

METHODS OF CONTROLLING THE TECHNOLOGICAL FACTORS INFLUENCING PIG FATTENING AND CARCASSES QUALITY

METODE DE CONTROL A FACTORILOR TEHNOLOGICI CARE INFLUENȚEAZĂ ÎNGRĂȘAREA PORCILOR ȘI CALITATEA CARCASELOR

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ABSTRACT | REZUMAT

Production systems that can reduce the amount of fat in pig carcasses refer to the improvement of the welfare conditions of fattened pigs and the strict control of nutrition according to the type of meat preferred by consumers in the pork market. In order to ensure the proper conditions for fattening pigs to perform regardless of the rearing system, they must be supplied with adequate shelter for maintenance and feed suitable for the intended purpose, with enough water, and with reliable production technologies. One of the most effective management methods to reduce the amount of fat in pig carcasses is to control the microclimate in shelters, especially the temperature, with effects on the accumulation of reserve fatty substances for the thermoregulation of vital functions in conditions of thermal stress, but also to control nutrition because maintaining the quality of pork is critical and feed quality influences meat quality and fat quality from the perspective of physical and nutritional characteristics, with an impact on human health: there is a close relationship between dietary composition and body fat in pigs, therefore it is relatively easy to manipulate the composition of pork fat by changing the type of fat. High levels of saturated fat in humans are associated with cardiovascular disease, so efforts should be made to increase the intake of "healthier" fats by manipulating feed recipes for fattening pigs.

Keywords: pigs, fattening, management, nutrition

Sistemele de producție care pot reduce cantitatea de grăsime din carcasele de porc se referă la îmbunătățirea condițiilor de bunăstare a porcilor îngrășați și controlul strict al alimentației în funcție de tipul de carne preferat de consumatorii de pe piața cărnii de porc. Pentru a asigura condiții corespunzătoare pentru ca porcii de îngrășat să funcționeze indiferent de sistemul de creștere, aceștia trebuie să fie aprovizionați cu un adăpost adecvat pentru întreținere și hrană adecvată scopului prevăzut, cu suficientă apă și cu tehnologii de producție fiabile. Una dintre cele mai eficiente metode de management pentru reducerea cantității de grăsime din carcasele de porc este controlul microclimatului din adăposturi, în special a temperaturii, cu efecte asupra acumulării de substanțe grase de rezervă pentru termoreglarea funcțiilor vitale în condiții de stres termic, dar de asemenea, să controleze nutriția deoarece menținerea calității cărnii de porc este critică, iar calitatea furajelor influențează calitatea cărnii și calitatea grăsimii din perspectiva caracteristicilor fizice și nutriționale, cu impact asupra sănătății umane: există o relație strânsă între compoziția alimentară și grăsimea corporală la porci, prin urmare, este relativ ușor de manipulat compoziția grăsimii de porc prin schimbarea tipului de grăsime. Nivelurile ridicate de grăsimi saturate la oameni sunt asociate cu bolile cardiovasculare, așa că ar trebui depuse eforturi pentru a crește aportul de grăsimi „mai sănătoase” prin manipularea rețetelor de hrană pentru îngrășarea porcilor.

Cuvinte cheie: porci, îngrășare, management, nutriție

Research carried out in the field of raising and exploiting pigs for meat highlights different rearing systems for fattening pigs, each presupposing:

1. A certain type of fattening farm: Diet can influence the growth performance and selected biochemical parameters of blood serum characterising health

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status in fattening pigs (23); Eating rate can affect feed intake, growth performance, and carcass quality (5). Farmer practices influence fattening pig performances (3). Final fattening pig body weights have a significant influence on the fattening traits, meat quality, and pig carcasses (4, 7, 9, 14, 15, 19, 20, 21); Housing systems and slaughter weight influence market realisation of slaughter pigs by SEUROP classification (22); On-farm rest periods can change carcass composition, meat quality traits, and stress levels in culled sows (8); The most effective pig fattening is by

approximately 100 kg of body weight when considering fattening profitability, pig fattening, and meatiness at the existing price ratio (21).

2. A production price.
3. Different economic results: Pig farmers' profitability (in Swaziland) is influenced by access to extension services, access to market information, pig production experience, and target market (6);
4. Investment efforts.
5. Production expenses.
6. Productive indicators: genotype and some genetic factors can influence productive traits in pigs; Meat productivity can depend on the age of the farm's equipment and on the size class of the sow herd (1).
7. The production of a certain type of meat: Dabant, Landrace, and Yorkshire pig breeds do not show statistically important differences in fat, minerals, muscle water content, and proteins (13).

