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Accuracy of calculation of body mass on the basis of measurements

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Methodology of research

ABSTRACT

Purpose: The results of measurements shows that the chest size is not enough accurate to establish the body mass of living animals in all development stages, therefore additional measuring of the trunk length was used to increase reliability of the estimate.
Design/methodology/approach: During the test 30 fattened animals were considered and were weighed by electronic weighing device EC 2000. The trunk length (d) and the chest size (o) were measured simultaneously. The body mass (T) was calculated according to the equation: $T = o \times d / 50$. By the statistical package SPSS 12.01. for Windows the basic statistics for the studied properties was calculated. By the t-test the calculated and the actually weighed body masses of animals were compared.
Findings: On the young fattened cattle it was established that with 240 - 290 kg body mass, when the body form is most rectangular, the accuracy of calculation on the basis of measured body parts, is the greatest. The percentage difference between weighed and calculated body mass is only 0.06%, which is very accurate.
Research limitations/implications: For wide applicability of measurement results on the living animals in all stages of growth it would be necessary in the equation for the calculation to include also the trunk size in the middle of the body and the size in the rear part.
Practical implications: On small farms where the cost of purchase of the digital weighing device would be too great a burden, thus, measuring of the chest size at 3 cm behind the elbow joint, in the middle of the trunk (behind the last rib), and measuring of the size in the rear part of the body and the trunk length from the middle of the withers to the tail root are more appropriate.
Originality/value: The animals which phenotypically feature cylindrical shape in the period of growth can be measured most simply in the front middle and rear part of the body and, then, their body mass can be determined very accurately on the basis of the data obtained.
Keywords: Technological devices and equipment; Weighing; Body dimensions; Cattle

1. Introduction

Following up of the development of young animals is very important, since the incorrectnesses become obvious soon in the development itself and in the economy of raising. On the young animal the body mass is one of highly important indicators of the development of the animal, therefore, following it up is very important. Accurate data on the body mass are obtained by weighing with the use of various weighing devices, such as the spring ordinary weighing devices or more modern electronic weighing devices. In our researches the electronic weighing device EC 2000 produced by the maker Tru-test was used [1]. As the animals cannot always be weighed, often, alternatively, the individual body parts are measured. Usually, measuring of the chest size suffices. As much as the calves deviate from the optimal body development, also establishing of the body mass deviates. In order to calculate the body mass more accurately, it is necessary to

consider also the trunk length in addition to the chest size. To increase the accuracy of calculation of the body mass, it is appropriate to complement the formula by covering in the measurements also the size of the middle and rear part, since, thus, the back width is considered [2, 3].

2. Description of the approach, work methodology, materials for research, assumptions, experiments etc

2.1. Weighing

In recent literature, i.e., during the last 20 - 30 years, the authors were not concerned about the determination of the mass on the basis of the body dimensions, since they were of the opinion that the weighing devices were more accurate and available to anyone. For following up the mass, particularly in intensive raising, the spring and/or electronic weighing devices were purchased. Thus, for weighing the birth mass the weighing device of at least 1 kg accuracy and for further weighing the weighing device of at least 2 kg accuracy are to be used [4, 5].

We do not leave the indicator or load bars in water. After using we store the indicator in a cool dry place. The indicator automatically turns off after 15 minutes of no activity, to limit discharge of the internal battery [1, 6].

For following up of convenient feeling of animals during raising and for establishing their production results the use of new methods including top computer technology is nowadays of greater and greater importance. A more accurate description of some non-invasive methods of establishing the stress by means of modern equipment, e.g. Polar Sport Tester Profi in production conditions can be found in recent publications [7, 8, 9, 10].

2.2. Measuring

The Lydtin's rod and the measuring tape are used for taking the body measurements and the compasses for taking the head measurements. Most measurements are taken by means of 117 cm long hollow Lydtin's rod. The hollow houses a 1 m long thinner extractable rod. Both rods are marked with a centimeter scale. The Lydtin's rod ensures measuring of up to 217 cm length. The beginning and end of certain body dimension are taken by two foldable arms, one of which can be moved vertically on the rod. The Lydtin's rod can measure: the height of the withers, the croup height, the body length, the croup length, the chest width, the haunch width and the chest depth. The measuring tape is 2 m long and made of linen or metal. Frequently, on one side it is marked with distances in centimeters, while on the back side the animal's body mass corresponding to certain measurements is indicated. The measuring tape serves to measure the chest size. On some measuring tapes the body mass is separately indicated for fattened and reproductive cattle. There are certain differences between the body masses stated by individual authors. The compasses are metallic and ensure measuring of up to 60 cm length [11, 12].

