, the combination of both the "a" and the "L" values, never tested before, improved the correlation coefficients.

The correlations between the visual judgement and the Retrolux III were also better than those obtained by BECHEREL (1990), ($r=-0.73$ and $r=-0.68$), but were similar to those obtained with the Retrolux II ($r=-0.74$) on a large number of carcasses, by QUILICHINI (1986,1987).

The correlations were much lower for the measurements with both the invasive instruments (0.43 to 0.61), however those measurements were performed on other muscles (LL and BF).The Danish Probe has never been tested before on veal carcasses and should probably be adjusted

before definitive conclusions can be made.

As for the Invasive Meat Colour Meter, the results were worse than those obtained by EIKELENBOOM and Al (1990). In that experiment, the Surface and the Invasive apparatus had similar correlations with the visual assessment. In our experiment, the reference measurements were mainly based on one muscle, the RA, which LEGRAS (1980) considered as the best muscle representative of the colour of the carcass. The difference observed between the two experiments could be due to a difference in the experimental material.

Similar results were obtained when the other reference methods were used : the Chromameter CR 300 ("L" and "a" values combined) and the Surface Meat Colour Meter were best related to the "L" and "a" values of the Spectrophotometer and to the Haem content. Nevertheless, the results obtained with the Haem content were a little disappointing, espacially for the Retrolux III.

In a first conclusion, the surface measurements (Chromameter CR 300, Surface Meat Colour Meter and Retrolux III) were best related to the reference measurements, especially to the visual assessment. Since two of them has facilities for automatic registrations and available on the market, their ability to correctly predict the colour classes as determined by visual assessment was also tested.

4 Validity of the prediction of the colour as determined by visual assessment :

This test was realized on the Chromameter CR 300 and the Surface Meat Colour Meter, with the linear regression model and the logistic model.

A sample of 253 carcasses was choosen. The carcasses without instrumental measurements were first eliminated. The carcasses with various visual assessments too different (more than one class of colour between two assessments) were also eliminated.

The linear regression model theorically allows to calculate the relation between continuous variables, whereas the logistic model is based on the use of discontinuous variables. In our case, the instrumental measurements provided continuous data, while the visual assessments were expressed in colour classes, which are discontinuous. Both methods were used in order to control the validity of the tests.

A predicted value of the colour class was calculated by linear regression and the logistic model, from the instrumental measurements, and then compared to the actual visual assessment (mean value).

Prediction and validation cannot be made on the same sample : Therefore lots were drawn in a sample composed of 85% of the carcasses to predict the colour classes. The validation was made on the 15 % remaining carcasses, with calculation of the proportion of carcasses well predicted.

That drawing of lots was repeated 17 times and the mean value determined.

89 % and 84 % of the carcasses were correctly classified with the Chromameter ("L" and "a" values combined) and the Surface Meat Colour Meter respectively. These results confirmed those relative to the correlation coefficients (§3).

The logistic and the linear regression provided the similar results.

A similar test was realized on 367 carcasses to compare the proportion of colour classes correctly predicted by the Chromameter CR 300 to the proportion of colour classes correctly predicted by any of the visual assessment (with reference to the mean of the three other assessments): with 82 % verous 75%. The Chromameter appeared to be more reliable than an individual visual assessment.

CONCLUSION

In that experiment, five instruments were tested in order to compare their ability to assess the colour of veal carcasses on line, with reference mainly to the visual assessment.

The measurements with the Chromameter CR 300 ("L" and "a" values combined) and the Surface Meat Colour Meter were best related to the visual judgement of carcass colour, the haem content in Rectus abdominis and the measurements with the Spectrophotometer.

It is concluded that at present, the surface measurements on Rectus abdominis, with both the Chromameter CR 300 and the Surface Meat Colour Meter, are most suitable in providing an objective on line assessment of the colour of the veal carcasses.

