Introducing objective criteria for the transformation of energy and protein along the feed-consumable-by-humans chain in pig farming through the Clark Energy Distribution and Clark Protein Transformation System

Dimo Penkov[1*], Gergana Marcheva[2], Radka Nedeva[2], Valentin Katsarov[3]
[1] *Agricultural University – 4000 Plovdiv, Bulgaria*
[2] *Agricultural Institute – 9700 Shumen*
[3] *Trakia University – 6000 Stara Zagora*
[*]Correspondence: dimopenkov@gmail.com

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Abstract

AIM: to describe the methodology of calculating of Clarcs of energy distribution/protein transformation along the trophic chain “fodder – carcass meat” (in the case – “fodder-meat from *M. longissimus dorsi”*). METHODS: Experiment for fattening of 21 pigs (Danube white breed) from 30 to 110 kg live weight in 2 phases (30–60 and 60–110 kg). Controlled: Total fodder consumption, total metabolizable energy and total crude protein consumption, total weight and chemical composition of *Musculus longissimus dorsi* in the end of experiment. RESULTS: Clarc of energy distribution – CED (MEfodder – GEmeat of *M. longissimus dorsi*) – 0.0014 (0.14%); Clarc of protein transformation – CPT (CPfodder – CPmeat of *M. Longissimus dorsi*) – 0.0038 (0.38%).

Keywords: Clarc of energy distribution, Clarc of protein transformation, pigs – fattening

Introduction

Feed consumption per unit of production is a major indicator in pig production. On the one hand, it is part of the productive performance of animals and is the basis for building breeding and technological strategies (Dragoev et al., 1994) and, on the other hand, economically, the basis for controlling the cost of production (Angelova, 1983; Angelova et al., 1985).

At the present stage of scientific development, it is considered that this indicator should be supplemented by additional criteria for reflecting the transfer of nutrients from feed to human-consumable products. The basic requirements for these criteria are both biological and environmental. The former is considered appropriate for moving to nutrient and energy transfer from food to production (net utilization of substances) – Pirgozliev & Rose (1999), and the rationale for the second group is that when more nutrients and energy are transferred to production, less pollution will be produced and emitted in nature (Ilchev et al., 2008).

Guided by these requirements (Penkov & Genchev, 2018) have proposed criteria for an objective assessment of the transformation of energy and protein/amino acids from the primary feed to the secondary unit of the eco-technological chain (animal feed, consumable by humans) in poultry. The ”Clark for Energy Distribution, Clark for Protein/Amino Acid Transformation” indicators were based on the relevant ones in the ecology of chemical elements, and in particular of heavy metals (Dobrovolski, 1998; Baykov, 1994).

The purpose of this study was to introduce the appropriate Clark system and to develop a methodology for their evaluation in pig fattening. An additional objective of the development has been the adaptation in methodology so that it can compatible and can to data from the established methodologies for monitoring the fattening characteristics of pigs.

Material and Methods

Introduction of calculation methodology for Clarc for energy distribution (CED) and Clarc for protein/amino acid (CP(AA)T) transformation:

The proposed calculations for meat-breeding poultry, proposed by Penkov & Genchev (2018), were adapted for pig production:

CED = MJ gross energy (GE) obtained from one pig for a standard control period (derived from carcass meat testing) / MJ metabolizable energy (ME) accepted for the whole standard fattening period [1].

CPT = kg crude protein (CP) obtained from one pig for the standard control period (obtained from carcass meat testing / kg CP accepted for the whole standard fattening period [2]

In order to present the methodology for calculating the corresponding Clark methods, an experiment was performed with the control fattening of 21 pigs of the Danube White breed from 30 to 110 kg live weight.

After reaching the pre-slaughtered live weight, the animals were slaughtered under the Animal Welfare Act. Slaughter analysis was carried out and the carcass dimensions were established according to the Regulations for Breeding Value, Productivity and Ranking of Breeding Pigs (1996).

A sample of *M. longissimus dorsi* was taken from 3 points and they were averaged for analysis. The chemical composition of the meat was determined by the Weende method (AOAC – 2007) and the energy content by the formula of Schiemann et al. (1971).

The energy and protein nutrition of feed was determined by its component composition and basic nutrition information for the components (Todorov et al., 2016).

Table 1. Contents of nutrients in the combined fodders

Contents	Starter	Finisher
Metabolizable energy (ME), MJ	12.83	12.76
Crude protein, %	17.15	15.17
Crude fiber, %	6.02	7.29
Crude fats, %	2.63	2.51
Lysine, %	0.84	0.72
Methionine, %	0.31	0.30
Ca, %	1.01	0.52
Total P, %	0.69	0.46

Results and Discussion

Table 2 summarizes the main feed intake, crude protein exchange energy for the standardized phase fattening period and total (system input).

