XVII IMEKO World Congress
Metrology in the 3rd Millennium
June 22–27, 2003, Dubrovnik, Croatia

IMPROVEMENT OF THE "TWO-POINT" METHOD FORMULA FOR DETERMINING THE FLESHINESS OF PIG CARCASSES BASED ON OPTOELECTRONIC CHOIROMETER MEASUREMENTS

Vladimir Pašagić, Dubravko Risović, Srđan Divjak*

State Office for Standardization and Metrology, Zagreb, Croatia,
*Institute Rudjer Bošković, Zagreb, Croatia

Abstract – In the EU, the empirical relation used for determination of the fleshiness of pig carcasses based on measured thickness of fat and muscle tissue in predetermined measuring points is determined by prescribed procedure. The devices for measuring the thickness of fat and muscle tissue are mainly optoelectronic or ultrasound devices. In RH an optoelectronic device, ERO-1 has been developed according to the regulated technical and metrological demands valid in the EU. The ERO-1 device is calibrated and its length-measuring capability is traceable to RH's national standard. The data gathered in measurements with ERO-1 devices (5 devices) over a period of two years have made possible the improvement of the "two-point" method formula. We have developed a new empirical relation for determining the percentage of the fleshiness of a pig carcass using the "two-point" method. The newly developed empirical relation provides better concordance with biological characteristics of pigs population and removes certain irregularities that were observed and related to the use of currently valid empirical relation employed with verified and validated method of "two-points", used in EU and other countries.

Keywords: "two-point" method, empirical relation

1. INTRODUCTION

History of classification [1] is very long, but the introduction of electronic probes started in the eighties. Nevertheless a lot of small slaughterhouses cannot be equipped with these too costly instruments. There is therefore a need for simple methods, very cheap and easy to use. These non-electronic methods correspond more or less to the first methods used in the past to classify pigs, like ZP method and Intrascope. Compared to electronic probes Intrascope and ZP (two points) method are respectively around 10% and 15% less accurate. Non-electronic methods are used in the small slaughterhouses of about 10 european countries. With the Intrascope one or two fat depths are measured and some countries have also introduced the carcass weight in the equation to predict the lean meat content. The ZP¨ method consists in measuring one fat depth and one muscle depth in the rump region at the split line. Only France has added the sex in order to remove biases between females and castrated males. This country has designed a specific ruler making easy the conversion into lean meat percentage. Non-electronic techniques are also used in case of failure of the electronic probe but the speed of the slaughter line and the need of computerized data are the main limitations of such methods.

2. MEASURING METHODS AND INSTRUMENTS

In the application of the introduction of singular measuring devices of objective classification of pig carcasses to commercial cathegories and classes a singular and objective procedure must be ensured, leading to fair payment to the producers. One of the basic requirements for the realization of the above-mentioned is the application of precisely determined criteria for determining the cathegories and classes, and also regulated measuring methods that are accurate enough. There exists a possibility for application of various measuring methods, that is instruments for measuring the attributes of pig carcasses and halves but one must keep in mind that only the methods that live up to the following requirements can be considered: a) are practicable, b) can be applied under standard working conditions with little loss of time and c) comparable way of system application with acceptable expenses is ensured.

In the EU various measuring methods are in use, those being [2]:

1. two-points method (in the following text ZP)
2. optoelectronic (in the following text OE)
3. ultrasound (in the following text US)
4. optical (in the evaluation phase)

Measuring devices, thanks to technological advancements, are becoming increasingly more precise and affordable, but the operating principle remains the same, that being measuring the lengths of the thickness of fat and muscle in one or more places.

Based on the measured lengths the calculation of the muscle percentage is conducted. The calculation is based on empirically-acquired relations.

The accuracy of measuring depends on both the applied length-measuring instrument and on the classificator. In order for the length-measuring instrument to be adequate it has to be under supervision by the laboratory with the ability to check on the accuracy of the given instrument.

The principle of operation of all optoelectronic devices is the measuring of the reflected light which is emited by the device into the fat/muscle.

