VISION BASED CLASSIFICATION AND PAYMENT OF BROILERS

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Abstract – The purpose of this study was to calibrate the VTS2000 vision classification equipment to be used in the Danish broiler industry and to evaluate whether the classification can be used in a value based payment to the farmers. A standard cutting of chickens was described and used as reference for the calibration of the classification parameters carcass weight, total breast fillet weight and total breast fillet yield. The calibration included two equipment placed in two slaughterhouses. After calibration the precision of the classification was ±140 gram for carcass weight, ±76 gram for fillet weight and ±2.76 % for fillet yield (with 95 % certainty). The classification is estimated to be precise enough for payment systems based on flocks with more than approx. 4,000 chickens. Vision equipment on the slaughter line has also the potential to be used in veterinary control.

Key Words – chicken, reference cutting, calibration

I. INTRODUCTION

In the pig and cattle industries classification of the slaughtered animal has been used for many years and payment based on the classification is widely used.

At present day the Danish broiler slaughterhouses pay the farmers by live weight for the animals. The transport truck with the live chickens is weighed and the weight of the truck and the cages is subtracted. This gives an imprecise estimation of the live weight since varying amounts of litter, manure, water, snow etc. may be included. Even more importantly, the quality of the chickens is generally not included in the payment system. The value of the chickens depends not only on the weight but also on the quality. Especially the slaughter yield and the meat content are of value and these quality parameters are highly affected by primary production factors like the composition of the feed. In order to obtain more valuable products, the broiler industry wishes to use a payment system that encourages the farmers to use production methods that will result in chickens with more meat and less fat and thus more value.

Therefore, this study has looked at the possibilities of a new classification system for broilers on which the payment can be based. To overcome the inadequacies of live weight, an estimation of the slaughter weight and the total breast fillet content was chosen for the new classification system. The breast fillet is the most valuable part for the Danish slaughterhouses. Because of the high slaughter speed (approx. 12,000 per hour) vision technology was chosen.

II. MATERIALS AND METHODS

Classification equipment

As classification equipment the VTS2000 from E+V technology [1] was used. The equipment was placed on the slaughter line just after the plucker and before the evisceration. The equipment includes two cameras taking a digital image of the back and of the front side of each chicken and computers that collects the images and calculate a number of different points, lengths and areas that can be used in estimation of the classification parameters.

Reference material

In order to calibrate the equipment, 259 Ross 308 chickens were produced. To ensure large variation in weight and breast meat content, the chickens were distributed on 10 weight groups (target live weight: 1040, 1349, 1596, 1853, 2115, 2380, 2643, 2988, 3239 and 3480 gram) and 4 feeding/parent groups (low wheat / parent category 0, high wheat / parent category 0, norm wheat / parent category +1 and norm wheat / parent category -1). The chickens were fed a concept feed with low, norm or high addition of wheat. The parent category represents the age of the mother hen when the egg was laid where +1 is 24-29 weeks, 0 is 30-45 weeks and -1 is 46-65 weeks.

The chickens were divided between two slaughterhouses where they were slaughtered and measured by a VTS2000 equipment.

After slaughter, the carcasses were cut in a standard presentation, weighed and then cut into parts with all parts also being weighed. The weight of the carcass in standard presentation served as reference for the *slaughter weight*. The combined weight of both outer and both inner breast fillets served as reference for the *total fillet weight*. The combined weight of both outer and both inner breast fillets divided by the weight of the carcass cut in standard presentation and multiplied by 100 % served as reference for the *total fillet yield*.

Classification equations

Classification equations for carcass weight, total fillet weight and total fillet yield were made based on measurements from both slaughterhouses / VTS2000 equipment and the corresponding references using regression analysis (details are confidential). The measurement error of the classification was calculated as RMSED (Root Mean Square Error of Deviation):

$$RMSED = \sqrt{\frac{\sum_{i=1}^{n}(\hat{y}_i - y_i)^2}{n}}$$

and the Bias was calculated as:

$$Bias = \frac{\sum_{i=1}^{n}(\hat{y}_i - y_i)}{n}$$

where

$\hat{y}_i$ = the predicted value of chicken i,
y_i = the reference value of chicken i and
n = the number of chickens

The precision of the classification was calculated as:

Precision = 2 x RMSED

It was tested if Bias=0 using proc ttest in SAS [2].

