Welfare of Italian Heavy Pigs

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Italian heavy pigs are characterized by much higher body weights and age at slaughter (approximately 160–170 kg, and over 9 months of age) than the majority of pigs reared in Europe. This results in peculiar behavioral and rearing-related needs compared to smaller pigs. However, there is a limited body of research dealing with the welfare of this productive category, and several aspects have not been investigated yet. In particular, the lack of knowledge on space requirements, injuries, and positive welfare (included human–animal relationships) are crucial aspects that should be explored in order to define a baseline to set up measures for the improvement of the production system. It is hoped that this content will help to promote knowledge and specific policies aimed at enhancing the ethical attributes of this renowned production, thus improving animal welfare, meeting consumers' expectations, and increasing the value of its marketing chain.

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1. Introduction

Protected Designations of Origin (PDO) and Protected Geographical Indications (PGI) labels represent the excellence of European agricultural food production and are both the result of a unique combination of human and environmental factors that are characteristic of a specific territory. Consumers' expectations of these products have increasingly included implicit ethical attributes, such as environmental sustainability and animal welfare [1][2].

Among the pork-based Italian PDO products, the most well-known are the cured hams, such as the worldwide appreciated Parma ham and San Daniele ham. These types of productions constitute the majority of Italian pork manufacturing. For example, the production of Parma Ham (which is the largest one) is estimated in 2020 with a production value of EUR 720 million, revenue from consumer sales of EUR 1.500 million, and exports amounting to 29% of the 8.7 million hams produced [3].

According to EU Regulations 1151/2012 [4] and 668/2014 [5] on quality schemes for agricultural products and foodstuffs, in order to be labelled as PDO or PGI these specialities must comply with specific rules throughout the entire production cycle. Taken as a whole, this broad regulatory framework is aimed at obtaining specific high-quality characteristics, which are mainly related to compositional and sensorial attributes of the cured hams.

As an example, Parma ham specifications [6] concern:

- age of pigs (more than 9 months) and body weight at slaughtering (average per batch: 160 ± 10% kg). These requirements imply that males need to be castrated to preserve meat quality;
- genetics: pigs must derive only from specific genotypes included in the production specifications (e.g., Italian Large White, Italian Landrace, Italian Duroc crossbreeds and hybrids deriving from cross-breeding programs with aims consistent with those pursued by the Italian Herd Book for the production of heavy pigs);
- type and quantity of feedstuffs allowed: all the raw materials that can be used in the diets in the different phases of the production cycle and their inclusion levels are explicitly listed. The requirements relating to a minimum age at slaughter and a maximum weight per batch determine the need for moderate weight gains. The animals must therefore receive a rationed feed;
- quality of the raw thighs (the so-called “green hams”) and meat processing techniques (preparation and curing of the thighs, main qualitative parameters of the final product);
- traceability along the whole production cycle (since January 2020, it has been fully computerized);
- age of pigs (more than 9 months) and body weight at slaughtering (average per batch: 160 ± 10% kg), these requirements imply that males need to be castrated to preserve meat quality.

Concerning animal welfare, the specifications do not include any additional provision other than those already in force by the European legislation on the protection of pigs [5] even though these animals may require additional care due to their heavier weight at slaughter and the longer duration of the rearing period. Moreover, according to a recent audit from the EC [7], few data exist about the welfare conditions of Italian pigs and the presence of implementation strategies. On the contrary, data deriving from a study carried out in the Bologna area (north Italy) indicate that the majority of consumers tend to attribute to PDO products a particularly high content in terms of animal welfare [2]. This observation may indicate that consumers expect PDOs to have multiple qualitative traits, including ethical ones.

Additionally, considering that other European and worldwide countries have been increasing pigs’ slaughtering body weight over the past decades to dilute fixed costs [8], the investigation over the welfare level of Italian heavy pigs could be beneficial also under other production contexts.

The sections below summarize the main findings on the welfare of Italian heavy pigs, pointing out also future perspectives and knowledge gaps.