Methods of establishing of body mass in use

For selection of animals it is important to know and consider the body measurements. There are positive relations between the body measurements and the production capacities. Thus, for example, the body frame, size and length are in positive relation to intensity and capacity of meat production. Only the animals with sufficient body frame and with well muscled top - quality body parts can be successfully fattened to high body mass. With frequent establishing of the body mass the raisers can follow up the development of the animals, particularly the growth of young animals. The most reliable information about the body mass of cattle can be obtained by weighing the animals. Frequently, however, the raisers do not have available the weighing devices. Then, they can resort to approximate establishing of the body mass on the basis of animal's chest size. The information thus acquired is, usually, less accurate than if obtained by weighing. The differences are affected by the breed type, satiety of the animal, manner of feeding and even tightness of the tape during measuring [13, 14].

The tabular values were prepared on the basis of more than 50 years of practice and experience of the German-Austrian schools of agriculture for establishing the body mass without the weighing device. The data in them are valid, if the cattle is normally raised. If the animals are measured before the transport, they may have lost 4 - 5 % of the body mass [11, 15].

[16] states that for establishing the cattle body mass the following formula can be used:

$$T = F \times o^3 \tag{1}$$

where:
T - body mass (kg)
o - chest size (m) measured at 3 cm behind the elbow joint
F - factor (85 for grown up cattle, 87 for calves)

According to this method of calculation most frequently a correction must be made. For fat or thin animals the correction of ± 4% to ± 7% and for very fat or very thin or fattened cattle even the correction of ± 10% are taken into account [17].

Test process

The test took place in 2004 and 2005; a group of 30 young bulls was studied. On the first weighing the young bulls were moved from the quarantine barn into the barn for fattening, where the animals were placed into the group boxes in groups of 10 together. The groups were formed depending on the body mass and the animals remained together until the end of the test. A plan of 5 weighings was made, starting from moving; they were weighed and the average body mass of 182.70 kg with average age of 135 days was recorded. In the same time also the trunk length, the chest size, the withers height and the croup height were measured. Those measurements were performed during all five stages of weighing.

For collecting of data the measurements and the weighings were repeated every 2 months after arrival into the barn. After measurements the results obtained were processed immediately. On the basis of the calculation of the daily growth with different

body masses of bulls also the feed ration was determined [18]. Also consuming of the feed, the health state and the feeling of the animals were followed up. Testing of the bulls concerned ended with the average age of 382 ± 12.69 days and with the body mass of 485.33 ± 40.85 kg (fifth weighing), followed by weighing prior to slaughter.

For the determination of the body mass on the basis of measurements performed by us another formula [16] was used as follows:

$$T = \frac{o \times d}{50} \quad (2)$$

where:
T - body mass (kg)
d - trunk length from the middle of withers to tail root (cm)
o - chest size measured at 3 cm behind the elbow joint (cm)

2.3. Statistical analysis

The data were statistically processed by statistical package SPSS 12.01. for Windows [19]. The parameters of the basic statistics were calculated and the differences between the calculated and weighed masses of animals were compared by independent t-tests [17].

3. Description of achieved results of own researches

In table 1 it can be seen how, on the first weighing, the calculation of the body mass on the basis of measurement overestimates the body mass. The chest size in relation to the rear part of the body is well developed on very young animals as indicated by the 13.51% deviation ($p \leq 0.05$). During the second weighing it was found out that the differences were minimum, i.e., 0.06%. During that period the growth of bones is very intensive and the calculation implies the body shape which is most similar to the rectangle and there is no statistical difference between the calculated and measured mass. During the third weighing the difference of 5.84% was established ($p \leq 0.05$) between the calculated and weighed mass, however, the ratio changed in favour of the weighed body mass. It was found out that the body measurements and the calculation did not cover completely the development of the body. The chest size and the trunk length increase slower than filling of the rear part so that the body mass is underestimated. Further, it can be seen that during the fourth and, afterwards, fifth weighing the body measurements, such as the size and the length, do not take into account the build-up and filling of the body and the latter is underestimated in the calculation of the mass for 10.62% and/or 11.03%, which leads to significant difference between the masses ($p \leq 0.05$).