The above calculations were made on the calibration data set. Ideally they should have been made on an independent validation data set but unfortunately that was not possible within the scope of the study.

III. RESULTS AND DISCUSSION

Figure 1 shows an example of the two images taken by the VTS2000 equipment. Note that the images are taken before evisceration. This is done because the carcasses are then more rigid and uniform in their presentation and any accidental damage due to the evisceration is omitted from the classification.

Figure 1 Images of back and front of a chicken taken by the VTS2000 equipment

Reference material

Figure 2 shows a carcass from the reference material in standard presentation. The use of a standard presentation in the reference material is essential since this allows for a uniform classification of the slaughter weight no matter how the slaughterhouses may choose to cut the chickens as a product or as raw material for further cutting into parts.

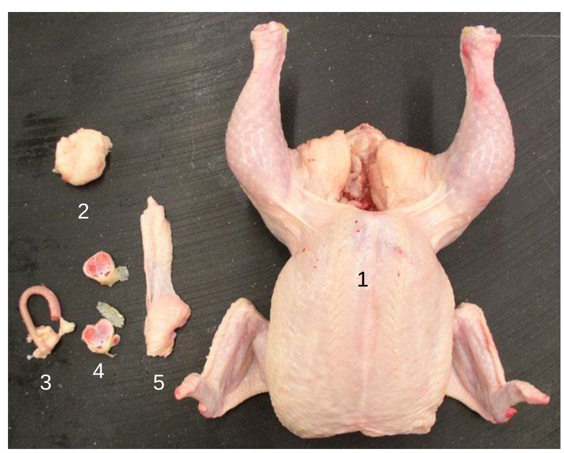

Figure 2 Carcass in standard presentation (1). Cut off are rests of leaf fat (2), neck and oesophagus (3), rest of the feet (4) and neck skin (5).

In the reference material, the carcasses are also cut into parts in a standard manner as shown in figure 3. The sum of both outer and both inner fillets (1 and 2 in figure 3) is the reference for the total fillet in the classification.

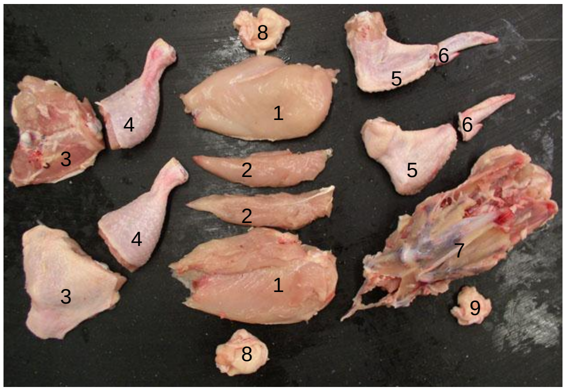

Figure 3 Reference cutting of carcass into parts. Outer and inner fillet without skin and fat (1, 2), thigh (3), drumstick (4), wing 2-joints (5), wing tip (6), carcass shell (7), scraps (skin and fat) from filet (8) and scraps (skin and fat) from thigh (9).

Table 1 shows the results of the reference cutting.

Table 1 Reference material
Carcass weight, total fillet weight and total fillet yield for the two slaughterhouses/equipment (N=259)

	Mean	Stand. dev.	Range
Slaughterhouse A (n=136)			
Carcass weight (gram)	1728	522	824-3193
Total fillet weight (gram)	530	174	240-1024
Total fillet yield (%)	30.5	1.9	26.3-35.4
Slaughterhouse B (n=123)			
Carcass weight (gram)	1805	554	882-3082
Total fillet weight (gram)	546	173	247-972
Total fillet yield (%)	30.2	1.8	25.6-34.0

Classification equations

The classification equations for carcass weight, total fillet weight and total fillet yield were developed using measurements and reference data from both slaughterhouses (two equipment). Table 2 shows the bias and the precision of the classification parameters for the individual slaughterhouses and for the two combined.

