MODELLING THE ANIMAL – ENVIRONMENT INTERACTION AND ITS IMPACT ON THE WELFARE AND THE ECONOMY OF FARM ANIMAL PRODUCTION

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Abstract
Welfare, the level of animal comfort can make a great difference in economical results between herds with a similar general production system. The goal of our effort in the field of animal welfare is to create the virtual system of evaluation of animal welfare from the stand point of physical conditions maintained in the stables, the system and condition of feeding, the maintenance of care including veterinary care. The mutual interference between the genotype, feeding and environment is used for modelling this process as it is expressed in the form of the body mass growth and the product formation by the animals. The described modelling approach is based on the self-regulating model of body mass growth accomplished directly from the data commonly used by farmers with the best animal care.

Introduction
When investigating the Animal – environment interactions we have to handle two distinct systems. The environment, the background of which are the local climatic conditions. They can change in a circadian and seasonal rhythm according to a great variability of radiant temperature, air temperature, wind velocity, humidity and barometric pressure, rain and snow falls. The homoeothermic animal is characterized by the constant value of its core temperature. This feature maintains his vital functions at a given appropriate level. However for this privilege, the homoeothermic animal must pay by producing the thermostatic heat in the same amount as he simultaneously leaves to the environment. The only external source of energy needed for the biological processes accomplished in the organism is the feed. However the feed energy consumed for the thermostatic heat production is lacking for the synthesis of proteins lipids and sugars needed to the body mass growth or milk or egg production. That means, the production of the farm animals depends not only on their genetics and feeding, but also on their relation to the environment. This implies that the growth process has to be interpreted not only by the empirical descriptive models based on the use of the logistic or exponential growth functions (Emmans 1997, Moughan, P.J., Verstagen, M.,W.,and A., Visser-Reineveld (editors):1995, and many others). Neither only in the other way based on biochemical interpretations, (see McNamara, J. P., France, and J., Beever,: D.2000). The self regulating growth model created by Ludvik Novák (1996) produces the growth curve as a process of conversion of the feed energy into the thermostatic heat and the mass of synthesized proteins, lipids and carbohydrates. The calculation is carried on independently of the growth of the real organism (ie the considered farm animal) from the data about the feed, environment and the biological characteristic of the simulated organism. The self regulating model was validated in experiments with the regulated feeding in Wistar rats (Novák, Pipalová 1996), on the growth of broilers and pigs (Novák, Zeman, 1997, Novák, P., Novák,L. et al. 1998, Novak. L. 2003, Novák, P et al. 2004, Novák, L. et al 2004.).

Material and Methods
Our effort in the field of animal welfare is focused on the development of the virtual model for the evaluation of animal welfare based on physical conditions maintained in the stables, the system and conditions of feeding, maintenance care and the veterinary care. The final objective of the elaborated methodology is to include the influence of the local climate and various stressing factors linked with the technology and the maintenance care on the economic profitability of the farms. This is a very important fact because it enables to solve problems about the economical impacts of the EU legislation concerning the welfare of farm animals.

Results and discussion
The mutual interference between the genotype, feeding and environment is one of the areas suitable for modelling the growth of the animals. Our modelling approach is based on the body mass growth from the data commonly used by farmers with the best care devoted to the animals

In comparison with classical approaches used in the solution of welfare problems (Broom. 1986), the virtual system elaborated by our team is characterised by the fact that the core of the system generates automatically the body mass growth from the basic elementary biologic data about the organism. The relation of the organism to the ambient surroundings is described by the physical data (e.i. core temperature, thermal insulation of the core regarding the environment, radiant and air temperature, relative humidity, air movement, barometric pressure). The relation of this data to the organism's welfare is interpreted according to the biophysical rules; they do govern the energy balance between the organisms and their surroundings (Novak, L., Novak, P., Schauberger, G.:2000).

All the processes are carried out **inside the stables.** That means the construction of stable building modifies the influence of the surrounding local climate and the **concentration of animals** inside the stable invokes the need for the **adequate ventilation, heating or cooling**. The high concentration of wastes and urine, sources of ammonia, sulphuric compounds raises up new problems leading to unpleasant odours.

