NUTRITIONAL COMPENSATION OF ENERGY INTAKE IN FATTENING PIGS UNDER CONDITIONS OF HIGH TEMPERATURE

Lehotayová A., Bučko O., Debrecéni, O.

Slovak University of Agriculture in Nitra, Slovak Republic

Abstract

This study was conducted to evaluate the effect of high-temperature environment (30 ˚C) on performance and fattening parameters of Large White breed by the nutritional compensation. High temperature causes difficulties in the heat balance of pigs and it can be regulated by the energetic subsidy in the diet. Twenty-four pigs with initial weight of 50 kg were assigned to dietary treatment with addition of fat and treatment without fat. One of the groups was kept in the standard conditions. The addition of fat in the diet of pigs housed in hot temperature environment improved the average daily gain and decreased average daily feed intake compared to pigs kept in a high temperature without fat addition in the diet. Nutritional compensation during heat was showed in the costs per kg gain which were lower in the group with the fat addition in the diet. It can be concluded that the addition of fat in the diet for pigs kept in hot temperature environment can be a good compensation of energy intake during the heat stress.

Key words: pigs, high temperature, fat addition

It was found that the high ambient temperature strongly affect physiology, behaviour and performance of pigs (Huynh et al., 2005). Heat stress is one of the major concerns in pork production during high temperatures (Souza, 2009). The first visible sign of how pigs react to increasing temperature is a change in behaviour (Huynh, Aarnink, 2005). The thermoregulation mechanisms of pigs represent great expenses in energy for heating loss (Fagundes et al., 2009). Pigs are highly sensitive to high and low temperatures mainly due to their missing ability to sweat (Pedersen et al., 2003, Nardone, et al., 2010). It was known that this sensitivity is due to a combination of factors, among which are a poor thermoregulatory system, keratinized sweat glands, pre-sence of a subcutaneous fat layer and intensive metabolism (Wolp et al., 2012). Therefore, maximum efficiency of pig production is compromised by conditions of high temperature, especially in heavier animals (Le Bellego et al., 2002; Quiniou et al., 2000).

Control of the thermal environment in the context of husbandry seems to be the most viable alternative for obtaining satisfactory results for pig production in hot conditions. However, new nutrition practices have also been studied as an alternative in reducing the negative effects of heat stress (Wolp et. al. 2012). Nutrition is one of the tightest link between living organisms and the environment, and significantly influences performance of animals (Buchová, Brestenský, 2009). Based on current knowledge, the use of modified diets is one of the nutritional strategies aimed at improving the productivity of pigs in hot conditions (Wolp et al, 2012). A reduction in crude protein with supplemental amino acids has been used to maintain performance and to reduce nitrogen excretion (Ferreira et al., 2007; Le Bellego et al., 2002; Zangeronimo et al., 2007). However, these diets can also be used to solve problems arising from a hot environment. This assumption is justified because the digestion of nutrients is a factor that generates heat, especially digestion of protein in comparison to carbohydrates and lipids (Stahly and Cromwell, 1986). It is known that lipids have an influence on protein digestibility and amino acid availability (Almeida et al., 2007).

Quiniou et al. (2000) showed a relation between the daily feed intake and body weight of the animals when exposed to higher temperatures. Thermal stress has a significant negative effect on the pigs with higher body weight; heavier pigs eat less than pigs with lower weight. Rinaldo et al. (2000) indicated that during the warm season feed intake was a major limiting factor to growth rate. The aim was, therefore, to verify if diet with the addition of fat can influence the performance and physiological parameters in fattening pigs housed in a hot environment.

