

EFFECT OF TWO DIFFERENT FLOOR SPACE ALLOCATIONS ON THE CARCASS CHARACTERISTICS IN LARGE WHITE YORKSHIRE GROWING PIGS

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ABSTRACT

The present study was conducted to find out the effect of floor space allocations on the carcass and meat quality of growing pigs. Twenty Large White Yorkshire piglets with 3-4 months age and average body wt of 18 kg were selected from the pig farm for this study. The piglets were uniformly divided into two groups i.e. To group (Open area along with covered area or Control group) as per IS recommended floor space of 1.8 square meter per piglet (0.9 covered and open area each) and Tc group (Covered area only) of 0.9 square meter per piglet. At the age of 24 weeks, three barrows were slaughtered from each group to study carcass characteristics and pork quality parameters. The results revealed that major carcass traits i.e. fasting body weight, carcass weight with and without head and major cut up parts i.e. Boston butt, picnic shoulder, ham, loin, belly and jowl did not differ significantly between To and Tc group. However, the back fat thickness, loin eye area, lean meat yields in To group was significantly ($p < 0.05$) higher than Tc group but no difference was observed in pork pH and nutrient composition. So, it was concluded that IS (3916-1966) recommended open area for pig housing did not improve quantitative and qualitative pork production, hence may be removed to increase resource use efficiency of pork production.

Keywords: Indian standards, pig housing, open area, carcass characters and pork quality

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INTRODUCTION

India is a tropical country that experiences hot weather conditions over large parts of the country, particularly in the plain and coastal regions. Rearing pigs under such climatic conditions is challenging because pigs are highly susceptible to heat

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stress. Elevated ambient temperature, particularly when accompanied by high relative humidity, adversely affects feed intake, growth performance, and overall productivity of pigs (Collin *et al.*, 2001).

In intensive production system, available floor space and type, greatly determines housing microenvironment of pigs. This housing microenvironment significantly affects behavioural response (Vermeer *et al.* 2014) and physio biochemical process of animals (Oh *et al.* 2017), ultimately affecting welfare, growth performance, carcass yield and quality (Lehotayova *et al.* 2012; Pearce *et al.* 2013). Hence, efficient space utilization, without affecting quality pork yield, is very critical for profitable pork production.

Indian standards -3916 (1966) of pig housing recommend 0.9- 1.8 square meter covered as well as open area from weaner to finisher stage. Whereas, in leading pig producing countries, pigs are reared on less space without provision of open area (Cho and Kim, 2011). Therefore, allocation of open area for pigs, in tropical Indian conditions with much higher daily mean temperature of 25°C (Sirohi and Michaelowa, 2007), may have beneficial effect to mitigate heat stress through open sky cooling during sunset hours of the day. Earlier, Kaswan *et al.* (2015) successfully reduced of IS -3916 (1966) recommended covered floor space allowance up to 50% for fatterer pigs without affecting final body weight and major carcass characteristics and better resource use efficiency (Pal *et al.*, 2024). However, no study has been

conducted to assess the impact of removal of IS recommended open area for pig housing, therefore, keeping in mind, present study was conducted to investigate that effect of reducing IS-3916 (1966) floor space through removal of open area on carcass yield and pork quality during summer season.

MATERIALS AND METHODS

Location and Ethical Permission

The study was conducted after ethical permission from CPCSEA, New Delhi vide memo no. 25/23/2019, CPCSEA, dated 09.12.2019, during summer season between April to June, 2020 at the Pig Farm (latitude 130.90°N and longitude 75.80°E, ht. from MSL) of Department of Livestock Production Management, Guru Angad Dev Veterinary and Animal Science University, Ludhiana-1411004, Punjab (India).

Housing and Management of Experimental Pigs

The experimental piglets were housed in open type shed with concrete floor and 3-meter-high flat type reinforced concrete (RCC) roof. The shed had pens with partition wall of brick with mortar up to a height of 0.64 meter and above installed with two horizontal GI railings at vertical distance of 0.30 meter. Each pen had two linear GI feeders and two automatic drinking bowls for round the clock drinking water availability. The experiment involves a total of total of 20 piglets of 3 months of age with average initial body weight of 18.94 ± 1.04 Kg.