2. Good Feeding

2.1 Absence of Prolonged Hunger

During the entire growing-fattening phase (approximately 6 months), pigs are traditionally liquid-fed twice a day. The liquid feed is obtained by mixing the commercial feed with water or milk whey, usually in a 3:1 water: feed ratio (up to 1:5 ratio when milk whey is used). Studies on lighter pigs show that when the traditional 3:1 water-to-feed ratio is used, the daily allotment of liquid feed is generally considered sufficient to satisfy both the nutritional and the water requirements [9]. According to Hurst et al. [10], liquid feed at 3:1 water-to-feed ratio gave also the best

performances in terms of average daily gain (ADG) and feed conversion ratio (FCR), as compared to pellet feeding, in conventional growing-finishing pigs.

The guidelines of the Parma Ham Consortium require pigs to be slaughter at over 9 months of age and an average body weight (BW) of 160 kg ± 10% per batch. Therefore, feeding Italian heavy pigs has the purpose to obtain mature animals within a specific body weight range, and this implies restricting feed and energy intake in the diet [11]. This last statement can be particularly relevant with some genetic lines that are characterized by high production efficiency. and an increased risk of oesophago-gastric lesions (OGLs) [12]. Oesophago-gastric lesions are severe and common issues in finishing pigs [13] [14]. In heavy pigs, oesophago-gastric ulcers (OGUs) showed a great variation between farms (120), ranging from 0% to 36% of prevalence, with 20% of mild-severe ulcerations, and with some farms being able to manage and avoid them. Reduced OGUs have been correlated with the use of straw [15] and to a reduction of tail lesions [15][16] and associated with positive effects of anthelmintic treatments and stability of the groups [14], demonstrating their importance in the welfare of pigs.

2.2 Absence of Prolonged Thirst

Not many studies have addressed the water requirements of Italian heavy pigs. As stated above, in Italian heavy pig production, liquid feeding is the most common technique in the growing-finishing stage. Liquid feeding was also considered a method of reducing the volume of farm effluents, and since the daily allotment of water provided in this way was considered sufficient, additional drinkers were not always provided. On the contrary, studies evidenced that, if environmental temperatures are moderate (during the winter season) and no illness occurs, liquid-fed pigs (3:1 water: feed ratio) offered supplementary water from the drinkers do not show growth or behavioral parameters changes compared to animals provided with non-working drinkers [17]. Animals, however, accessed the non-working drinkers throughout the trial, indicating that the motivation to obtain additional water may persist even when the theoretical water requirements have been fulfilled by the daily liquid fed ration [17]. Moreover, in another study [18]the demand for additional water by liquid-fed pigs did not differ from dry-fed pigs, suggesting a similar motivation to drink water. It is reasonable to say that with very high temperatures (such as summer temperatures in south Europe) and insufficient environmental control, the presence of additional drinking water can help the animals to cope with the thermal stress, also if more efficient solutions should be adopted (e.g., cooling systems) to avoid wasting water.

3. Good Housing

3.1. Comfort around Resting and Ease of Movement

Floor space availability certainly represents the design criterium that has the greatest impact on freedom of movement and comfort around resting of intensively-reared pigs, consequently influencing their level of welfare and productivity [19][20]. Besides the need for a “personal space”, in order to avoid the constant physical contact with other animals, pigs also require space to rest and to move. Pigs tend to use separate areas for the different activities of resting, feeding, defecating, and urinating. If this division of the pen in different functional areas cannot

be obtained due to the lack of space or to design errors, there is a risk that overlaps will occur between the areas (for example, between the rest area and the defecation area) resulting in a decline in the level of animal welfare. In this case, “dirtiness” (soiled pigs) could be used as a parameter that would reflect the negative effect of lack of space on animal welfare [21]. Another important parameter to consider is represented by the size of the pen: small groups of animals (4–10 pigs) require, in proportion, more space than larger groups [22]. European legislation [23], while providing for a progressive increase in space as the live weight of pigs increases, sets to 1 m^2/head the minimum floor space allowance for pigs over 110 kg body weight (BW) without further requirements for heavier animals, with the only exception for organically reared pigs (minimum indoor area of 1.5 m^2/head for pigs weighing more than 110 kg [24]), that, however, account only for a very limited number on the total volume (less than 1%) [25]. However, according to EFSA recommendations [22], higher coefficients should be used (k = 0.036 for pigs up to 110 kg and k = 0.047 above 110 kg) in order to allow all pigs to lay down separately in lateral recumbency and at the same time.

