RESEARCH ARTICLE

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Energy and protein net utilization in the chain "feed-meat" in rabbit's fattening through the introduction of the "Clarc energy distribution/Clarc protein transformation" system

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ABSTRACT

Using specific original indexes "Clarc of energy/protein distribution/transformation" the energy and protein transformations in the eco-technical chain "fodder – pure meat (edible parts)" by the 2-nd period of fattening of rabbits have been calculated. Data from real experiments with New Zealand white rabbits have been used. The following results have been reported: Clarc energy distribution (digestible energy in fodder – gross energy in meat) - 0.1877 or 18.77%; Clarc of protein transformation (crude protein in fodder – crude protein in meat) - 0.3818 or 38.18%. The proposed "Clarcs" can be used in at least 3 directions: Biological (most important) - for objective calculation of transformation of nutritional substances in the food pyramid; breeding - for selection of animals with higher levels of transformation of the food substances; technological - for assessment of the currently used technologies and optimization them to increase the efficiency.

Key words: Clarc of energy distribution, Clarc of protein transformation, rabbits fattening

Introduction

As it is well-known rabbits are animals with high fertility, very intensive growth, and high feed conversion rate (Skandro et al, 2008). They consume a lot of unconventional feed (Koleva et al., 2011). The species has very good adaptive abilities and is also suitable for breeding and meat production with small capital investment (Radev et al., 2003).

Rabbit meat is one of the highest quality white lean meats available on the market (Nistor et al., 2013). Compared to other types of meat (pork, beef, chicken) rabbit meat is richer in Ca, P, and lower in fat, cholesterol (Dalle Zotte, 2002; Combes, 2004), and purines (Hernandez et al., 2007). It has a high proportion of polyunsaturated fatty acids (Petracci et al., 2009). Rabbits' meat quality depends on the breed, the age of the rabbits, their ration etc. (Klont et al., 1998).

The net transformation of energy and protein from feed to animal production is the correct way to investigate the contribution of a given fodder to the production of edible products (Pirgozliev & Rose, 1999). For the determination of feed nutritional properties different types of energy (digestible, metabolizable, net) are used. In reporting the produced effect, we take into account the delta of growth and expenditure of feed per one unit of total growth (meat, milk, eggs) without counting the ratio water/nutrients in these products (Santjago et al.,2007; Kabakchiev et al., 2014; van der Merwe, 2015; Purina Animal Nutrition, 2019; Taj, 2015).

Penkov and Genchev (2018) propose the introduction and standardization of two main indices that objectively report the processes of net transformation of energy and protein in the eco – technical chain "feed-consumable animal products" - Clarc of energy distribution (CED) / Clarc of protein transformation (CPT).

The aim of the present work was to introduce a methodology for calculating of CED and CPT for fattening rabbits and to further elaborate it in the section "application in separate fattening periods".

Materials and Methods

A study was conducted with a total of ten male (2x5) and ten female (2x5) weaned rabbits from New Zealand White breed (45-50 days old) with initial average body weight 1.300 kg (Grigorova et al., 2009). The animals were raised in wire cages lined in a single layer and fed *ad libitum* with standard granulated total mixed ration (TMR) for growing rabbits (Table 1). Water was supplied via nipple drinkers. The trial lasted 42 days (87-92 days of age). At the end of the experiment, five male and five female rabbits were selected for slaughter based on the average body weight. After the slaughter (preliminary treatment with chloroform, acc. Directive 2010/63/EU) carcasses were released by all organs (including edible) and decapitated in the *ceruicis vertebram primum*. The carcasses were divided into two halves and 24h *post mortem* a complete boning of the left half was performed. The obtained lean meat was multiplied by 2. Two parallel samples/carcass of raw meat were previously taken in the area of: *m.longissimus dorsi* (in the area of the fourth thoracic vertebra); *m. semimembanosis; m. deltoideus; m. oblicuus abdominis*. For chemical analysis a proportionally averaged sample was given by the following formula:

Total sample weight = meat weight in every carcass part * percentage of the weight of the respective part of the total weight of the carcass.

Chemical analysis of the meat samples included the following assays: water content by drying to constant weight; fat content after Kjeldahl's method and ash content by ignition in a furnace at 440˚ (AOAC, 2007). The GE content in the diet and the meat was established using the basic data (Todorov et al., 2016) and the formula of Schiemann et al., (1971).

The "Clarce of energy distribution" (CED) and the "Clarce of protein transformation" (CPT) were calculated with the formula (Penkov & Genchev, 2018):

CED = Total gross energy content in 1 kg meat/Total digestible energy intake for 1 kg growth.

CPT = Total (crude) protein content in 1 kg meat/Total (crude) protein intake for 1 kg growth.

Statistical analysis of the data obtained was performed using Excel 2000, single factor, ANOVA program. All values are presented as mean ± SE.

Results

During our investigation (explanation and "Clarcs" recalculation) the data only for the fattening period from 47th day (with initial average body weight 1.300 kg of the rabbits) to the end of fattening (87-92 days of age) were used.

The composition and nutritional value of rabbits TMR is given in Table 1.

The nutritional values of the diet meet the generally accepted nutrition requirements for fattening rabbits from New Zealand White breed (Martens, 1997; Ouhayoun, 2003). For the further calculating the Clarcs of distribution/transformation of the entrance of the ecotechnical chain were used the digestible energy (DE) and crude protein (CP) data in the diet.

