

## **ASSESSMENT OF THE ENERGY NUTRITION OF SUNFLOWER CONCENTRATE K2 FOR PIGS USING DIFFERENT APPROACHES**

In modern pig farming, the energy value of feed is one of the key factors that triggers the efficiency of pork production. Energy itself is the main limiting factor in the growth, development and productivity of animals, ensuring the course of all physiological and metabolic processes in the body. Insufficient or, conversely, excessive energy levels in a rational diet lead to reduced growth, reduced feed conversion, irrational use of nutrients and, as a result, to economic losses.

The issue of accurately determining the energy value of feed is particularly relevant due to the fact that feed accounts for the main increase in the cost of pork production - in absolute terms, from 60 to 75%. Under such conditions, even minor errors in the assessment of energy value can lead to significant overspending of feed resources or underperformance of animals.

Rational balancing of rations and compound feed formulations in terms of energy allows to realize the genetic potential of pigs to the maximum, to increase the efficiency of nutrient use and to reduce feed costs per unit of production. That is why accurate and scientifically based methods for determining the energy nutritional value of feeds are a necessary prerequisite for optimizing feeding in the conditions of modern intensive pig farming.

Special attention is required to assess the energy nutritional value of new feed components and non-traditional sources of protein and energy, which are increasingly consumed in the production of compound feeds. In order to correctly include such components in the corresponding rations, it is necessary to objectively apply their energy value and the level of use by the animal body. In modern scientific practice, methods for determining the energy nutritional value of feeds for pigs can be conditionally combined into several main groups.

### **1. Physico-calorimetric methods for determining energy.**

This group of methods is based on the direct measurement of thermal energy contained in feed or released during its metabolism. The most common is the determination of the gross energy of feed by complete combustion of the sample in a bomb calorimeter. The result is the amount of heat released during the oxidation of organic matter in the feed.

The same group includes the methods of direct and indirect calorimetry, which are used in experiments on animals. Direct calorimetry involves measuring the heat released by the animal's body in special calorimetric chambers, while indirect calorimetry is based on determining gas exchange (oxygen consumption and carbon dioxide release) and subsequent calculation of heat release. Such methods allow assessing the use of feed energy at the metabolic level and determining net energy indicators.

Thus, within this group of methods, it is possible to determine various energy characteristics - from the gross energy of feed to the body's heat losses during the assimilation of nutrients.

## **2. Balance and indicator methods of animal research.**

This group of methods is based on the assessment of the use of feed energy directly in the animal body by conducting special physiological experiments. The classic approach is the balance method, which takes into account the amount of feed consumed and energy losses with feces, urine and gases. On the basis of such studies, indicators of digestible and metabolizable energy of feed are determined.

Within this group, experiments to determine the digestibility of nutrients are also widely used, which allows establishing their assimilation coefficients and on this basis calculating the energy value of feed.

A separate variety is indicator (marker) methods, in which inert substances are added to the feed - for example, chromium oxide or titanium dioxide. The ratio of marker concentrations in feed and excrement determines energy digestibility coefficients without the need for complete collection of feces, which greatly simplifies the conduct of experiments. Thus, within this group there are several approaches - classical balance experiments, studies of nutrient digestibility and indicator methods, which differ in the complexity of the conduct, accuracy and volume of information obtained.

## **3. Calculation methods for assessing energy nutritional value.**

These methods are based on the use of the results of chemical analysis of feeds. Based on the content of basic nutrients (crude protein, fat, fiber, nitrogen-free extractives, etc.), the energy value of feed is calculated using special empirical equations.

In world practice, various systems and models are used for this, in particular NRC, Noblet or INRA. Depending on the model used, indicators of digestible, metabolizable or net energy can be determined.

The advantage of calculation methods is their efficiency and the ability to quickly assess a large number of feed ingredients, however, the accuracy of such calculations largely depends on the quality of the initial data and the correctness of the models used.

In order to increase the efficiency of using domestic feed resources, it is relevant to study new high-protein ingredients, in particular sunflower concentrate K2. The main task of this work is to determine its energy nutritional value and assess the prospects for use in pig feeding.

Sunflower concentrate K2 is characterized by a high level of nutrition: the content of dry matter is 91.1%, crude protein - 44.4%, crude fat - 1.4%, ash - 6.9% and crude fiber - only 9.8%.

Compared to traditional sunflower meal, which usually contains 30-36% crude protein and 16-22% crude fiber, concentrate K2 has a significantly reduced level of fiber and a significantly higher concentration of protein. This ratio of nutrients is achieved by removing the seed coats, which are the main source of structural carbohydrates.

Reducing the content of crude fiber from ~18-20% to 9.8% and simultaneously increasing the protein level to 44.4% creates the prerequisites for improving the digestibility of nutrients. A smaller amount of fiber reduces the restriction of enzyme access to nutrients, which probably contributes to more efficient feed digestion and an increase in the level of metabolizable and net energy.