Another aspect related to good housing and deserving consideration is flooring, since it can affect animal comfort, health, and presence of lesions. In consideration of their high weight at slaughter, the Italian Ministry of Health allows the adoption of fully slatted floors with a maximum width of the openings of 20 mm (2 mm more compared to the EU Directive on pig protection [23]) and a minimum width of the slats of 80 mm [26]. In general, older pigs have been reported to be at higher risk to develop bursitis because their greater body weight exerts additional pressure on the limbs and they spend a greater proportion of time lying [27][28]. Bursitis in heavy pigs was assessed, to the best of the authors’ knowledge, only by Bottacini et al. [27] (observations were made after slaughter by observing only the front limbs, due to technical constraints), finding a maximum batch prevalence of 10%. This prevalence already represents a welfare concern. Moreover, the authors reported that examining only the forelimbs may have underestimated the actual prevalence since bursitis is reported to occur more frequently on the hind legs. Slatted floors have been also associated with an increased prevalence of injuries and lameness in pigs, because they provide the animals with many particular challenges (uneven walking surface, reduced weightbearing surface, lack of bedding, and sharp slat edges) [28]. To our knowledge, no study specifically measured lameness prevalence in Italian heavy pigs on farms, but these parameters should be monitored to assess the effect of flooring characteristics on pigs.

3.2 Light Requirements

Mandatory levels of environmental illumination for pigs are set by the European legislation on pig protection [23]to a minimum of 40 lux for at least 8 h/d.This provision reflects the existence of a need of pigs in terms of light intensity and duration, which must be fulfilled to allow their explorative and social activities [29]. Literature dealing with pig requirements in terms of environmental illuminance is not abundant and, in some cases, contradictory due to a certain degree of confusion between daylight duration, light intensity, and light source (natural/artificial). An artificial photoperiod longer than the minimum set by legislation (i.e., more than 8 h of light-phase per day) resulted in more favorable daily weight gain and feed efficiency [30][31]. On the other hand, growth parameters were not affected by the light intensities tested [32]. A light intensity above the minimum set by legislation resulted in a higher percentage of observations indicating resting behavior (i.e., higher calmness degree) [30][31]. A higher level of light was

associated with a lower number of aggressive interactions between animals [32]. Taken as a whole, these results suggest that, given an appropriate dark period for animal rest of a least 8 h of darkness, increased duration of the photoperiod and/or of light intensity above the minimum mandatory levels can favorably affect growth parameters and welfare level of heavy pigs. Moreover, without detracting from what has just been reported regarding the light requirements of heavy pigs (in terms of both duration and intensity), a recent study by Marinelli et al. [33] showed that under specific situations, such as when new groups of animals need to be formed, a 48-h period of darkness can reduce the severity of skin lesions resulting from fighting.

4. Good Health

4.1 Absence of Injuries

Most studies on heavy pigs were conducted under experimental conditions and/or considered only one farm, therefore there is a lack of epidemiological knowledge on the prevalence and type of injuries across farms. Scollo et al.[34] recorded on-farm the prevalence of lesions from tail biting in 67 farms of heavy pigs. The results showed that, on average, the prevalence of tail lesions was higher in the fattening sites (0.26%) compared to weaning sites (0.09%). The study identified some risk factors for tail lesions, such as tail length, adverse air quality (as perceived by the observer), and timeliness in feed supply, in weaning sites. In the fattening sites, only stocking density was statistically associated with tail lesions. However, the scarcity of studies about on-farm lesions highlights the need for further research on this topic. Assessing skin and tail lesions on the carcasses would be more practical and feasible. The study by Vitali et al. [35], conducted on 79 batches of tail-docked heavy pigs, observed tail lesions on 34.0% of the carcasses, of which only 4.4% were severe lesions (open wounds and/or loss of tissue) [35]. The same authors reported high differences between this result and previous studies on tail lesions in tail-docked Italian heavy pigs [27][36], mainly imputable to different scoring systems and places of observation [37].