REFERENCES :

-EIKELENBOOM G., VAN DER WAL P.G., KAUFMAN R.G. STERRENBURG P., SCHNEIJDENBERG T. CH. G.P., 1989. Proc. 35 th ICOMST, Roskilde, Denmark, p. 220-222.

- EIKELENBOOM G., HOVINK-BOLINK A.H., HULSEGGE B., 1992. Meat Sci. 31, 343-349.

- HORNSEY H.C. 1956, J. Sci. Food Agri. 7, 534-540.

- LEGRAS P., 1981. Viandes et Produits Carnés 2, 17-23.

- QUILICHINI Y., 1986. Viandes et Produits Carnés 7, 19-23.

- QUILICHINI Y., 1987. Viandes et Produits Carnés 8, 3-8.

- RENERRE M., QUILICHINI Y., BECHEREL F., 1990. Viandes et Produits Carnés 11, 241-242.

Table 1 : MEAN VALUES AND STANDARD-ERRORS

		SET 1 (160 carc.)	SET 2 (167 carc.)	SET 1 + SET 2
REFERENCE MEASUREMENTS	Visual assessment (mean values)	2,02 ± 0,57	2,08 ± 0,50	2,05 ± 0,54
	Spectrophotometer "L" value Measurements on Ra	46,8 ± 2,5	45,3 ± 2,1	45,9 ± 2,4
	Spectrophotometer "a" value Measurements on Ra	6,0 ± 1,7	6,4 ± 1,7	6,2 ± 1,7
	Spectrophotometer "b" value Measurements on Ra	7,6 ± 0,9	8,2 ± 0,8	8,0 ± 0,91
	Haem content Micro g iron / g meat Measurements on Ra	2,52 ± 0,49	2,64 ± 0,57	2,58 ± 0,54
INSTRUMENTAL MEASUREMENTS	Chromameter CR 300 "L" value Measurements on Ra	45,1 ± 2,2	44,6 ± 2,1	44,8 ± 2,2
	Chromameter CR 300 "a" value Measurements on Ra	7,3 ± 1,4	6,9 ± 1,3	7,1 ± 1,4
	Chromameter CR 300 "b" value Measurements on Ra	3,2 ± 0,8	3,4 ± 0,7	3,3 ± 0,8
	Danish Probe (Measurements on Bf)	34,9 ± 11,5	32,6 ± 9,8	33,8 ± 10,7
	Danish Probe (Measurements on Ll)	30,7 ± 9,9	27,2 ± 11,1	28,9 ± 10,7
	Danish Probe "Pigment"	33,1 ± 9,4	29,9 ± 8.7	31,5 ± 9.1
	Invasive Meat Colour Meter (Measurements on Bf)	1,34 ± 0.28	1,36 ± 0.24	1,36 ± 0.26
	Invasive Meat Colour Meter (Measurements on Ll)	1,51 ± 0,30	1,42 ± 0,29	1,46 ± 0,30
	Surface Meat Colour Meter Measurements on Ra	2,20 ± 0,36	1,98 ± 0,32	2,11 ± 0,36
	Retrolux III % of Reflected Light Measurements on Ra	20,2 ± 9,2	16,7 ± 7,9	18,4 ± 8.7

Table 2: PEARSON CORRELATION COEFFICIENTS BETWEEN INSTRUMENTAL MEASUREMENTS AND REFERENCE MEASUREMENTS

	Retrolux III (Ra)	Chromameter CR 300 (Ra)			Surface Meat Colour Meter (Ra)	Danish Probe			Invasive Meat Colour Meter	
		L	a	b		Bf	Ll	Pigment	Bf	Ll
Visual assessment (mean values)	- 0,76	- 0, 85*		- 0,27	- 0,81	0,61	0,43	0,60	- 0,58	- 0,58
Spectrophotometer "L" value	0,68	0,66	- 0,76	0,18	0,75	- 0,54	- 0,38	- 0,54	0,50	0,48
Haem content	- 0,54	- 0,61	0,73	- 0,15	- 0,68	0,42	0,31	0,44	- 0,45	- 0,43

* "L" and "a" values combined