It can be seen that the first phase lasted an average of 70 days and the second – 33 days. The average daily increase for the whole experimental period was 0.672 kg, for the first subperiod 0.655 kg and for the second subperiod 0.704 kg.

Similar to our results were those obtained by Simkus et al. (2008), and Konstantinovich (2009), who also found a positive effect of some biologically active algae substances on growth.

On the basis of the total feed consumed by phases and the content of metabolizable energy and crude protein in 1 kg of fodder, a total energy intake of 1 pig over the whole fattening period of 3893 MJ was established, and of crude protein – 49960 grams (Table 2).

Table 3 summarizes the main system output data. For the sake of clarity, we have only taken

Table 2. Fodder, metabolizable energy (ME) and crude protein (CP) from 1 pig for the whole experimental period (entrance of the system)

Indexes	I phase (30–80 kg LW) LS ± SEM	II phase (80–110 kg LW) LS ± SEM
Duration of the period (days)	70	33
Daily consumption from 1 pig, kg	2.773 ± 0,041	3.33 ± 0.145
Mean fodder consumption from 1 pig for the whole phase, kg	194.11 ± 2.87	109.89 ± 4.79
Metabolizable energy (ME) consumption from 1 pig for the whole phase, MJ	2490.43 ± 36.82	1402.20 ± 61.12
Total ME consumption for the whole fattening period (30–110 kg) – MJ	3892.63 ± 42.97	
Crude protein (CP) consumptiom from 1 pig for the whole phase, g	33289.87 ± 490.21	16670.31 ± 726.64
Total CP consumption for the whole fattening period (30–110 kg), g	49960.18 ± 555.96	

Table 3. Produced meat and chemical composition of *musculus longissimus dorsi* (exit of the system)

Indexes	LS	SEM
Edible meat (without bones) from *m. longissimus dorsi*, kg	0.882	0.174
Crude protein in the meat, %	21.46	0.56
Crude fats, %	2.71	0.69
Gross energy (GE), MJ*kg-1	6.185	0.39
Accumulated crude protein in the edible meat of *m. longissimus dorsi* of the tested pigs, g	189.28	6.06
Accumulated crude fats in the edible meat of *m. longissimus dorsi* of the tested pigs, g	23.90	1.01
Accumulated GE in the edible meat of *m. longissimus dorsi* of the tested pigs, MJ	5.455	0.28

data for *Musculus longissimus dorsi*, but they can similarly be investigated and calculated in respect of all major parts of the carcass. If the calculation of Clarcs for the meat of all standard carcass parts was then the sum of these will give the global Clarcs of distribution/transformation from fodder to the whole edible carcass' meat.

It is important to note that all Clarcs were calculated and the nutritional values of feed and meat were taken only in the native state.

The established average mass of *M. longissimus dorsi* was 0.882 kg, while the chemical composition in the native state was:

Crude protein – 21.46%; Crude fat – 2.71%; NPE – less than 1%. On this basis, the estimated gross energy was 6.19 MJ*kg-1. With an average production of 0.882 kg of undercut per pig, the output of the system will be accumulated 5,455 MJ of gross energy and 189.28 g of crude protein.

The input and output of any amino acid can be calculated using the same methodology.

The results obtained in Table 3 are in unison with a series of studies conducted with pigs of the Danube White breed (Nedeva, 2002), which indicated the following protein and fat values in MLD: crude protein 22.97%–24.18% and crude fats 2.09%–2.68% for the first experiment and crude protein 23.6–24.37 and crude fats 2.17%–2.65% for the second experiment.

Based on the obtained inputs and outputs of the system, Table 4 calculates the Clarc of energy distribution and Clarc of (crude) protein transformation from feed to the undercut. The values of the two Clarcs can be seen to be very low, but the system chosen by us has a very low

Table 4. Clarc of energy distribution (CED) and (crude) protein transformation (CPT) from the fodder to m. longissimus dorsi

Clarcs	LS
CED (MEfodder – GEmeat)	0.0014 (0.14%)
CPT (CPfodder – CPmeat)	0.0038 (0.38%)

relative share of all the meat in the carcass, although with the highest quality.

The following question is debatable in this case: Is it appropriate for the system output to account for the difference in weight between the end (110 kg of Live weight) and the starting (30 kg of Live weight) of the trial, or the initial accumulated meat has to be subtracted from the final?