Feeding and Watering of experimental pigs

All experimental animals belonging to the different treatment groups were provided with the same basal experimental diets formulated in accordance with the recommendations. Three different experimental rations were provided according to the age and nutritional requirements of the pigs. The diets contained 19% crude protein (CP) and 3,099 kcal/kg metabolizable energy (ME) during 3–4 months of age, 19% CP and 3,102 kcal/kg ME during 4–5 months of age, and 17% CP and 2,731 kcal/kg ME during 5–6 months of age were provided. A weighed quantity of feed was offered two to three times daily. The quantity and frequency of feeding were adjusted throughout the experimental period to ensure continuous availability of feed in the feeders and facilitate ad libitum feeding.

To determine daily feed intake, the quantity of feed remaining in each feeder was weighed every morning before the fresh feed was offered. Daily feed intake was calculated from the difference between the quantity of feed offered and the corresponding quantity of feed refused. To ensure continuous availability of fresh drinking water, each experimental pen was equipped with two bowl drinkers. The water supply line connected to the bowl drinkers was fitted with a water meter to monitor and record the daily water consumption of pigs in each treatment group.

Experimental Design

Twenty Large White Yorkshire piglets with 3–4 months age and average initial body of 18 kg were selected from the pig farm of Department of Livestock Production Management, College of Veterinary Science, GADVASU, Ludhiana for this study. All the selected piglets were vaccinated and healthy. The piglets were uniformly divided into two groups i.e. To group (Open area along with covered area or Control group) as per IS recommended floor space of 1.8 square meter per piglet (0.9 covered and open area each) and Tc group (Covered area only) of 0.9 square meter per piglet.

Recording of Parameters

Measurement of carcass characteristics

For the study of carcass characters and meat quality parameters, three barrows, considered each as a replicate, with maximum, minimum, and mean body weight from each group were selected at the age of 24 weeks. The pigs were slaughter and carcass traits were recorded with help of technical expertise and logistic support of Department of Livestock Products Technology, GADVASU, Ludhiana. All the barrows were off fed around 12 hours before sacrificing with free access to water and pre-slaughter live weight or fasting weight was recorded immediately prior to sacrifice using electronic weighing balance. The barrows were sacrificed following standard procedure after proper stunning at 70 V, 250 mA by electricity. Briefly, bleeding by

heart puncturing with knife followed by wet scalding by hot water at 65°C for 5 to 6 min, scrapping and removal of hairs, singeing by blow lamp, evisceration and removal of gastrointestinal tract (GIT). The head was severed by a vertical cut immediately behind the base of ears through the atlas joint and then slightly forwarded following the natural line of the first fold of the cheek. Evisceration was done by making an incision along the medial line on the ventral side followed by pulling and removal of visceral organs.

Dressing percentage was calculated by dividing the hot carcass weight with live weight and then multiplied by 100. Carcass length was measured as a straight line as possible from the cranial (anterior) tip of the aitch bone to the cranial edge of the first rib and next to the vertebra. BFT (Back fat thickness) in all the live experimental animals were recorded using pulse ultrasound scanner (Renco Lean-meter series -302, S/N: 45000) at the end of experiment at the 6 months of age. Skin was saturated with light oil (cooking or mineral oil) and good contact between skin and probe was made. Readings were taken at 3 points i.e. first rib, last rib and last lumbar vertebrae at 2.5 inch off the mid line. Readings were obtained in mm. Average of these 3 readings was used as BFT (mm) value for the animal. LEA (Loin eye area) was determined by tracing the cut section of longissimus dorsi (LD) muscle between 10th and 11th ribs on butter paper. Estimated lean percentage of carcass was determined using equation of Burson (2001) as follows:

$$\text{Lean \%} = 8.588 + (0.465 \times \text{hot carcass wt.}) - (21.896 \times 10\text{th rib fat depth}) + (3.005 \times 10\text{th rib loin muscle area})$$

Each half of the carcass was divided into 5 major wholesale cuts i.e. boston butt, picnic shoulder, loin, belly and ham in addition to a minor cut i.e. jowl, weight of trimmed cut of parts were measured using standard weighing balance and represented as percentage of total dressed carcass weight. Weights of different edible and inedible offal were also recorded.

Pork quality parameters:

Samples of longissimus muscle were taken from the carcass after dissection, sealed in polythene bags and stored at -20 °C for further analysis. Meat samples were dried at 70°C in a hot air oven till a constant weight; ground manually in pestle and mortar and analyzed for dry matter, fat, protein and total ash contents of dissected longissimus muscles as per the procedures of AOAC (2007).

