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Review

Guinea pig for meat production: A systematic review of factors affecting the production, carcass and meat quality

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ABSTRACT

In developing countries, interest in guinea pig farming is growing exponentially because it provides a regular source of high quality animal protein for domestic consumption. Guinea pigs (*Cavia porcellus*) are prolific animals, grow and are capable of reproduction on a flexible diet, and are adaptable to a wide range of climates. This article mainly reviews findings on guinea pig meat production, including factors affecting raising guinea pigs, carcass and meat quality. We also present some studies that describe biological and pathologic effects on carcass component composition. During the last decades no standard procedure has been established for guinea pig carcass evaluation, which makes very difficult any comparison of results with other studies around the world. Herein we highlight a variety of factors that significantly affect carcass and meat quality. Some of these factors are production systems, environmental and genetic factors, management systems, the diet and health status, age, sex and reproductive management.

1. Introduction

Food security is defined as having physical, social and economic access to sufficient quantities of safe and nutritious food to meet dietary needs for a healthy life (FAO, WFP and IFAD, 2012). In this review, we focus on the use of the guinea pig as a food source, and as a pet or laboratory animal has resulted in its worldwide distribution (Dunnum & Salazar-Bravo, 2009). In developing countries, interest in guinea pig farming is growing exponentially because it provides a regular source of high quality animal protein for domestic consumption, contributing to food security and providing a small but frequent economic income for the population (Ngoula et al., 2017), specifically the Andean region, and some countries from Asia and Africa (Lammers, Carlson, Zdorkowski, & Honeyman, 2009). However, the nutritional characteristics of guinea pig meat are currently drawing some attention despite the little information on its nutritional value.

In a very interesting review, Cawthorn and Hoffman (2016) summarized the complexity of several unconventional or exotic animals that are eaten around the world, such as the guinea pig, which evoke strong emotions and controversy. Owing to their ubiquity and ease of capture, rodents have served as a food for mankind throughout the ages, especially in times of food shortages (Fiedler, 1990). The cavy, for instance, has been a staple meat for some of the people in the Andes for at least 3000 years (Kyle, 1994). Although the guinea pig is considered a pet in many countries and cultures, in Andean countries most of the guinea pig produced is consumed or exported to other countries where Andean people live. Nonetheless, guinea pig meat consumption is marginal when compared with other conventional types of meat such as chicken, pork or beef.

The genetic diversity and relationships among the guinea pig population are poorly documented. Furthermore, genetic selection in selective breeding for larger-sized animals is recent and has mainly been carried out in Peru and Ecuador, resulting in the Tamborada and Auqui breeds, respectively (Spotorno et al., 2006).

This article reviews the main findings on guinea pig meat production, including factors affecting raising guinea pigs, carcass and meat quality, and some studies based on guinea pigs to predict biological and pathologic effects as well carcass component composition.

2. Origin and uses of Guinea pig worldwide

2.1. Historical and geographic migration of Guinea pig

Guinea pig, “cuy”, “cavy”, or “cobayo” (name varies according to

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geographical/social region in South America) was domesticated approximately 3000–6000 years ago in the highlands of South America and was the first rodent raised for food (Gade, 1967; Lanning, 1967; Wing, 1977). Kimura et al. (2016) analyzed the ancient mitochondrial DNA of the pre-Columbian archeological guinea pig from different Caribbean sites and concluded that guinea pigs were introduced initially to Puerto Rico from the modern-day region of Colombia. This type of study allows researchers to directly infer human movements. Previous phylogenetic and morphological research on guinea pigs using ancient and modern samples from South America and Europe indicate that domestic guinea pigs, including those introduced to Europe following colonization of the Americas (Pigière, Van Neer, Ansieau, & Denis, 2012), all derived from a single domestication of wild guinea pigs (*Cavia tschudii*) in the western Central Andes, specifically the Peruvian highlands, over 2500 years ago (Spotorno et al., 2006; Spotorno et al., 2007; Spotorno, Valladares, Marin, & Zeballos, 2004; Walker, Soto, & Spotorno, 2014; Wing, 1986).

2.2. Multipurpose uses of Guinea pig

Domestic guinea pig is multipurpose in different regions around the world. It is among the few species that are popular pets all over the world, are used as laboratory animals in scientific research, and provide a source of meat, particularly for the rural population in Andean and Asian countries. Also, they are used in rituals related to ancestral spirits, in the disperse sections of the Andean Region and in African countries like Nigeria (Onuorah & Ayo, 2003).

The role of the guinea pig as a meat producer is becoming more important. Guinea pig is likely to produce animal protein, at a comparatively low cost, based on feeds, fodders and vegetal residues. The common opinion, not scientifically supported, that guinea pig meat is tasty and low in fat compared to meats from other animals, may be partly attributed to the fact that guinea pig is usually fed with fodders and vegetal residues from crops and traditional markets.

