Livestock Science 147 (2012) 148–153

Contents lists available at SciVerse ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Soybean oil and crude protein levels for growing pigs kept under heat stress conditions

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ARTICLE INFO

Article history:
Received 19 November 2011
Received in revised form
19 April 2012
Accepted 23 April 2012

Keywords:
Ideal protein
Heat stress
Performance
Physiological characteristics
Swine
Thyroid hormone

ABSTRACT

This study was conducted to evaluate the effect of different levels of soybean oil (SO) and crude protein (CP) on performance and physiological and hormonal parameters of pigs in high-temperature environment. Eighty-four growing pigs with initial weight of 36.9 ± 3.0 kg were assigned to treatments in 2×3 factorial arrangement of dietary treatments plus 1 [two levels of CP, 18% and 15.5%, and three levels of SO, 1.5%, 3.0%, and 4.5% with all pigs kept at room temperature of 32 °C, and an additional treatment (control) with 18% CP and 1.5% SO with pigs kept at 22 °C], in a randomized block design with the block being the initial weight. In animals maintained in the high-temperature environment, there was no interaction between CP and SO levels in any of the variables evaluated. The addition of SO improved ($P < 0.05$) the average daily gain (ADG) and feed:gain (F:G), but did not affect the average daily feed intake (ADFI). The reduction of CP resulted ($P < 0.05$) in lower ADFI. Compared to animals kept at the comfort temperature, a high-temperature environment decreased the F:G ($P < 0.01$) of animals fed diets with 18% CP and 1.5% SO. However, increasing the SO level resulted in similar values of F:G. For animals kept in a high-temperature environment, CP can be reduced in diets supplemented with amino acids only in diets with high SO levels. The high-temperature affected ($P < 0.01$) body temperature and respiratory rate, but was not sufficient to change the levels of T3 and T4. It is concluded that SO levels should be increased in diets for animals kept in high-temperature environment, and the CP levels can be reduced only under these conditions, since supplemented with amino acids.

1. Introduction

For many years, environment, as well as management, health, genetics, and nutrition, has been considered to be a limiting factor for maximum animal production. Among domestic animals, pigs are more sensitive to high temperatures. It was known that this sensitivity is due to a combination of factors, among which are a poor thermoregulatory system, keratinized sweat glands, presence of a subcutaneous fat layer and intense metabolism. 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).

Physiologically, pigs produce heat as a result of their production and maintenance functions. However, their body development and production efficiency are possible only if this body heat production is minimal (Tavares et al., 2000). To adapt to these conditions, the animals increase their respiratory frequency (Manno et al., 2006)

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http://dx.doi.org/10.1016/j.livsci.2012.04.014

or direct blood flow to the body periphery, raising the skin temperature (Carvalho et al., 2004). Another mechanism is to reduce food intake (Witte et al., 2000). This reduction is employed in an attempt to decrease production of body heat from metabolism. In practice, this reduction in food intake is related to lower performance of animals and a longer period of time taken to reach slaughter weight (Kiefer et al., 2005; Witte et al., 2000).

In this context, 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 regions. However, new nutrition practices have also been studied as an alternative in reducing the negative effects of heat stress.

Based on current knowledge, the use of modified diets is one of the nutritional strategies aimed at improving the productivity of pigs in hot periods. 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).

Besides the reduction of crude protein in diet, the inclusion of oil can also be an advantage, because the caloric increment is even lower (Li and Sauer, 1994; Noblet et al., 2001; Spencer et al., 2005). In this sense, a combination of these factors may be beneficial to animals kept in hot environments (Le Bellego et al., 2002). However, there has been little study on the effects of lipids in reduced crude protein diets containing synthetic amino acids. It is known that lipids have an influence on protein digestibility and amino acid availability (Almeida et al., 2007).
In this instance, an imbalance of amino acids could be involved and, consequently, loss in animal performance.

The aim was, therefore, to verify if diets with different levels of soybean oil, formulated with reduced crude protein supplemented with amino acids, can influence the performance and physiological parameters in growing pigs housed in a hot environment.

2. Materials and methods

The experiment was conducted at the Swine Experimental Center, Department of Animal Science, Federal University of Lavras, Lavras, Minas Gerais, Brazil. The experimental protocol was approved by the Bioethics Committee of the Federal University of Lavras.

2.1. Experimental design, animals, housing, and diets

Eighty-four barrows from a commercial line (Tempo × Topigs 40, TOPIGS, Helvoirt, The Netherlands) with initial weight of 36.9 ± 3.0 kg were used. The animals were housed in groups of two in two air-conditioned rooms in pens with concrete flooring, $1.38 \times 2.82\ m^2$ in size, equipped with semi-automatic feeders and adjustable nipple drinkers. The experimental period lasted 30 d.

The rooms were equipped with automatic equipment (MT-530 Super, Full Gage Controls, UL Inc., US) responsible for the circulation of heated or cooled air in the room and infrared lamps and fans. All equipment was connected to a central panel, allowing the automatic adjustment of the internal temperature of the rooms. In the high temperature environment, the control panel was set to 32 °C, while in a thermoneutral environment, it was regulated at 22 °C. The relative humidity was set to be between 60% and 70% in both environments.

The air change of the rooms was constant, regulated by blowers and fans attached to a pipe with small holes for air distribution. The equipment automatically stayed on for 15 min and off for 2 min.

The temperature and relative humidity were monitored daily inside the rooms at 08:00, 13:00 and 18:00, by a maximum and minimum thermometer, barometer and dry and wet bulb and black globe thermometers (INCOTERM Thermo-hygrometer dry and wet bulb, code 5203.03.0.00; Porto Alegre, Brazil) placed at the center of the room and at a half height of the animals. The recorded values were then used to calculate the black globe humidity index (BGHI), according to Buffington et al. (1981), characterising the thermal environment in which the animals were kept.

The animals were assigned to treatments in 2×3 factorial arrangement of dietary treatments plus 1 [two levels of CP, 18% and 15.5%, and three levels of SO, 1.5%, 3.0%, and 4.5% with all pigs kept at room temperature of 32 °C, and an additional treatment (control) with 18% CP and 1.5% SO with pigs kept at 22 °C], in a randomized block design with six replicates of two animals per experimental pen. The criterion for the block was the initial weight of animals.

The experimental diets (Table 1) were corn and soybean meal based, containing vitamins, minerals and amino acids to meet the minimum requirements suggested for the lineage (Tempo × Topigs 40; TOPIGS, Helvoirt, The Netherlands). Water and feed were supplied ad libitum. Diet supply and orts were measured daily.

2.2. Sampling and measurement

Surface temperatures (neck, shoulder and leg) were measured in all animals, every 7 d, by an infrared thermometer (INCOTERM Digital Infrared Laser Thermometer Pointer—ST600, Porto Alegre, Brazil) orientated to the skin. The rectal temperature was measured by introducing a thermometer into the rectum of the animal for 1 min. The respiratory rate (breaths/minute) was obtained with the animal lying down by counting the flank movements of the animals for 15 s.

The animals were weighed at the beginning and end of the experiment. feed:gain (F:G) was obtained using the relationship between average daily feed intake (ADFI) and average daily gain (ADG) in the period.

At the end of the experiment, the animals' blood collection was performed by puncturing the orbital sinus with hypodermic needles $16G \times 1.27$ cm, without fasting,