Material and Methods

The aim of the experiment was to compensate high-temperature environment (30 ˚C) by the energy subsidy in the diet and to evaluate the effect of heat on performance of the pigs. The experiment was carried out in the laboratory conditions of the Experimental centre at Department of Animal Husbandry, Slovak University of Agriculture in Nitra. The average initial body weight of the pigs was 50 kg and the experiment

finished when the pigs reached slaughter weight 100 kg. In this experiment, 24 pigs of Large White breed were used. The pigs were divided into three groups. The first group of the six pigs was housed in air-conditioned climatic chamber 4 x 3 m with high constant temperature 30 ˚C (HT). The second group of eight pigs was housed in air-conditioned climatic chamber 4,3 x 4,4 m with high constant temperature 30 ˚C (HTF) and the diet was enriched by fat. The third group of 8 pigs was housed in the pens in thermoneutral environment (TT), standard conditions for fattening pigs.

The composition of the diet and nutrients is showed in Table 1 and 2. Pigs were offered a standard diet ad libitum in the second group enriched with fat and the pigs had free access to water. Daylight in the climatic chamber was provided from 06:00 to 18:00 h. The floor surface area of the chamber was divided into 2 sectors, solid floor with adjustable nipple drinker and feeder (feeding-lying area) and solid floor with bedding (lying-fouling area), the floor and the chamber was made from tiles. Urine and faeces were removed every day and the straw was delivered to the lying-fouling area every day. The temperature in the climatic chamber was measured every half an hour by temperature dattaloger HDL. When the pigs reached slaughter weight 100 kg, they were electrically stunned in the slaughter house according to legislation and standard practises STN 466164. One video camera (fish-eye) in every chamber and in the pen was used to record the behaviour of the pigs. The chambers were equipped with automatic equipment responsible for the circulation of heated air in the chamber. The control panel was set to constant 30ºC, while in a thermoneutral environment was self ventilation. The relative humidity was set to be between 60 % and 70 % in both environments.

The basic statistical characteristics of analysed traits were calculated. The data were subjected to analysis of variance. All analyses were run with the statistical software package SPSS 11.

Table 1. Nutrient composition

	HT	**HTF**	**TT**
Dry matter (%)	86,22	86,51	86,22
Metabolisable energy (MJ)	12,52	13,42	12,52
Nitrogen substances (g)	163	159	163
Lysine (g)	9,97	9,83	9,97
MetCys (g)	6,16	6,03	6,16
Threonine (g)	6,42	6,28	6,42
Tryptophan	1,91	2,07	1,91
Crude fiber (g)	33	31	33
Ca (g)	18,52	18,47	18,52
Fat (g)	50	122	50

HT – high temperature, HTF – high temperature and fat addition, TT – thermoneutral temperature

Table 2. Composition of the diet

	HT	**HTF**	**TT**
Barley	28,50 %	26,50 %	28,50 %
Wheat	30 %	28 %	30 %
Corn	22 %	22 %	22 %
Soybean meal	16 %	16 %	16 %
Tri - Phosphoral	3,50 %	3,50%	3,50 %
Fodder fat	0	4 %	0

HT – high temperature, HTF – high temperature and fat addition, TT – thermoneutral temperature

Results and Discussion

Considering the pigs were kept under high temperature (table 3), interaction (P<0.05) between high temperature and thermoneutral temperature in average daily feed intake was observed. The highest average daily weight gains were showed in standard conditions with thermoneutral temperature. The same results were showed by Rinaldo and Mourot, (2001), they observed pigs in conditions with 20 °C and 27 ° C, during the warm season, there was a reduction in the average daily gain and daily feed intake as compared to the cool season. The differences between groups were no significant. In the group of pigs housed in high temperature in the chamber with fat addition in the diet were found higher average daily gains than in the group without fat addition (1,042 vs. 1,006).