In addition, the concentrate is characterized by a sufficiently high content of amino acids, in particular lysine - 1.82% (SID - 1.53%), methionine - 1.0% and threonine - 1.81%, which further increases its feed value.

Thus, given the improved chemical composition, reduced level of structural carbohydrates and increased concentration of nutrients, it can be assumed that sunflower concentrate K2 has a higher energy nutritional value compared to traditional sunflower meal. This justifies the need for experimental determination of its energy value and efficiency of use in pig diets.

Given the available data on the chemical composition of sunflower concentrate K2, as well as the complexity and actual impossibility of conducting full-fledged balance studies specifically on pigs in modern conditions, to solve the problem, it is advisable to apply calculation methods for assessing energy nutrition.

Such approaches are based on the use of indicators of the chemical composition of feed (content of crude protein, fat, fiber and other components) and allow, using validated equations (in particular, the NRC, Noblet, INRA systems), to determine the levels of digestible (DE), metabolizable (ME) and net energy (NE) specifically for pigs.

Given the characteristics of the studied product and the goal set, it is advisable to use the Noblet approach in this work. This system was developed specifically for pigs and provides a more accurate assessment of energy nutrition by determining net energy (NE) taking into account the efficiency of using individual nutrients.

An important advantage of the Noblet method is its high sensitivity to the content of fiber and structural carbohydrates, which is of fundamental importance when evaluating sunflower concentrate K2 with a reduced level of crude fiber. This allows a more objective assessment of the impact of changes in the chemical composition on the energy value of the feed. The Noblet method is based on the results of large-scale experimental studies in which the energy value of feeds was determined on pigs using respiratory chambers. In particular, the study evaluated 61 diets on pigs with a live weight of about 45 kg, for which the digestibility (DE), metabolic (ME) and net energy (NE) indicators were determined. The results obtained became the basis for the development of

equations for predicting the net energy of feeds for pigs based on their chemical composition, which formed the basis of the modern Noblet system.

Determination of digestible energy (DE)

Digestible energy was calculated according to the equation of Noblet & Perez (1993):

$$DE=4151-122\times\text{Ash}-52\times\text{CF}+23\times\text{CP}+38\times\text{EE}$$

Substituting the values of chemical composition, we obtained:

$$DE=4151-122\times 6.9-52\times 9.8+23\times 44.4+38\times 1.4$$

$$DE=3874 \text{ kcal/kg}$$

Determination of metabolizable energy (ME)

Metabolic energy was defined as 96% of digestible energy:

$$ME=0.96\times DE=0.96\times 3874=3719 \text{ kcal/kg}$$

Determination of net energy (NE)

Net energy was calculated according to the regression equation proposed by Noblet et al. (1994), which takes into account the different efficiency of nutrient energy use:

$$NE=0.700\times DE+1.61\times EE-0.91\times CP-0.87\times ADF$$

where  $ADF = 14.8 \%$ .

$$NE=0.700\times 3874+1.61\times 1.4-0.91\times 44.4-0.87\times 14.8$$

$$NE=2661 \text{ kcal/kg}$$

Summary of results

As a result of calculations, it was found that the energy nutritional value of sunflower concentrate K2 is:

digestible energy (DE) — 3874 kcal/kg,

metabolizable energy (ME) — 3719 kcal/kg,

net energy (NE) — 2661 kcal/kg.

The results obtained indicate a high level of energy value of the studied product. The increased NE value compared to traditional sunflower meal may be due to the reduced crude fiber content and higher nutrient concentration, which contributes to a more efficient use of energy by the pig body.

However, the calculated values may differ slightly from the actual indicators, which is due to the use of generalized equations and the lack of experimental data on the actual digestibility of nutrients in this product.

Calculating the energy nutritional value of feeds solely on the basis of their chemical composition has limited accuracy, as it does not take into account the actual availability of nutrients to the animal body. In this regard, experimental data from the Bangkok Animal Research Center

(Thailand) were used to clarify the energy value of sunflower concentrate K2, in which nutrient digestibility coefficients for a similar high-protein sunflower concentrate were determined.

The study found that the digestibility coefficient of crude protein is 95.72%, crude fat - 94.59%, crude fiber - 63.40%, and starch - 95.72%.

For correct calculation, the content of nitrogen-free extractives (BER) was determined, which was 37.5%. Taking into account the digestibility coefficients, it was found that the content of digestible protein is 42.49%, digestible fat - 1.32%, digestible fiber - 6.21%, and digestible BER - 35.90%.

Based on the energy equivalents of nutrients (protein — 5.65 kcal/g, fat — 9.40 kcal/g, carbohydrates — 4.10 kcal/g), it was found that the digestible energy (DE) of sunflower concentrate K2 is 4251 kcal/kg.