Guinea pigs can provide a suitable and substantial amount of meat for human consumption because they are prolific animals, grow, reproduce and are adaptable to a wide range of climates and diets (Lammers et al., 2009). Guinea pig production could be a cheap option to meet the growing needs for protein in developing countries, especially for low income population groups. Rosenfeld (2008) explored the role of guinea pig in the pre-Columbian Andean diet and concluded that guinea pigs were crucial in the diet of these people. Nowadays, guinea pig is offered to tourists as a tasty and expensive regional dish in the Andean Region (Ecuador, Peru, Colombia and Bolivia), which helps in allowing sustainable economic growth in rural areas.

Regarding to its uses in scientific research, guinea pig is more physiologically and immunologically similar to humans than other small animal models (Padilla-Carlin, McMurray, & Hickey, 2008), and for this reason it is used worldwide as a surrogate human model. Some examples are summarized in Table 1.

3. Animal production systems and factors affecting the production

Guinea pigs have several characteristics that convert them into an attractive protein source. First, they are herbivores that require moderate or no amount of concentrated feed supplements. This species has a voluminous caecum and colon and can retain digesta in the large gut for a considerable time (Sakaguchi, Becker, Rechkemmer, & Engelhardt, 1985; Sakaguchi, Heller, Becker, & Engelhardt, 1986). The caecum of the guinea pig has been shown to contain concentrations of short-chain fatty acids similar to those in the bovine gastrointestinal tract (Henning & Hird, 1970).

Interesting reproduction features are observed in guinea pigs: They don't have seasonal breading habits or limitations, therefore present several births over the year (Trillmich, 2000). They have 80% of litters conceived at post-partum oestrus, with a mean gestation period of 68 days (Rowling, 1949), so the partum interval is approximately 70 days. On the other hand, caviomorphs are distinct from other rodents in that they produce extremely precocial offspring, guinea pigs in particular. Compared to altricial species, neonates are physiologically mature (except for reproductive functions). Agile and relatively independent at birth, they have open eyes, exhibit fully developed fur and feeding apparatus, and start to forage almost immediately after birth (Michel, Chastel, & Bonnet, 2011). In guinea pigs, most of the offspring development is achieved before birth (Künkele, 2000). Weir (1974) reported neonates can survive the weaning at 5 days of life. However, Fonteh, Niba, Kudi, Tchoumboue, and Awah-Ndukum (2007) recommended the weaning time after 11 days at birth, subjected to an appropriate diet.

More research is needed on factors that affect guinea pig meat production. However, in the next section, we review important factors which influence the farming of guinea pigs, such as: environmental, management, genetic and health.

3.1. Environmental factors

Photoperiod does not affect the guinea pig's reproduction or growth, assuming sufficient food and thermally neutral ambient conditions (Trillmich, 2000). However, Guenther, Palme, Dersen, Kaiser, and Trillmich (2014) reported that differences in photoperiodic conditions during development clearly affected the somatic and reproductive development of young males of *Cavia aperea*. Under an increased photoperiod, wild male cavies grew faster during later development, a difference that vanished when they reached adulthood. It might be that the domestication process modified this physiological effect in guinea pigs.

Temperatures ranging from 18 to 25 °C provide the best environment for a guinea pig (Ngoula et al., 2017). These authors tested the effect of three temperatures (20–25 °C, 35 °C and 45 °C) on male guinea pigs. The relative weight of testicles, epididymis, vas deferens and seminal vesicles was not significantly affected by the temperature levels, but the percentage of minor abnormalities was higher in animals exposed to 45 °C and oxidative stress parameters increased. Bauer, Womastek, Dittami, and Huber (2008) performed an experiment where one group of guinea pigs received 16 h of light and 25 °C (long and warm days, LD/25) and another group received 8 h of light and 15 °C (short and cold days, SD/15). The authors reported that in the first generation the environmental conditions did not affect the litter size and pup body weight. However higher testosterone levels were found in LD/25 males than in SD/15 males, and short-day conditions retarded puberty in male guinea pigs. The study also reported that no effect was found in females (Bauer et al., 2008). Thermal treatment did not influence reproductive output, reproductive effort, or offspring characteristics. This suggests that pregnant female guinea pigs cope with cool (but not extreme) thermal conditions by reducing activity and baseline cortisol levels, possibly to save energy via an adaptive response. Interestingly, the greater amplitude of the stress response of the cool regime females was also observed in their offspring 2 months after parturition, suggesting that hormonal ambience experienced by the individuals in utero shaped their stress response long after birth (Michel et al., 2011).

3.2. Management factors

Chauca (1997) defined three management types in guinea pig production:

a) Family management is the most common in Andean, African and Asian countries; animals are maintained in a room of the house (usually the kitchen) or very close to the house, and fed with vegetarian kitchen waste and weeds;

b) Family-commercial management is more common in areas closer to cities; the guinea pigs receive better feed including some