Table 2 Classification equations
Bias and precision for the two slaughterhouses and combined

Slaughterhouse	A	B	Both
Carcass weight	+1.8	-3.6	0
(gram)	±155	±121	±140
Total fillet weight	+2.4	-4.9	0
(gram)	±78	±74	±76
Total fillet yield	+0.11	-0.04	0
(%)	±1.3	±1.5	±2.76

None of the biases were statistically significant (t-test, all $p > 0.1$). For the total data set, the carcass weight is estimated with a precision of ±140 gram (95% certainty). The total fillet weight is estimated with a precision of ±76 gram and the total fillet yield with a precision of ±2.76%. At slaughterhouse B the precision is slightly better than at slaughterhouse A for carcass weight and fillet weight and slightly poorer for fillet yield. The differences between the two slaughterhouses are so small that they have no practical implications. They are probably due to differences in the slaughter process before the classification but can also be due to small unintended differences in the reference material or in unknown differences between the two equipment, although much was done in order to make both reference material and equipment identical.

The precision of the classification may not seem too impressive for the individual chicken but the classification is to be used in payment of flock sizes of many thousands. The precision of the average classification of a flock depends on the flock size (N) and the standard deviation of the flock (STD) in this way:

$$Precision_{flock} = \pm 2 \times \sqrt{\frac{STD_{flock}^{2}}{N} + \frac{RMSED_{chicken}^{2}}{N}}$$

It can be seen that the precision of the flock average will be better when the flock is larger. To have a meaningful payment system, the precision of the classification should be small compared to the variation (standard deviation) of the flock. The variation within flocks of normal production is not yet known but based on the reference data we can assume that the standard deviation will be approx. 220 gram for slaughter weight, 75 gram for fillet weight and 1.3 % for fillet yield. If we as an example say that the precision should be smaller than 5 % of the standard deviation, the flock size should be at least 2,000 chickens for the carcass weight, 3,000 for the fillet weight and 4,000 for the fillet yield. Therefore, if the payment were to include fillet yield, then the flock size should not be smaller than 4,000. In that case the precision would be ±6.70 gram, ±2.66 gram and ±0.06 % or better for the average flock slaughter weight, fillet weight and fillet yield respectively. Statistically (t-test; $p < 0.05$) it will then be possible to distinguish between flocks if the mean difference is more than approx. 11 gram slaughter weight, 6 gram fillet weight and 0.1 % fillet yield.

Flock sizes are normally up to 30,000 chickens in Denmark.

IV. CONCLUSION

Vision classification including carcass weight and total breast fillet meat can be precise enough to be used in a broiler payment system, if it is based on the average classification of flocks. The flock size should be so large that the precision of the average classification is small compared to variation of the flock. With the normal flock sizes in Denmark this will not be a problem.

A payment system based on vision classification can better than the existing payment system reflect the value of the chickens. The weight of sellable products is estimated more precisely and the content of the most valuable meat is included.

The precision of the classification of the individual animals may not be good enough to be used in an individual sorting of the chickens at the slaughterhouse to different products but – as for the payment – *flocks* may be sorted for different use based on the average classification. The variation of the flock may also be of use.

It is important to underline that the classification equations developed in this study are only valid for chickens that are comparable to the reference chickens in the study. If other types of chickens are to be classified, new equations must be developed. The same is true, if the chicken population changes considerably over time for example as a result of the new payment system. The equations should be checked from time to time.

As can be seen in figure 3, the reference cutting included other parts than the total breast fillet. It is therefore possible to develop classification equations for these other parts as well, based on the collected reference data.

The Danish broiler industry is presently implementing the vision classification and a payment system based on the vision classification is being developed.

The introduction of vision on the slaughter line may have other applications than classification – for example veterinary control, which is currently being investigated at DMRI.

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REFERENCES

1. E+V Technology GmBH, http://www.eplusv.de/start.htm,

2. SAS version 9.2. SAS Institute Inc., Cary, NC, USA