The metabolic energy (ME) was determined according to the approach adopted in the Noblet system as 96% of DE:

$$ME=0.96 \times DE=0.96 \times 4251=4081 \text{ " kcal/kg "}$$

The net energy (NE) was calculated according to the Noblet concept taking into account the average metabolic energy utilization factor:

$$NE=0.74 \times ME=0.74 \times 4081=3020 \text{ " kcal/kg "}$$

У результаті встановлено, що енергетична поживність соняшникового концентрату K2 становить:

- DE — 4251 ккал/кг,
- ME — 4081 ккал/кг,
- NE — 3020 ккал/кг.

The obtained values indicate a significantly higher estimate of energy nutritional value compared to calculations using Noblet equations based on chemical composition. This is explained by taking into account high digestibility coefficients of nutrients, in particular protein and carbohydrates. At the same time, it should be noted that the use of generalized digestibility coefficients may lead to a certain overestimation of net energy indicators, since individual characteristics of metabolism and energy loss for heat production are not taken into account.

For additional assessment of energy nutritional value of sunflower concentrate K2, a domestic regression approach was applied to determine metabolic energy based on the content of digestible nutrients. The calculation was carried out using an equation that takes into account the contribution of digestible protein, fat, fiber and nitrogen-free extractives to the formation of the energy value of the feed.

Taking into account the previously determined values of digestible nutrients (digestible protein — 424.9 g/kg, fat — 13.2 g/kg, fiber — 62.1 g/kg, BER — 359.0 g/kg) it was established that the metabolizable energy is 16313 kJ/kg, or 3897 kcal/kg.

Further calculation of net energy was carried out according to the Noblet approach, using the average coefficient of metabolic energy utilization (0.74). As a result, it was established that the net energy of sunflower concentrate K2 is 2884 kcal/kg.

### Comparative assessment of the energy nutritional value of sunflower concentrate K2 using different methods

Evaluation method	Види енергетичної поживності			Features of the method
	DE, ккал/кг	ME, ккал/кг	NE, ккал/кг	
Calculation by equations Noblet & Perez (1993) та Noblet et al. (1994)	3874	3719	2661	Assessment based on the chemical composition of the feed
Calculation based on digestibility coefficients from the experiment (Thailand)	4251	4081	3020	Experimental nutrient digestibility coefficients were used
Calculation according to the domestic regression equation of exchange energy with further definition NE за Noblet	—	3897	2884	Digestible Nutrient Rating

As a result of the conducted studies, it was found that the energy nutritional value of sunflower concentrate K2 significantly depends on the chosen method of assessment.

#### Conclusion

The closest to the real estimate is the energy nutritional value of sunflower concentrate K2 obtained by the Noblet equations ( $\approx 2660$  kcal/kg NE), or slightly higher taking into account the improved chemical composition of the product ( $\approx 2700$ – $2850$  kcal/kg). This is explained by the fact that the Noblet system is based on a large number of direct experiments on pigs and takes into account physiological energy losses, in particular the thermal effect of nutrients, which is of fundamental importance for high-protein feeds.

The method based on the use of digestibility coefficients (3020 kcal/kg) probably overestimates the energy nutritional value, since it uses generalized and too high digestibility coefficients and does not sufficiently take into account energy losses on metabolism. At the same time, the domestic regression approach gives an intermediate estimate, which partially approaches the real values, but also depends on the accuracy of the determination of digestible nutrients.

Therefore, the most reasonable range of net energy for sunflower concentrate K2 is approximately 2700–2850 kcal/kg, and the values are probably closer to the lower limit of this range. Values over 3000 kcal/kg should be considered unlikely without confirmation in direct experimental studies on pigs.

#### Prospects for further research

A promising direction for further research is the experimental determination of the energy nutritional value of sunflower concentrate K2 directly on pigs using balance or indicator methods.

Particular attention should be paid to:

- determination of digestible and metabolizable energy in physiological experiments;
- estimation of net energy using indirect calorimetry;
- establishment of amino acid digestibility coefficients (SID);
- research into the impact of the product on productivity and feed conversion.

The results obtained will allow to refine existing models of energy nutritional assessment and increase the accuracy of ration formation.

Sources:

Noblet, J., & Perez, J. M. (1993). Prediction of digestibility of nutrients and energy values of pig diets from chemical analysis. *Journal of Animal Science*, 71(12), 3389–3398.

Noblet, J., Fortune, H., Shi, X. S., & Dubois, S. (1994). Prediction of net energy value of feeds for growing pigs. *Journal of Animal Science*, 72(2), 344–354.

Mykhailo SYCHOV

Doctor of Agricultural Sciences, Professor,

Head of the Department of Animal Nutrition and Feed Technology named after P.D. Pshenichny National University of Life Resources and Environmental Management of Ukraine