The interaction between the energy intake through the feed, the cooling power of the environment and the actual state of the body mass maturity on the welfare of the growing organism are presented in **Scheme 1**. The intake of metabolizable energy and its partition between the total heat production (THP) and the formation of the net energy for production (NEp) is influenced by the cooling power of the environment (CPE). If in this model the prices of the feed and the slaughter prices of the animals are supplied, it is possible to figure out the economy of raising the organism. Such a possibility under the actually defined conditions is presented in the demo-model at: http://fvhe.vfu.cz/2502/2210/files/EKONWE_dEM2002cz5.xls. The most important thing on this methodology is its independence on any coefficients. They should be measured in real previous experiments, because the input data are values that describe the energy input through feed intake in [MJ/day], the actual body mass of the modelled organism [kg], the value of genetic body mass [kg] and the cooling power of the environment [MJ/day], calculated for the actual core temperature [^{o}C], the thermal insulation [m^2K/W] of the core against the temperature [^{o}C], relative humidity [%] and movement [m/s] of the air in the livestock building. The relation of the microclimatic values within the livestock building to the local climatic conditions depends on the construction of the building expressed in the thermal insulation of the walls, windows and doors [m^2K/W], further on the volume of the air-flow exchanged by the ventilation system V [m^3/hour], and the local meteorological values. (Schauberger 1988a and 1989)

Conclusions

In comparison to the classical approaches used in the resolution of welfare problems, the virtual system elaborated by our team is characterised by the fact that the core of the system generates the body mass growth automatically from the basic elementary biological data about the organism and its feed. The relation between the animals and the ambient surroundings is described by the physical data (i.e. core temperature, thermal insulation of the core to the environment, radiant and air temperature, relative humidity, air movement, barometric pressure,). The relation between these data and animal welfare is interpreted according to the biophysical rules; they do govern the equilibrium of energy exchange between the animals and their surroundings

Aknowledgements

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Scheme 1.