4.2 Absence of Disease

The majority of studies on disease prevalence in Italian heavy pigs were conducted using post-mortem assessments. This can be explained, as the monitoring of health at slaughter involves assessments that cannot be performed at the farm, for example, lesions of the pluck (lung, pleura, and liver). The prevalence of gross anatomic lesions can then be linked retrospectively to on-farm conditions, or data can be used for an epidemiologic investigation on health and disease.

Pluck lesions (i.e., enzootic pneumonia-like lesions, pleuritis, pericarditis, and white spots on the liver) have been recorded in some studies on heavy pigs [35][38][39][40][41], with the purpose to assess lesion prevalence and to benchmark and monitor the occurrence of diseases on farms. For example, a recent study monitored pluck lesions and found a 30.2% prevalence of enzootic pneumonia-like lesions, showing a reduction trend compared to previous data retrieved from the literature in the same category of pigs [35][39]. In this study, a reduction in enzootic pneumonia lesions has been associated with PRRS (Porcine Reproductive and Respiratory Syndrome) vaccination, while chronic pleuritis did not show to be influenced by any of the tested farm conditions (i.e., farm

dimension, ventilation system, floor type, farrow-to-finish system; all-in/all-out procedures). Further studies will be necessary to provide a more complete report for the farmers, helping to accurately identify risk factors affecting pig health and welfare.

4.3 Absence of Pain Caused by Management Procedures

According to Directive 120/2008 EC [23], mutilations should be avoided because they cause pain and suffering to the pigs. Some exceptions are allowed, such as castration for animals intended for typical products, or in case alternative procedures are not available. In heavy pig production, two types of mutilation are still practised: castration and tail docking.

In 2010, the European Declaration on alternatives to surgical castration of pigs, recommending the abandonment of surgical castration by 2018, was signed [42]. In consideration of the high age at slaughter and of the need for excellent quality thighs, castration is an unavoidable practice for the production of Italian heavy pigs intended for PDO hams. From a practical standpoint, it is worth noting that, due to the higher age and longer lifespan, Italian heavy pigs need an additional dose of vaccine compared to lighter animals (3 vs. 2 doses) [43]. This results in higher costs and greater operational difficulties due to the administration of the product by injection to animals of high weight.

As for consumers' acceptance of meat from immunocastrated pigs, a recent survey carried out on a representative sample of the Italian population [44] indicated that immunocastration is perceived in a predominantly positive manner (54.5%), with a relatively low level of risk perception (34.2%), and a good willingness to pay more for meat deriving from immunocastrated pigs (+18.7%). These outcomes are confirmed by a further study involving respondents from several European countries, including Italy [45], showing, even though with marked differences among nations, that castration with anesthesia had the highest acceptance (85%), followed by immunocastration (71%) and production of entire males (49%) while the practice of surgical castration was the least accepted (32%), mainly due to animal welfare concerns. These results may indicate that, once all scientific doubts have been resolved, immunocastration could become a common practice also in the production of Italian heavy pigs, with clear benefits in terms of animal welfare.

The other mutilation procedure that is common worldwide and also in heavy pig production is tail docking, which is carried out with the purpose to prevent tail lesions derived by tail biting behavior. However, According to the Directive 120/2008 EC [23], this practice should not be carried out on a routine basis unless other preventive measures proved to be ineffective.