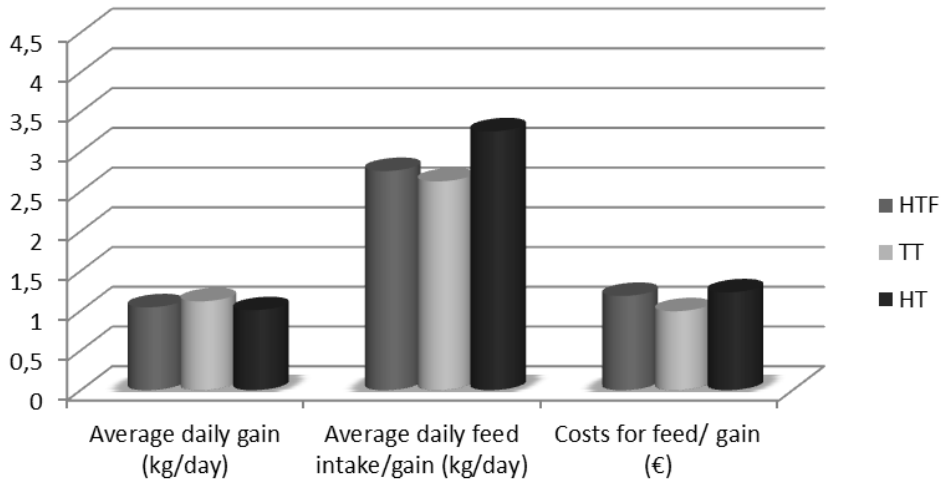
Average daily gain in the normal condition was 1,118 kg/day what was more than in the group housed in high temperature with fat addition in the diet, what is consistent with the results of Mourot and Rinaldo (2001). We can conclude that the average daily feed intake/gain (kg/day) in the group of pigs in high temperature achieved significantly higher intakes (P <0.05) than pigs in normal conditions what is no consistent with the result of Rinaldo, Le Dividich and Noblet (2000) and Rinaldo and Mourot (2001). Considering the metabolisable energy in the group of pigs housed in high temperatures without added fat in the diet was showed that the metabolisable energy (40,773 MJ) in this group was higher than in the group of pigs in the normal conditions, the difference between the groups were statistically significant (P <0.05).

Table 3. Performance of fattening pigs kept in high-heat and standard environments fed with different diets

		Average daily gain (kg/day)	Average daily feed intake/gain (kg/day)	Metabolisable energy (MJ)
HT High temperature n=6	**x**	1,006	3,257[b]	40,773[b]
	s	0,237	0,603	7,548
	v %	23,563	18,511	18,511
HTF High temperature and fat addition n=8	**x**	1,042	2,758	37,006
	s	0,145	0,316	4,238
	v %	13,957	11,451	11,451
TT Thermoneutral temperature n=8	**x**	1,118	2,627[a]	32,884[a]
	s	0,139	0,562	7,031
	v %	12,443	21,381	21,381

a,b P <0.05

Figure 1. Average daily gain, average daily feed intake and costs for feed of fattening pigs kept in high-heat and standard environments fed with different diets



HT – high temperature,
HTF – high temperature and fat addition,
TT – termoneutral temperature

Conclusion

The results showed that the highest average daily gain reached the group of pigs housed in standard conditions, the metabolizable energy per kg of gain was the lowest compared to other groups. The lowest average daily gain was found in the group of high temperature without the addition of fat in the diet, the pigs reached the highest metabolizable energy per kg of gain. It can be concluded that from the economic aspect the pigs in the standard conditions showed the most effective parameters, the increased financial costs caused by thermoregulation mechanisms can be compensate by energy subsidy of nutrients in the diet.

References

ALMEIDA, E.C. - FIALHO, E.T. - CANTARELLI, V.S. - ZANGERONIMO, M.G. - PEREIRA, R.A.N. - RODRIGUES, P.B. 2007. Ileal digestibility and endogenous losses of amino acids in soybean oil diets to growing pigs. In *Brazilian Journal of Animal Science*, vol 36, pp. 1045–1051.

BUCHOVÁ, B. - BRESTENSKÝ, V. 2009. *Výživa a kŕmenie ošípaných* [online]. <http:// www.agroporadenstvo.sk/zv/osipane/ chovosipanych02.htm>

FAGUNDES, R.G.S. – DA SILVA, R.G. – GOMES, J.D.F. – SOUZA, L.W.O. – FUKUSHIMA, R.S. 2009. Influence of environmental temperature, dietary energy level and sex on performance and carcass characteristics of pigs. In *Brazilian Journal of Veterinary Research and Animal Science*, vol. 46, no. 1, pp. 32-39.