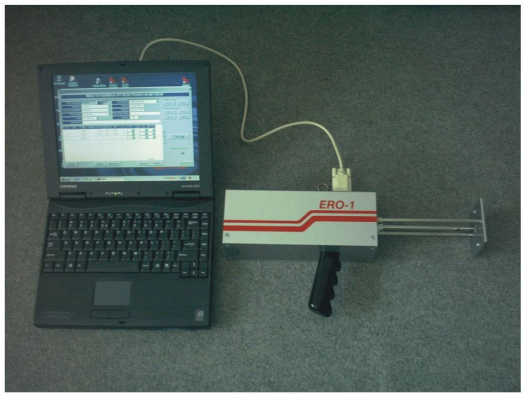
Every OE device [2] has a steel bar with a knife on top, which has to go through the pig half, that is the opening on the marked spot. On that steel bar, just behind the knife there is an opening from which the device emits light. As muscle absorbs considerably more light than fat does the device registers a greater quantity of light when the mentioned opening is in the fat as opposed to when it is in the muscle. In such way the device measures the length of fat and meat. In order to conduct the measuring in a certain spot a plate, usually made of plastic, which by its shape enables the positioning of the device in the required position and on the required spot. That ensures greater measuring accuracy and reduces all negative factors that occur with the use of ZP method. The differences of the featured devices age mainly in the wavelength of the light the device uses and in the shape of the plate, the difference being in the designated measuring spots.

3. ERO-1, OE DEVICE

"Agroinspekt" and "DAM" companies have through joined efforts created an automatic device named ERO-1, complete with the accompanying program package for distribution of pigs on the slaughtering line in classes and categories. Experts of various areas of expertise have joined in on the project: veterinarians, optoelectricians, engineering technicians, computer scientists, ...

The device consists of a movement measuring device, reflectivity measuring device, accompanying structures and housing. Movement measuring device measures from 0 mm to 115 mm with the resolution of 0.2 mm and accuracy of ± 5 mm.

The device operates on the principle of measuring the reflected light with wavelengths of 565 nm by the depth of the probe's penetration into the tissue. The probe pierces the tissue by pushing the probe up to its mechanical end. By retracting the probe movement and the reflectivity of the tissue are measured.



ERO-1 and a portable computer with the "Piggy" program package.

During the measuring the device transfers the data on movement and reflexivity to the computer. The data analysis begins when the extraction is completed. First the measured length of fat (F) and muscle tissue (M) is determined in millimeters, and after that the data and the registered mass of the pig carcass is used to calculate the estimate of the muscle tissue percentage (MT(%)). The acquired data is shown on the computer display and are stored in the data file.

4. IMPROVEMENT OF THE ZP METHOD FORMULA

The data gathered in measurements with ERO-1 devices (5 devices) over a period of two years have made possible the improvement of the "two-point" method formula. We have developed a new empirical relation for determining the percentage of the fleshiness of a pig carcass using the "two-point" method. The newly developed empirical relation provides better concordance with biological characteristics of pigs population and removes certain irregularities that were observed and related to the use of currently valid empirical relation employed with verified and validated method of "two-points", used in EU and other countries.

Measuring the fat (F) and muscle (M) is conducted in such places which, by taking into consideration the built of pigs, produce F/M ratios that do not pass over certain values. By analizing the muscle tissue percentage (German and Slovenian) we arrive at the conclusion that the F/M ratio doesn't exceed about 0.625. When that ratio is greater the table assigns constant MT % values, that is for the same S the increase in M doesn't result in the increase of MT %. It is clear that such a result cannot correspond to reality and that those values are but an approximation for potential extreme cases and that those are not acquired through given formulae. Therefore, if we have the same F the meat percentage should increase with the increase of M. The results behaving in such way cannot be regarded as accurate but as an approximation at best. Therefore, the given relation for calculating MT % is not to be applied to any combination of F and M values.

The above mentioned results in two relations on which calculations of MT % is to be based., those being:

New relation for the ZP method (m is mass [kg])

$$MT\% = 48{,}3193 + b_i \cdot (F/M) - 0{,}0016 \cdot M^2 + \\ + 0{,}4857 \cdot M + 0{,}018 \cdot F^2 - 1{,}709 \cdot F \\ - 1{,}0832 \cdot \ln(F) + 0{,}05 \cdot (85 - m) \qquad (1)$$

- for F/M less or equal to 0,625 $b_i = b_1 = 28{,}0429$
- for F/M greater than 0,625 $b_i = b_2 = 25{,}8429$

Slovenian relation for the ZP method is [3]:

$$MT\% = 6{,}9360 + 66{,}7270 \cdot (F/M) + 9{,}7281 \sqrt{M} + \\ + 33{,}2966 \cdot \log F - 19{,}8084 \sqrt{F} - 0{,}1082 \cdot T \qquad (2)$$

- T is mass in kg

Referential mass equals 70 kg, that is, with the increase of mass the percentage of fleshiness also increases for chosen F and M values, while the decrease of mass leads to the decrease of the fleshiness percentage value.