An audit carried out in Italy by the European Commission on the Member States' activities to prevent tail-biting and avoid tail-docking [7] reported that until 2017, tail docking was routinely performed in almost 100% of pig farms, and that no measures for benchmarking tail lesions or risk assessment protocols were used. Moreover, the Ministry recommended that farmers should rear pilot groups of pigs with intact tails, defining progressive goals which have the potential to drive the production towards the abandonment of routine tail docking and the accomplishment of

the European standards [46]. Even if farmers are concerned about the abandonment of tail docking [47], only a few studies have been performed on rearing heavy pigs with intact tails in commercial farms. Di Martino et al. [48] investigated the effect of tail docking in heavy pigs undergoing stressful conditions, highlighting that fattening undocked pigs showed a higher prevalence of moderate tail lesions as compared to tail-docked pigs, and that severe tail lesions and mortality rates did not differ between the two groups, as well as blood physiological indicators. Based on these encouraging results, it is certainly necessary to promote the study of strategies aimed at reducing aggressive behaviors among undocked pigs.

5. Appropriate Behaviour

5.1 Expression of Behaviors: Environmental Enrichment

Heavy pigs, similarly to the majority of pigs raised for food production, are usually kept indoors, in a barren environment that does not meet their need to express species-specific behaviors (such as rooting) and does not fulfil their intrinsic motivations. Because of that, the permanent provision of manipulable materials is explicitly listed among the requirements set out in the EU Directive on the protection of pigs [23]. In addition, the Commission Recommendation 2016/336 [49] states that enrichments should be edible, chewable, investigable, manipulable, of sustainable interest, accessible, given in sufficient quantity, and clean. Materials possessing all these characteristics are defined as ‘optimal materials’ and can be used alone, whereas ‘suboptimal materials’ (i.e., materials possessing most of the characteristics listed, but not all) should be used in combination with other materials. On the basis of the above-mentioned characteristics, straw litter can be considered as a very effective (optimal) enrichment, able to increase satiety and avoid tail biting outbreaks [50][51]. However, since most heavy pigs are kept on totally/partially slatted floors, straw use can interfere with slurry-removal systems, thus different enrichment tools have been used, and the preferred by mostly Italian farmers are hanging chains [52]. According to Scollo et al. [53], long straw available at all times in a metal rack attached to the wall increased the motivation for exploring, reduced serum haptoglobin and tail lesions in undocked heavy pigs. Therefore, straw seems to be an important tool in both increasing explorative behavior and preventing biting and lesions, particularly in the early stage of the growing-fattening phase (weeks 3 to 18 over a 30-week fattening period starting at approximately 80 d of age). Moreover, the consumption of small amounts of straw (70 g/day/pig) represents a protective factor against the onset of oesophago-gastric ulcers in undocked heavy pigs [54].

Concerning undocked heavy pigs reared on fully slatted floor, Nannoni et al. [55]compared the effect of edible blocks (100 × 30 × 10 cm; optimal enrichment material) and wood logs (suboptimal enrichment material) placed into metallic racks. In both cases, hanging chains served as control. No differences were observed in growth parameters, hair cortisol concentration, neutrophil/lymphocyte ratio, bristle cortisol, and skin lesions at the end of the trial and gastric lesions [16][56]. Edible blocks were more attractive than hanging chains which, in turn, were more attractive than wood logs. Small, although significant, differences were noted for the quality of the carcasses which, however, did not result to have a commercial impact. The basic similarity of the results from animals receiving different enrichments in this study could indicate that

under appropriate rearing conditions (small and stable groups, higher space allowance, good human-animal relationship), a good level of animal welfare can be achieved.

5.2 Positive Emotional States and Good Human-Animal Relationship

Promoting positive welfare is attracting considerable research interest, because it considers the emotions of the animals, or rather their behavioral, neurophysiological, and cognitive components [57] [58]. In intensive livestock production, many welfare problems can originate from inadequate stockmanship [59]. Accordingly, the human-animal relationship has been considered a pivotal issue in pig production [60].

To the best of the authors' knowledge, no studies have investigated the emotional state and the human-animal relationship in Italian heavy pigs. Therefore, this information is still largely unknown in this type of production. Assessing affective states using valid tools such as qualitative behavior assessment (QBA) or fear tests might provide meaningful information on the pig herd, and be helpful in the identification of welfare issues, also considered the previously described welfare challenges that these animals may face.

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