In figure 1 it is shown how the weighed body mass of bulls (Mass 1) increased and the body mass calculated on the basis of measurements (Mass 2) is compared. Thus, during the first weighing the body mass was lower than the body mass calculated according to the measurements of the chest size and length. The measurement of the body mass was much more accurate during the second weighing, where it approached the 0.06% difference. Figure 8 also shows that the body mass deviates more and more, when the growth of the animal's body is slowed down and build-up of meat in the middle and rear part starts [2, 20]. It can also be seen that the calculation of the body mass on the basis of measurements is a linear value which, with 240 to 290 kg, coincides with the actually weighed body mass by means of the electronic weighing device.

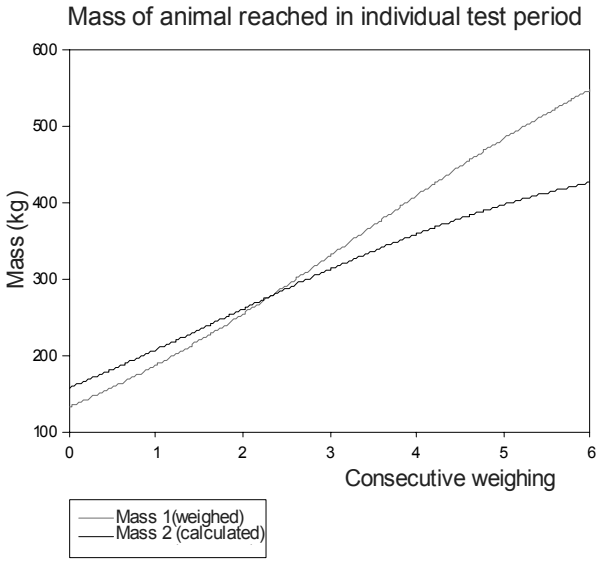

Fig. 1. Comparison of body masses obtained by weighing and calculation in test period

Table 1.
Representation of consecutive measurements

	Measurement 1	Measurement 2	Measurement 3	Measurement 4	Measurement 5
	$\overline{x}$ ± SD	$\overline{x}$ ± SD	$\overline{x}$ ± SD	$\overline{x}$ ± SD	$\overline{x}$ ± SD
Weighing	182.70±14.81[a]	260.82±22.65	329.15±31.05[a]	404.27±45.13[a]	485.33±40.85[a]
Measurement	207.39±16.79[b]	260.66±16.94	309.94±21.69[b]	361.33±30.05[b]	402.67±31.47[b]
Difference (%)*	+ 13.51%	- 0.06%	- 5.84%	- 10.62%	- 11.03%

[a.b] - differently designated mean values in the same column mutually differ significantly *($p \leq 0.05$)*
* weighed mass is 100%

4. Conclusions

The economy of fattening depends considerably on the growth of the animals calculated from the difference of masses between two consecutive measurements. When studying the influences of the growth and age of animals on the body mass reached in the individual studied period the following conclusions were made during the comparison of the results of weighings and measurements:

1. The influence of the age is important for the calculation of the body mass, since it has been proved that all body parts of the cattle during the growth do not grow simultaneously and equally. During the second weighing, when the body shape was most rectangular, the deviations were minimum, i.e., only 0.06%.
2. It was found out that with 240 - 290 kg calf mass the body mass could be established very well by calculation on the basis of measurements even without the weighing device. The accuracy with that body mass was between 0.44 kg and 2 kg.
3. As at certain age the animal does no more develop in the chest part, but its body fills in the back, thigh and in the parts which were not covered by measurement, the formula used for calculation would have to be complemented with the data of measurements of the trunk size in the middle of the body and the size in the rear part.
4. Establishing the body mass by the use of the electronic device EC 2000 of the maker Tru-test ensures high accuracy of measurements, since the allowable deviations are only + - 1%. On large cattle - breeding farms the purchase of the modernized weighing device with "serial port" is economically justified.
5. In cattle fattening barns, where compact floor surfaces, allowing firm installation of measuring sensors (load bars) with aluminium base, are available, it is possible to install the frame for restraining the animal. In barns with chasing corridor the mass is established, when the animals pass over the weighing device. Where the mentioned adequate floor surfaces are not available, the measurements and the calculation of the body mass according to the equation with proposed additional measurements are applied.

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