The analysis of different meat production systems with a certain percentage of fat in the carcass was the aim of the studies undertaken by different researchers in different types of farms with stable and mixed management. The objectives of the research aimed at the quality of the meat obtained according to the management system, at the control of technological factors to increase the efficiency of pig raising (2, 5, 7, 21), but also at the role of balancing feed rations on the amount of fat in carcasses (9, 14, 15, 17, 19).

MATERIALS AND METHODS

The increased demand for pork has a major influence on the activity of professional farms that must quickly adapt their production systems to the needs and consumption preferences of consumers in order not to be taken out of the market. Integrated farms can meet these demands only if they have implemented production management, have specialised biological material to produce cane, and have high-performance exploitation systems that lend themselves to these requirements. Within this scientific approach, using the specific analysis methods of analysing the quality of the production obtained in each exploitation system, it was subjected to research:

1. A system of exploitation of pigs for meat in the classic system, with its advantages and disadvantages, for finding solutions to improve the exploitation to produce meat with less fat and to make the farms competitive through the products offered for sale;
2. The types of meat that can be obtained depending on the equipment on the farm;
3. The ability of farms to adapt productions to the demands of the pork market;
4. The response of the biological material to the welfare conditions offered regarding the quality of meat and fat.

The study was carried out on a farm located in Timis County, Romania, in two groups as follows:

Group I, consisting of 180 fat pigs operated at an average temperature of 10–12.5°C, in a shelter provided with a paddock and without a heating source, had a weight at the beginning of the experiment of 40.5 ± 2.33 kg and an age of 70 ± 2 days.

Group II, consisting of 200 heads, was fattened at a temperature of 14.5–16.5°C, in a shelter equipped with a paddock, but the animals did not have access outside. There were possibilities to heat the shelter; the floor was 40% full from the surface of the box and 60% grate; the average weight was 40.7 ± 1.88 kg; and the animals were same age.

During the 78-day study period, the following technical parameters were monitored:

- a. the average daily gain recorded daily during the entire fattening period;
- b. specific consumption at different temperatures.

During the entire fattening period, the two batches were fed with combined feed in the form of flour, specific to the fattening period.

The statistical analysis was done with the help of the t-test programme using the GraphPad Prism 9.0 software for Windows (GraphPad, USA).

RESULTS AND DISCUSSIONS

For fat pigs to express their productive characteristics in terms of performance parameters (1), it is necessary to provide them with the best welfare conditions according to the quantity and quality of meat demanded by the market. Pig fattening farms must be able to perfect their operating systems and operating conditions – the system of rearing, feeding, watering, and control of microclimate factors – and specialise their human resources to cope with these demands. Because pork of a certain type and with certain properties (the quality of the fat) is obtained in several production systems, we believe that it is necessary to analyse the most used production systems with their advantages and disadvantages depending on the management systems.

Stable maintenance of pigs for fattening

It involves the increase of investments in the implemented technology and their maintenance in shelters with controlled microclimates and the mechanisation of the main technical operations – feeding, watering, and evacuation of manure.

Within this exploitation system (professional farms), large herds are concentrated, and the nutrition system can be controlled to obtain a certain type of meat (with a certain proportion of fat) for consumption or for meat preparations.

The analysis of this system shows that fattening in stables presents the disadvantage that, without a technological factor, it can lead to the appearance of metabolic or respiratory diseases, which increase the fattening period and increase operating expenses, preventing the farmers from supplying the market with the amount of meat or the type of meat required. To reduce animal sensitivity and preserve animal health and biosecurity, it is recommended for the analysed professional farm to improve production indicators through the following managerial measures:

- ensuring the well-being of fattened pigs through conditions that allow them to perform – shelter with possibilities to regulate microclimate factors, useful areas corresponding to age and category, nutrition for the quality of the forecasted production;
- using healthy hybrids with a high capacity to adapt to intensive exploitation for fattening;
- controlling the state of health through veterinary health management for the prevention of diseases;
- ensuring farm biosecurity through buffer areas around the farms.

Outdoor maintenance and shelters for fat pigs

In this system, a smaller number of fat pigs can be fattened because the paddocks have the disadvantage that the animals come into contact with external conditions, and if the system is not well managed, especially in winter and spring, currents can cause the appearance of respiratory diseases and loss of production because sick pigs no longer achieve the planned increases and consume more resources, thus making the fattening period longer, with effects on the technological flows of obtaining meat.