Our proposal is to adopt a second approach for two reasons:

- In the previous standard methodologies, the indicators were measured only at the end of the period and the accumulated database was calculated by this approach not only in Bulgaria.
- When first introducing Clarcs of distribution/transformation into poultry breeding (Penkov & Genchev, 2018), did not take into account the initial mass of tight and breast muscles in hatching (however small it may be). For the same reasons, it was not recommended to measure the amounts of meat in the relevant piglet portions at birth and until the start of the standardized experience, and that they were to be automatically added to the final weights.

Conclusions

The introduction of Clark for the distribution of energy, Clark for the transformation of protein in pig fattening was relatively easy and complementary to methods for monitoring the meat production of pigs. It also complements scientific information in at least 3 scientific fields:

- Bio-ecological – objectively monitors the degree of transformation of substances from primary (food) to secondary (pig muscle) unit of the ecological chain.
- Selection – gives the basis for introducing new selection criteria in pig production.
- Technological (bio-technological) – efficiency testing of applied technologies for rearing (feeding, microclimate, etc.) on the effectiveness of transformation of nutrients.

The following Clarcs in the feed – meat chain of *M. longissimus dorsi* have been established in the experience:

- Clarc of energy distribution – CED (MEfodder – GEmeat) – 0.0014 (0.14%).
- Clarc of protein transformation – CPT (CPfodder – CPmeat) – 0.0038 (0.38%).

The developed methodology for calculating the Clarcs system did not contradict, but supplements the data obtained from standard methods of testing the meat production of pigs. It was easy to digitize and process results.

References

Angelova, L. (1983) Effective feed utilization in fattening of pigs with high biological growth capabilities. *Agricultural sciences*, 1983, 4 (Bg).

Angelova, L., Valchev, G., Stoeva, N., Mircheva, D., Stanchev, H., & Ivanov, S. (1985) Biological and economic efficiency in fattening of intense growing hybrid pigs fed limitedly or at will. *Bulgarian Journal of animal husbandry*, 1985, 3 (Bg).

Baykov, B. D. (1994). An objective method for assessment of the movement of chemical elements in anthropogenic ecosystems (domestic animal farms). *Toxicological & Environmental Chemistry*, *42*(3-4), 227-233.

Dobrovolskiy, V. (1998) Introduction to biochemistry, Moscow, Visshaya shkola, (in Russian).

Dragoev, P., Angelov, D., Petrov, P., & Nedeva, R. (1994) Influence of feed consumption on economical results in pig production. *Journal of University of Economics – Varna.* (bg)

Ilchev, A., Ganchev, G., Pavlov, D., Valcheva, P., & Nikiforov, I. (2008) Investigation on the effect from different protein levels on the nitrogen retention and excretion by growing pigs. *Bulgarian Journal of animal sciences*, 5, 122-130.

Konstantinovich, D. (2009) The use of a suspension of microalgae strain No. C-111 in the diets of young pigs, Dissertation, pp156 (RU).

Nedeva, R. (2002) Influence of different levels of Calcium and Phosphorus on the productivity of growing and fattening pigs. Dissertation.

Penkov, D., & Genchev, A. (2018). Methods for introduction of objective criteria for bioconversion of energy and nutrients along the feed-animal products chain in meat-type poultry farming. *Journal of Central European Agriculture*, *19*(2), 270-277. DOI: /10.5513/JCEA01/19.2.2152.

Schiemann, R., Niering, K., Hoffmann, L., Jentsh, W., & Chudy, A. (1971) *Energaetische Futterung und Energienormen,* VEB Deutscher Landwirtschaftsverlag, Berlin.

Simkus, A., Oberauskas, V., Zelvyte, R., Monkeviciene, I., Laugalis, J., Sederevicius, A., ... & Bartkeviciute, Z. (2008). The effect of the microalga Spirulina platensis on milk production and some microbiological and biochemical parameters in dairy cows. *Zhivotnov'dni Nauki*, *45*, 42-49.

Todorov, N., Marinov, B., Ilchev, A., Penkov, D., Georgieva, V., Ganchev, G., & Chobanova, S. (2016) Nutrient's composition of the main fodders fo r birds and rabbits. *Applied feeding of farm animals*, 301 - 304. ISBN: 978 - 954 - 2944 - 12 – 6.

AOAC international (2007) Official methods of analysis of AOAC (18 edition, rev. 2), Association of Official Analytical Chemists, Gaithersburg, MD, USA.

Regulations on Breeding Value, Productivity and Ranking of Breeding Pigs, 1996.

Regulation for amendment and supplementation of regulation No. 16 of 2006 on protection and human relations in breeding and use of agricultural animals (State newspaper 18/06) 10. *(Amend. SN 61/07) Slaughter, surgical manipulations, mutilations, killing and euthanasia of farm animals.*