To properly calculate the "Crarcs" the data for growth and the total amounts of the digestible energy and crude protein conversion for 1 kg growth only for the experimental period (entrance of the nutritive eco-technical chain) are actual. These, so as some other data assisting the correct calculations are shown in Table 2.

Carcass weight without head and internal organs, carcass yield, the lean meat weight, and meat chemical composition of the fattening rabbits are shown in Table 3.

To establish how much of pure meat comes from growth, which is obtained only during the fattening period (without knowing the data on growth and feed conversion from the previous period(s), the following calculations are needed:

-The total growth for the period.

-The carcass yield.

-The total meat in the carcass as described in the "Material and Methods" scheme.

-The carcass part weight, obtained during the fattening period.

-The lean meat in the carcass, obtained during the fattening period.

In the present study, the lean meat in the carcass obtained during the fattening period averages 801.23g.

In Table 4 the accumulated gross energy and crude protein in the muscles growled only in the tested period (finisher) so as the Clarc of energy distribution and Clarc of protein transformation are shown.

Discussion

The established in this experiment carcass yield was about 10% lower than that obtained in New Zealand White breed by our previous studies (Grigorova et al., 2009; Grigorova et al., 2010).

Table 1. *Composition and nutritive values of the TMR for the growing rabbits.*

Components	%
Oat	20
Barley	39
Wheat bran	42.64
Soybean meal	26
Sunflower meal	5
Alfalfa hay	30
Dicalcium phosphate	1.5
Limeston	1
Salt	0.4
Premix 6645 (for rabbits)	0.5
Cicostat	0.05
DL methionine	0.1
L lysine – dehydrate	0.13
Content in 1 kg fodder	
Dry matter - %	85.28
Digestible energy (DE) – MJ	9.11
Crude protein (CP) - %	16
Crude fiber (CF) - %	13
Calcium (Ca) - %	0.95
Phosphorus (P)-%	0.69

Table 2. *Total growth feed, energy and protein conversion ratio of the tested rabbits for the fattening period.*

Items n=5 ♂ and 5♀	X mean ± SE
Initial body weight – kg	1288.5±48.25
Final body weight – kg	2667.0±63.79
Total growth for the period – kg	1378.5±35.88
Feed conversion ratio – g*kg^{-1}	4022.5±392.0
Total digestible energy conversion – MJ	36.64±3.57
Total crude protein conversion – g	643.6±57.92
Digestible energy conversion for 1 kg growth – MJ (entrance of the chain)	26.58±2.49
Crude protein conversion for 1 kg growth – g (entrance of the chain)	466.88±42.02

Table 3. *Carcass weight without head and internal organs, total weight and meat chemical composition from the fattening rabbits.*

Items n= 5♂ and 5♀)	X mean ± SE
Carcass weight without head and internal organs – g	1529.50±68.45
Carcass yield - %	62.31±1.75
Weight of the part of the carcass, obtained in the fattening period (total growth period * slaughter yield) – g	858.94±22.36
Total meat in carcass – kg	1426.74±59.01
Lean meat in the carcass, obtained for the fattening period (= line 4*line 3/line 1) – g	801.23±20.85
Meat water content - %	75.13±1.87
Protein content (in native substance) – %	22.25±0.90
Fat content (in native) - %	2.30±0.49
Ash content (in native)	1.11±0.17
Gross energy (GE) content in 1 kg meat (native substance) – MJ	6.23±0.62

Table 4. *Accumulated gross energy (GE) and crude protein (CP) and Clarc(s) of energy distribution/protein transformation (CED/CPT) in meat of the rabbits*.

Indexes	X mean ± SE
Accumulated GE in the meat, produced only in the period of the experiment – MJ (exit of the system)	4.99±0.13
Accumulated CP in the meat, produced only in the period of the experiment – g (exit of the system)	178.27±4.64
Clarc of energy distribution (CED) – DEfodder-GEmeat	0.1877 (18.77%)
Clarc of (crude) protein transformation (CPT) CPfodder-CPmeat	0.3818 (38.18%)

This difference might be explained by the fact that in the above-mentioned experiments the carcasses had the head on.

Growth and feed conversion ratio obtained in the current research are not significantly different compared to those reported by Marinov et al. (2009) and Perrier and Ouhayoun (1996).

Concerning meat protein and ash content, our results are in agreemnet with those reported by Scandro et al. (2008), in New Zealand White rabbits. However, compared to our studies, these authors established twice lower fat values.

By so conducted scheme of fattening (only finisher stage) net transformation of the crude protein from the feed to the rabbit's meat is more than twice higher than a net utilization of digestible energy. In the available literature, there are no data for rabbits. The only ones which are received by us in the fattening of quails (Penkov & Genchev, 2018) are significantly different, but the approach for poultry is different as for the entrance (metabolizable energy is used) so in the exit of the ecotechnical chain (the transformation is measured only in the breast and leg's muscles).

Conclusions

By using data only for the finisher period, the following net transformation of the energy and the protein in the ecotechnical chain "fattened New-Zealand rabbits", described through the respective Clarcs have been established:

- Clarc of energy distribution (CED) – digestible energy in fodder – gross energy in the meat – 0.1877 or 18.77%.
- Clarc of (crude) protein transformation (CPT) – fodder – meat – 0.3818 or 38.18%.

The developed by us "Clarcs" can be used in:

- Ecology studies – to establish the transfer of the energy and nutrients from the preliminary (fodder, plants) to the secondary (animal's bodies, tissues) unit of the environmental/ecological chain.

- Breeding (selection) indexes.

Objective indexes to measure the effectiveness of technological solutions (feeding growing) in rabbit husbandry.

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