Using a well-managed production system by implementing the best management on each technological link that contributes to obtaining quality meat will have a multitude of advantages, including:

- Fattening animals will be more robust and livelier due to the favourable influence of environmental factors;
- Quality meat with good organoleptic characteristics can be obtained if concentrated fodder is replaced with green feed, especially alfalfa;
- Ration conversion indices will be better and with lower feed costs, but the duration of fattening will be extended due to the nutritional quality;
- It combines well the effects of green mass on ensuring the necessary mineral salts and vitamins.

We believe that, for the farm under study, an effective way to reduce the amount of fat in pig carcasses is to control the microclimate in the shelters during the fattening period, with effects on the accumulation of reserve fatty substances for the thermoregulation of vital functions in stressful thermal conditions. The thermal environment in the fattening house is the result of the interaction of air temperature, humidity,

and air flow. These factors, in turn, are determined by several factors, such as the weight and age of the fattening pigs, the number of animals in the stalls, the degree of isolation of the housing, the state, and the type of housing. In order to produce economically, it is recommended that the ideal air temperature for optimal production and meat with low amounts of fat should be adjusted according to:

- The physiological needs of fat pigs at a certain age;
- The method of ensuring ventilation and its degree of mechanisation;
- The type of floor in the stall;
- The way water and feed are supplied;
- The quality of the feed and the method of administration (wet or dry);
- The fattening technology implemented;
- The type of meat to be produced.

Fresh, clean air is essential to keeping pigs healthy and vigorous; cool, and dry air is far superior to hot and humid air, and a warm, humid area is the perfect environment for respiratory disease organisms to thrive and spread. The challenge for pig producers during cold weather is to keep the houses warm enough for the pigs while preventing moist air from accumulating in the shelters. Ensuring a proper comfort zone and sufficient useful space per fattening pig is essential for meat production. The clean stall allows greater control over the thermal environment of the fattening pigs by providing a source of heat as well as a place for the pigs to protect themselves from drafts. In cases of high temperatures, pigs' distance themselves from each other, and if the discomfort persists, the pen becomes wet due to the disorganisation of the batch and the failure to keep the resting area clean.

Fatty pigs enjoy management systems for low and high temperatures, so it was found that, in a cold environment, they have the following behaviour: they consume food more often and in larger quantities to regulate the temperature and not to produce weight gain. Although more feed energy is needed to maintain body temperature, growing pigs in concrete floor systems is severely affected by winter temperatures, except for piglets and young pigs that are supplied with heat. It is known that piglets have less fat to insulate themselves from the cold and need, in the first week of life, temperatures of 30°C to survive; in exchange, fat pigs protected from air currents without warm microclimates achieve optimal production at 14-16°C, if fattening is well managed and carried out in well-insulated shelters with air ventilation facilities to regulate humidity.

Performances of fattening pigs

As was observed in our study (Table 1), the level of feeding influences the performance obtained if the optimum temperature of 14.5 – 16.5°C is ensured in the shelters for fattening pigs.

Table 1

**Performance of fattening pigs
at the optimal temperature of 14.5-16.5°C**

Item	Feeding level	Performance	Improvement measures
Lean meat	High	reduced	consumption restriction
Specific consume	Moderate	low	low or very high feeding regime
Average daily gain	High	maxim	optimal consumption at a temperature of 14.5-16.5°C

The fat pigs kept at a temperature of 14.5-16.5°C achieved the following performances: the technological systems of feed administration can influence their optimal utilisation, but the microclimate in the shelters contributes substantially to highlighting the performance indices according to the biological value of the hybrids commercially used for meat production. The administration of feed ad libitum or limited, with granulated fodder or in the form of flour in one, two, or more meals, although specialists in the field recommend discretionary feeding if the fodder is of good quality, is not converted to optimal parameters if the microclimate factors are not respected depending on the age and weight of the pigs.

Regardless of the technological feed management system, discretionary feeding should only be done for commercial meat hybrids if the best management of nutrition and the best management of information on expected conversion rates at certain temperature variations are implemented on the farm from shelters. The following indicators presented in Table 2 were recorded at different operating temperatures for the fat pigs. Comparing the results obtained in the two batches subjected to research under different temperature conditions in the shelters, it was found that:

Regarding the average daily gain achieved, the differences are significant at a reference threshold of $p \leq 0.05$ between the two groups;

The differences are not significant for the specific consumption at a reference threshold of $p \geq 0.05$; the lowest consumption of 3.23 ± 0.33 is achieved by group II.