German relation for the ZP method is:

$$MT\% = 47{,}978 + 26{,}0429 \cdot (S/M) + 4{,}5154 \sqrt{M} - \\ 2{,}5018 \cdot \log F - 8{,}4212 \sqrt{F} \qquad (3)$$

In that relation mass has no effect on the percentage of fleshiness, that is the fleshiness percentage for the chosen F and M values is constant.

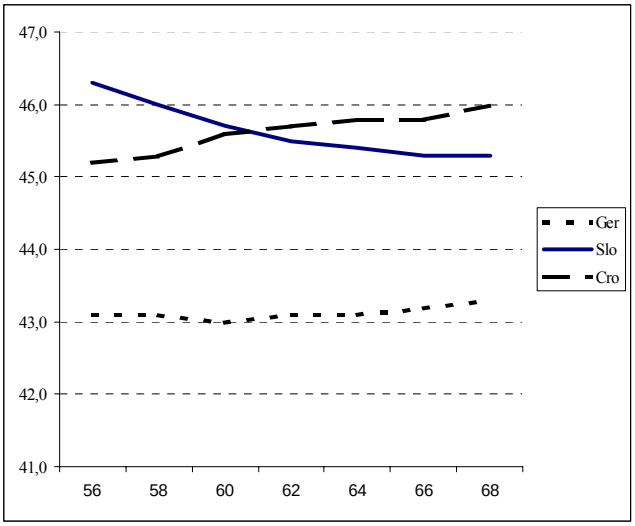
The example in table 1. gives the corresponding values of the fleshiness percentage for m = 85 kg and F = 40 mm, that is the chosen values of F/M are greater than 0,6.

Table 1.: Values of MT % for m = 85 kg and F = 40 mm

M (mm)	Ger	Slo	Cro
56	43,1	46,3	45,2
58	43,1	46,0	45,3
60	43,0	45,7	45,6
62	43,1	45,5	45,7
64	43,1	45,4	45,8
66	43,2	45,3	45,8
68	43,3	45,3	45,9
70	43,4	45,4	46,0

The graphic display of values from table 1, picture 1, clearly shows that for F/M ratios greater than approximately 0,6 the relations (2) and (3) produce unnatural values. For the chosen constant mass and the sonstant thickness of F we witness the decrease of fleshiness percentage even though the thickness of muscle tissue increases (M).

Picture 1.:



5. CONCLUSION

The analysis of the results acquired through parallel measurings with optoelectronic device ERO-1 and the ZP method (relation (3) was applied) made it possible to acquire a new ZP relation, (1).

Based on the conducted analysis we can conclude that the mass of the pig being classified has an influence on the fleshiness percentage, but the contribution of the F/M value is greater. Therefore, if we wish to decrease the error when measuring the fleshiness percentage for pigs with a relatively high F/M ratio (above 0,6) it is not possible to apply only one relation for the calculation of MT %. Considering that with the application of the ZP method the length-measuring devices with integrated computers can be used, the use of multiple relations for calculation of MT % should not pose an obstacle for their easy application.

REFERENCES

[1] Walstra, P., "Development in classification systems and the need for automation." *In : Grading & Classification. Technical report from Meat Automation Concerted Action* (MACA), European Commission FAIR-CT-97-1998. AFTS England, 8-12.

[2] EAAP, 1989. New techniques in pig carcass evaluation. Proceedings of the EAAP Symposium of the Commission on Pig Production, Helsinki, Finlande, 1 July 1988. EAAP publication n o 41., 105 pp.

[3] Pravilnik o spremembi in dopolnitvi Pravilnika o kakovosti zaklanih praąičev in kategorizaciji svinjskega mesa (Ur.l. RS, ąt. 53/1996)

Authors:

D.Sc., Vladimir Pašagić, Division of Metrology, State Office for Standardization and Metrology, www.dznm.hr (Ul. grada Vukovara 78, 10000, Zagreb, Croatia), phone 3707924, fax 3773238, vpasagic@inet.hrl.

D.Sc., Dubravko Risović, Institute Rudjer Bošković (Bijenička c. 54, 10000, Zagreb, Croatia), phone 4561111, fax 4680084, drisovic@rudjer.irb.hr

D.Sc., Srđan Divjak, State Office for Standardization and Metrology, www.dznm.hr (Ul. grada Vukovara 78, 10000, Zagreb, Croatia), phone 6106215, fax 6109322, sdivjak@dznm.hr