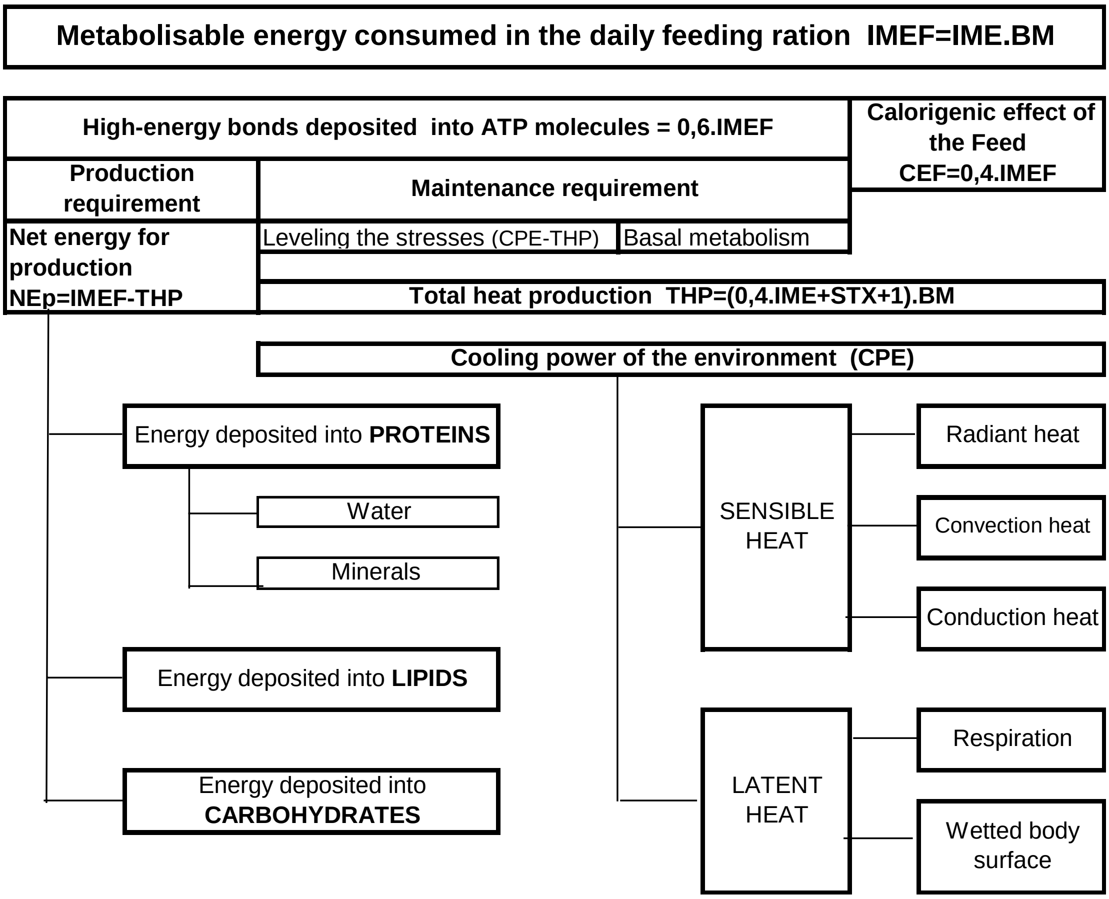
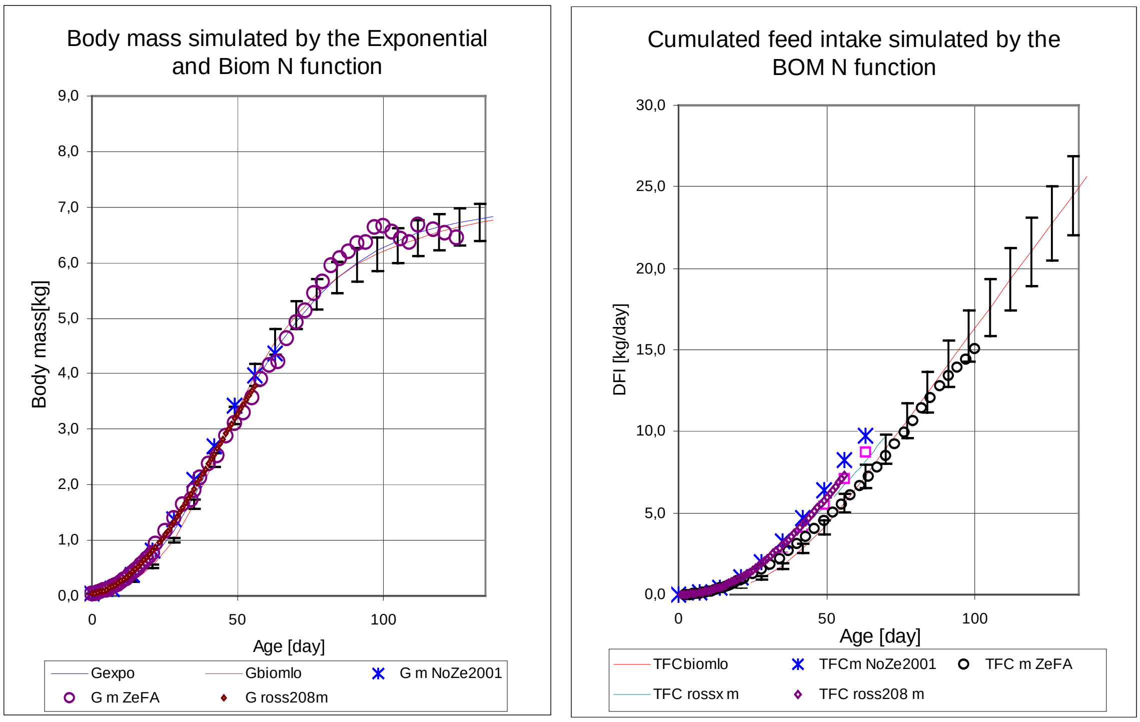


Fig. 1., Body mass growth and feed consumption in ROSS 208 cockerels ; calculated and measured values of body mass growth and feed consumption.Input data Zelenka, Fajmonova et. al 2001, Novak P. Zeman et al 2004

Interval	G_0/Gli	dGm	dGm biolo	DFI	IME	STX	SMEF	cOP	cPB	IMEF	THP
0	0,035	0,100	0,115	0,0095	4,720	0,15	12,06	0,5	0,16	0,114	0,075
7	7			0,240	2,242	0,15	12,06	0,55	0,16	2,990	2,810



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