The highest average daily gain is recorded in the case of the 2nd batch, which makes us conclude that if

the fattening pigs are provided with an optimal temperature in the shelter according to the age and weight category, a balanced feed from a protein-mineral point of view, they express their hereditary endowment at optimum parameters. We believe that for small and medium-sized professional farms whose activity is pig fattening, the following are required:

- Investments in the procurement of valuable genetic material;
- Investments in the procurement of installations to ensure the optimal temperature in the shelters;
- The implementation of production management in order to improve performance and reduce the fattening period, with a positive impact on the amortisation period of the financial effort for the procurement of equipment for regulating microclimate factors.

At high temperatures, in fattening pigs, facilities are needed to ensure the microclimate in the shelters. High temperatures above 20°C reduce the productive performance of fattening pigs not as losses because of death but because of reducing feed consumption: this can disrupt the technological flow by extending the fattening period and producing carcasses with a lot of fat. It is recommended, in hot conditions, especially during the summer, to protect and avoid stress in fat pigs by:

- Providing adequate quantities of fresh and clean drinking water for consumption ad libitum;
- Humidifying the walls of the shelters to regulate the humidity;
- Reducing the amount of waste water from the canals if the exploitation is done in stalls with a grid floor;
- Reducing the number of pigs per pen during the summer periods: this reduces the number of pigs in

Table 2

**Average daily gain and specific consumption
depending on the temperature in the shelter**

Group	Fattening days	Average daily gain (grammes)	Specific consumption (kg feed/kg weight)	The temperature in the shelter
I	78	688±3.2Aa	3.67±0.27 a	10-12°C
II	78	741±4.5ca	3.23±0.33 a	15.5-22.4°C

t-test: A-a $p \leq 0.001$, A-b $p \leq 0.01$, A-c $p \leq 0.05$, a-a $p \geq 0.05$

Table 3

Management measures to optimise heat stress in fattening pigs

High temperature in the shelter	
Fat pigs	Human resource
1. Distance themselves from each other;	1. Increases the area per fat pig by decreasing the number of pigs in the pen;
2. Increase the contact area with the concrete floor;	2. Humidifies the walls of the pen with water;
3. Get dirty and cool in the defecation area;	3. Increases the speed and volume of air currents;
4. Become restless and aggressive;	4. Sprinkles animals with water;
5. Consume little feed;	5. Sprinkles the hall floor and walls with water;
6. Become restless at the water source.	6. Provides more water, reduces the number of pigs, and cleans the stall.
Low temperature in the shelter	
Fat pigs	Human resource
1. Gather;	1. Reduces drafts and closes vents;
2. Lie down in the feed area;	2. Spreads sawdust in the stall;
3. Eat large amounts of feed;	3. Provides additional heat;
4. Catch cold diseases.	4. 4. Insulates windows and increases pig density in the shelter.

the total air space of a house and the amount of heat generated by fat pigs;

- Increasing the speed of air movement through the hall to cool the pigs.

Although fat pigs do not sweat, evaporative heat loss can lower body temperature, and if stress cannot be avoided, cooling strategies must be optimised to improve the performance of the human resources on the farm, as shown in Table 3.

Control of nutrition

Maintaining pork quality is critical; feed quality influences pork quality, and fat quality is a major component of pork quality. The quality of fats is defined from the perspective of physical and nutritional characteristics, but the major problems related to the quality of meat fats are: soft fats, unusual odours, and the impact of the composition of pork fat on human health. Soft fat is a major concern for pork processors because it can cause problems in meat processing, such as lower processing yields and low fat values, which affect pork producers. Soft fat oxidises faster and acquires an unpleasant smell faster, making it oily, a characteristic that is considered very undesirable by

most consumers. The use in feed rations of vegetable oils and co-products with a high level of vegetable oil to ensure energy levels reduces the firmness of pork fat. With 8.00% vegetable oils, pork quality is not affected, but it is recommended that fattening pigs be fed recipes that combine:

- corn with soybean meal to obtain lower amounts of fat in carcasses, but of good quality in terms of fat firmness;

- barley to produce carcasses with very little fat and of high quality in terms of firmness and colour.