Statistical Analysis: The data were analyzed with SPSS 20 statistical software. The data were subjected for independent two tail t-test for variance in various parameters due to housing treatments and means for statistical significance were compared at 5% level using Tukey's pair wise comparison.

RESULTS AND DISCUSSION

The results and discussions are presented under the following subhead.

Carcass Parameters

The results of carcass characteristics presented in Table 1 revealed that eviscerated carcass weight with and without head and carcass length did not differ significantly in To and Tc. This can be attributed to no significant difference in growth performance of pigs with reduction of floor space through removal of provision of open area (Kanwarpal *et al.* 2023) as indicated by similar fasting body weight of pigs in both the groups.

Among various cut up parts, major cuts viz. boston butt, picnic shoulder, ham, loin and belly did not vary between To and Tc, however only minor cut up part jowl was significantly ($p \leq 0.05$) higher in To than Tc. Similar to these findings, Kaswan *et al.* (2015) also did not find any reduction in yield of prime cuts with 50 % reduction of IS recommended covered floor space area of 0.9, 1.35 and 1.8 square meter during weaner, grower and finisher stages, respectively. However, Thomas *et al.* (2017) reported a linear decrease in hot carcass weight ($P < 0.001$) with reduction in floor space allocation only beyond 0.84 m² per finisher pig.

The results of offal presented in Table 2 indicated that, among various edible offal, except trotter ($p < 0.01$), all others viz. head, liver, heart, kidney, GIT and tail weight did not vary significantly between Tc and To housing groups. As size of vital visceral organs liver, heart, kidney, GIT is proportionate to body size of pigs, so no difference in edible offal might be due to

similar growth performance of pigs in both the treatment groups.

Among various inedible offal, the mean value of blood, lungs, spleen, trachea, gall bladder and leaf fat production were similar but mean value of total inedible offal in To group was significantly ($p < 0.01$) higher than Tc group. The higher mean values of trotter and total inedible offal in control (To) group may be due to cumulative effect of numerical higher value of different individual offal in To group than Tc.

Meat Quality Parameters

The results of meat quality parameters of growing pigs under two different space allocations are presented in Table 3. Initial pH is an important indicator of meat quality, determines rate of protein denaturation, possibility of PSE (pale, soft, and exudative) conditions of meat and ultimately drip loss and low water holding capacity (Maganhini *et al.* 2007, Vermeulen *et al.* 2015). The data on meat quality parameters presented in Table 3, indicates that mean pH in To and Tc groups (5.54 and 5.72) did not differ significantly and was slightly acidic within typical range of 5.4-5.8 as reported by Digler (2021).

Back fat thickness is an undesirable character affecting functional properties, indicated by decreased polyunsaturated fatty acids and increased intramuscular fat, SFAs, MUFAs and cholesterol (Jacyno *et al.* 2015, Kim *et al.* 2017).

(Important data may be written

here) Back fat thickness (BFT) in To group was significantly ($p < 0.005$) higher than Tc. Similar to these findings, Rossi *et al* (2008) also reported significant ($p < 0.05$) reduction in BFT with reduction of floor space allowance from 1.4 to 1.0 m² per pigs with corresponding k value of 0.047 to 0.033 floor space. However, Kaswan *et al.* (2015) reported no effect on BFT even at lowest floor space of 0.45 to 0.9 m²/pig from 9 to 80 kg BW with k value of 0.102 to 0.049. In present study, minimum k-value 0.061 for Tc and 0.116 for To, recorded with highest body weight at the end of experiment, were much higher than critical k value 0.034 affecting growth performance of pigs (Gonyou *et al.*, 2006, Averós *et al.* 2010). Moreover, removal of open area for pigs did not affect fat depth at 10th ribs.

The loin eye area (LEA) ($p < 0.001$) and estimated lean meat percent (LMP) ($p < 0.02$) were significantly higher in To (control). Lean carcass production has been reported in crowded conditions (Brumm, *et al.* 2001) as well as in outdoor houses with more space (Bremermann, 2001). Contrary to present findings, Patton *et al.* (2008), in indoor housing system, reported significant ($p < 0.05$) reduction in loin eye area with increasing space allocation from 0.70 m² of 1.13 m² per pig, while, Kaswan, *et al.* (2015) did not find any significant effect on LEA and estimated LMP of pigs with reduction of IS recommended covered floor area from 1.8 to 0.9 m² per pig. In addition to floor space, heat stress also, negatively affects loin eye area and lean meat production (Rani *et al.* 2018). So, in present study, instead of

space, higher LEA and LMP in To than Tc might be due to better thermal comfort.