FERREIRA, R.A. - OLIVEIRA, R.F.M. - DONZELE, J.L. - SARAIVA, E.P. - SILVA, F.C.O. - ORLANDO, U.A.D. - VAZ, R.G.M.V. 2007. Reduction of dietary crude protein levels and amino acid supplementation for 30 to 60 kg barrows maintained in a high environmental temperature. In *Brazilian Journal of Animal Science*, vol. 36, pp. 818–824.

HUYNH, T.T. - AARNINK, A.A.J. – VERSTEGEN, M.W. - GERRITS, W.J.J. - HEETKAMP, M.J. – KEMP, B. – CAHN, T.T. 2005 . Effects of increasing temperatures on physiological changes in pigs at different relative humidities. In *Journal of Animal Science*, vol. 83, no. 6, pp. 1385-1396.

HUYNH, T.T.T. - AARNINK, A.A.J. 2005. Heat stress in pigs. In *Pig Progress*, vol. 21, no.3.

LE BELLEGO, L. - VAN MILGEN, J. - NOBLET, J. 2002. Effect of high temperature and low-protein on the performance of growing-finishing pigs. In *Journal of Animal Science*, vol. 80, no. pp. 691–701.

NARDONE, A. – RONCHI, B. – LACETERA, N. – RANIERI, M. S. – BENABUCCI, U. 2010. Effects of climate changes on animal production and sustainability of livestock systems. In *Livestock Science*, vol. 130, no. 1-3, pp. 57-69.

PEDERSEN, S., SOUSA, P., ANDERSEN, L., JENKEN, K.H. 2003. *Thermoregulatory behaviour of growing-finishing pigs in pens with access to outdoor area*. Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Manuscript BC 03 002. May, 2003.

QUINIOU, N. - DUBOIS, S. - NOBLET, J. 2000. Voluntary feed intake and feeding behaviour of group-housed growing pigs are affected by ambient temperature and body weight. In *Livestock production science*, vol.63, pp. 245-253.

RINALDO, D. - LE DIVIDICH, J. – NOBLET, J. 2000. Adverse effects of tropical climate on voluntary feed intake and performance of growing pigs. In *Livestock Production Science*, vol. 66, no. 3., pp. 223-234.

RINALDO, D. - MOUROT, J. 2001. Effects of tropical climate and season on growth, chemical composition of muscle and adipose tissue and meat quality in pigs. In *Animal Research*, vol. 50, no. 6., pp. 507-521.

SOUZA, L. 2009. *How can heat stress affect your production?* [online]. <https://www.extension.umn.edu/agriculture/ swine/components/pdfs/heat_stress_souza.p>

STAHLY, T.S. - CROMWELL, G.L. 1986. Responses to dietary additions of fiber (Alfafa Meal) in growing pigs housed in a cold, warm or hot thermal environment. In *Journal of Animal Science*, vol. 63, pp. 1870–1876.

WOLP, R. C. – RODRIGUES, N. E. B. – ZANGERONIMO, M. G. – CANTARELLI, V. S. –FIALHO, E. T. – PHILOMENO, R. – ALVARENGA, R. R. – ROCHA, L. F. 2012. Soybean oil and crude protein levels for growing pigs kept under heat stress conditions. In *Livestock Science*, 2012, vol. 147, no. 1., pp. 148-153.

ZANGERONIMO, M.G. - FIALHO, E.T. - MURGAS, L.D.S. - FREITAS, R.T.F. - RODRIGUES, P.B. 2007. Performance and nitrogen excretion for pigs from 9 to 25 kg submitted to the diets with different levels of digestible lysine and crude protein. In *Brazilian Journal of Animal Science*, vol. 36, pp. 1382–1388.

Corresponding Address
Ing. Andrea Lehotayová, PhD.
Slovak University of Agriculture in Nitra
Faculty of agrobiology and food resources
Department of Animal Husbandry
Tr. A. Hlinku 2, 949 76, Nitra, Slovak Republic
E-mail: alehotayova@gmail.com

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