Research project objectives / Research hypothesis

Ketosis is a metabolic disease which appears most often in early lactation of dairy cows when the physiological demands for nutrients are very high and not met. The procedure currently used for detection of cows at risk of ketosis is not effective enough. Many cows are diagnosed too late, causing serious economic losses. Artificial neural networks offer a useful tool for developing a new, more efficient method.

In the planned research project the following hypotheses will be tested: 1) milk components such as fat and protein, lactose, urea and acetone content, β-hydroxybutyric acid (BHB) level and somatic cell count (SCC) may be indicators of negative processes in a cow organism, leading to ketosis (all mentioned milk components are collected in the routine milk evaluation system); 2) a method of identifying cows susceptible to ketosis in a population of cows under routine milk recording, based on artificial neural networks, may have high specificity and sensitivity; 3) a method based on artificial neural networks may allow more accurate identification of cows susceptible to ketosis than the methods currently used.

The aim of the research project is to examine relationships between milk composition and β-hydroxybutyric acid level in blood (BHBA), being an indicator of ketosis. Artificial neural networks will be used in the project. This method is able to relatively precisely model non-linear dependencies among the traits, and to do that without a priori knowledge.

Research project methodology

Metabolic diseases in dairy cows appear mostly in early lactation when the physiological demands for nutrients are very high. Ketosis is the most serious among diseases of this group, and high-producing cows are especially susceptible to it. According to published reports, clinical ketosis occurs in about 4–10% of dairy cows; subclinical ketosis is observed more often, in the range of 10–50%. In the initial period of ketosis the clinical symptoms may not be noticeable, and the negative processes in the cow may be determined from higher levels of ketone bodies in blood and milk, lower glucose levels, a higher fat to protein ratio, and higher acetone and urea in milk. Lower food intake, loss of body weight and lower productivity are the main symptoms of clinical ketosis. Even subclinical ketosis may lead to decreased milk yield (even 300 liters of milk less per lactation) and cause serious financial losses for dairy farmers.

Artificial neural networks offer a promising tool in the search for dependencies between milk composition and β-hydroxybutyric acid levels in blood (BHBA), an indicator of ketosis. One of the most valuable properties of neural networks is their ability to learn from examples. This capacity makes neural networks highly accurate in predicting different events and processes in which the rules that logically link causes with results are unknown or not clear. In such cases neural networks are able to predict future events based on examples from the past. Early and accurate diagnosis of ketosis by means of neural networks should enable dairy farmers to undertake remedial actions involving treatment and more sustainable nutrition.

Expected impact of the research project on the development of science and society

Ketosis, both subclinical and clinical, may be diagnosed by testing biochemical components in blood, such as BHBA, glucose and free fatty acids (NEFA). Significantly higher levels of BHBA and NEFA and lower levels of glucose indicate the beginning of the disease. However, such tests are too expensive to be routinely repeated in the whole cow population because such diagnosis requires testing of all cows in each dairy herd several times in the first month of lactation. In practice such tests are carried out only for cows with symptoms of ketosis.

Milk as a biological material is much easier to obtain and use than blood in populations of recorded cows, and milk components such as BHBA or acetone can be analyzed routinely without large financial outlays. From economic and animal-welfare points of view, it seems reasonable to look for dependencies between milk composition and subclinical ketosis. The relationship between ketosis and milk composition might be a good indicator of the onset of this disease, just as knowledge of a high somatic cell count (SCC) helps in detecting subclinical mastitis.

The procedure, which identifies cows at risk of ketosis, has been implemented in the SYMLEK system. The specificity of the procedure is high (90%) but its sensitivity (67–70%) is not sufficient. Hence the need for research to develop new procedures, Artificial neural networks may offer a promising alternative. Artificial neural networks have not been used for this kind of research in Poland yet. The use of this universal method in the planned project is novel.