Unusual odours are caused by the fats used to balance energy rations, which oxidise in improper storage conditions. For these reasons, to avoid unpleasant odours in the meat during the finishing period, fats must be excluded from the fodder rations. Fish oil and fishmeal are very susceptible to rancidity and unpleasant odors. The use of moderate fat in rations leads to good performance regarding the quality of the carcasses obtained from fattened pigs; the amount of fat is reduced, and the quality in terms of firmness is as shown in Table 4. Pork fat used in human food needs to be well managed because of the impact of its composition on human health. It is known that there is a

Table 4

The proportion of fat in the rations of fattening pigs to obtain quality carcasses

Item	Category – fat pigs		
	Fattening 31.0-80.99 kg	Finishing 81.0-106.0 kg	
	Share of ration (%)	In the first part of finishing (%)	In the last 21 days of finishing (%)
Animal fat	0.0-8.0	0.0-4.0	-
Vegetal fat	0.0-4.5	0.0-2.0	0-1.0

close relationship between dietary composition and body fat in pigs: for these reasons, it is relatively easy to manipulate the composition of pig fat by changing the type of fat fed into rations to regulate energy requirements. High levels of saturated fat are associated with cardiovascular diseases: efforts should be made to increase the intake of "healthier" fats by manipulating feed recipes for fattening pigs as follows:

- Adding omega-3 fatty acids with a beneficial effect on cardiovascular diseases, such as flax, flaxseed, or flaxseed oil, which can increase the amount of omega-3 fatty acids in pig fat by using them to regulate the energy requirements of the feed used during the finishing period;

- Introducing linseed in rations below 12.5% to improve the omega-3 fatty acid content of pork fat without a negative impact on the quality of the carcass, the fat in the carcasses regarding firmness and colour;

- Using green fodder and food waste in the rations of traditional breeds, Mangalița and Bazna: this is beneficial because it contributes to quality carcasses with reduced amounts of fat and a high proportion of unsaturated fatty acids.

It is worth remembering and comparing the data thus obtained from the research carried out for this purpose in the world:

- The digestibility of amino acids and energy in feed tends to be lower than the digestibility of feed such as corn and soybean meal (24);

- Sows fed large amounts of feed can access the feeders without becoming excessively fat, which simplifies feed management for the pregnant sow herd and can improve sow welfare;

- Due to the high fiber content (10, 11, 16, 18) and the limited availability of energy and amino acids, feed should not be supplied in large amounts in lactating sows and fattening pigs in the first part of fattening;

- Fat pigs from the traditional Romanian breeds Mangalița and Bazna behave well on pasture if they receive a diet supplemented with concentrated feed: they use more nutrients from the feed after an adaptation period of two months, but the digestibility of the feed increases with the maturity of the pig;

- Although pigs fed a diet of maize meal and soya achieve good gains, being omnivorous they can feed on a wide range of industrial or household residues performing valuable functions as recyclers of nutrients found in foods that are no longer suitable for human consumption

- Pigs from traditional breeds exploited in the open air to supplement the pork shortage make good use of the nutrients from dry waste from bakeries, and from rejected fruits and vegetables: popcorn, potato chips, grains, and pasta that do not meet specifications or are past a manufacturer's expiration date may also be included in the pig's diet;

- Other food waste from restaurants, schools, and

other institutions can be included in the diet of pigs operated in alternative systems on non-professional farms. Both marketing indications and sanitary-veterinary regulations regarding the inclusion of waste in pig diets should be checked to ensure compliance with pig feeding standards and meat traceability.

CONCLUSIONS

The performance of fattening pigs shows the type of management implemented on the farm – housing, facilities, quality of biological material, nutrition, and welfare – but, for a good distribution of the meat produced, it is necessary to adopt marketing and reliable technologies and adapt them to the demand, to cope with the trends for consumption. In order to reduce the amount of fat in the carcasses and improve its quality, firmness, and colour, through the managerial measures taken, it is necessary to control the technological factors that determine the production of meat and meat preparations with characteristics that satisfy the preferences of consumers of such products. Depending on the quantity and quality of marketable meat, farms must be able to improve their technologies to ensure welfare and to achieve performance according to the requirements, the production systems of a type of meat, and to operating conditions by controlling microclimate factors and nutrition because the quality of the feed and the ingredients incorporated in the recipes have major influences on the amount of meat obtained, the quality of the meat, and the fat in the meat. Although the quantity and quality of fat in carcasses and meat are defined from the perspective of physical and nutritional characteristics, the major issues related to fat quality are given by the quantitative and qualitative diets administered to fattening pigs, the way in which feed is stored, and the effects of consuming processed agri-food products on human health. For these reasons, the control of the nutrition of fat pigs must consider the proportions of vegetable oils and animal fats used in pig feed to cover the energy level of feed rations since there is a close relationship between dietary composition and body fat in pigs: for this reason, it is relatively easy to manipulate the composition of pork fat by changing the type of fat that is introduced into the rations to regulate the energy requirement and maintain the health of the consumers of such products.

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