The nutrient composition of meat (on fresh and dry matter basis) as indicated by protein, fat and mineral contents (total ash) of longissimus dorsi muscle, also did not vary significantly between two housing treatments. Similarly, Leek *et al* (2004) and Kaswan *et al* (2015) also did not report any deterioration in nutrient composition of meat with reduction of floor space for finisher pigs up to 0.53 and 0.9 m², respectively.

Not only total available floor space but its type also determines flexibility of pigs to move to relatively comfortable microenvironment in pig housing during heat stress conditions. Prolong housing conditions modify behavioral response (Vermeer *et al.* 2014) of pigs and activate a chain of physiological and biochemical reactions (Fernandez *et al.* 2015, Oh *et al.* 2017), ultimately affecting pigs' metabolism, culminating in poor carcass yield and quality (Lehotayova *et al.* 2012, Pearce *et al.* 2013).

In present study, even at 50 % reduction of floor space through complete removal of IS (3916-1966) recommended open area space use coefficient (k) value was much higher than most of other advanced countries and had no adverse effect on carcass yield, major cuts and nutrient composition of pork.

So, considering gradual increasing cost of land and labor input in prevailing highly competitive situations, these

preliminary finding suggests possible revision of Indian standards for pig housing need to be revised without affecting pork

yield and meat quality for improving resource use efficiency and economic return in intensive pig production.

Table.1. Carcass characteristics (absolute weight) of growing pigs under two different space allocations

Parameters	TC	TO	P Value
Major Carcass Traits			
Fasting weight(Kg)	63.07±3.06	68.70±4.50	0.36
Carcass wt. After Bleeding (Kg)	61.13±3.21	65.90±4.62	0.44
Carcass wt. (without head) (Kg)	39.42±2.68	47.29±4.00	0.18
Carcass wt. (withhead) (Kg)	43.61±2.84	51.88±4.04	0.17
Carcass length(cm)	71.03±2.14	70.70±0.80	0.89
Cutup parts			
Total Boston butt (Kg)	4.86±0.41	4.07±0.46	0.27
Total Picnic shoulder (Kg)	5.13±0.52	6.08±0.64	0.31
Total ham (Kg)	12.26±0.75	13.04±0.43	0.42
Total Loin (Kg)	12.56±0.64	16.22±1.90	0.14
Total belly (Kg)	4.14±0.39	6.68±1.10	0.10
Total Jowl (Kg)	0.47±0.06	1.19±0.01	0.01*

Means within same row for any parameter with p value<0.05 differ significantly at 5% level.

Table.2. Edible and inedible offal of pigs under two different space allocations

Parameters	TC	TO	P Value
Edible Offal			
Head(kg)	4.19±0.29	4.59±0.08	0.25
Trotter(kg)	0.90±0.06	1.33±0.05	0.01*
Liver(kg)	1.33±0.06	1.25±0.08	0.47
Heart(kg)	0.20±0.01	0.22±0.01	0.21
Kidney(kg)	0.20±0.01	0.22±0.01	0.41
GIT full(kg)	4.40±0.28	3.94±0.42	0.42
Tail(kg)	0.10±0.00	0.12±0.01	0.14
Total(kg)	11.32±0.30	11.67±0.29	0.45
Inedible Offal			
Blood(kg)	1.93±0.17	2.80±0.31	0.07
Lungs(kg)	0.50±0.01	0.46±0.07	0.56

Spleen(kg)	0.10±0.01	0.10±0.01	0.68
Trachea(kg)	0.16±0.02	0.26±0.04	0.09
GallBladder(kg)	0.06±0.01	0.04±0.01	0.20
LeafFat(kg)	1.08±0.17	1.18±0.25	0.75
Total(kg)	3.83±0.06	4.84±0.15	0.00*

Means within same row for any parameter with p value<0.05 differ significantly at 5% level.

Table.3. Meat quality parameters of growing pigs under two different space allocations

Parameters	TC	TO	P Value
pH (Fresh meat)	5.54±0.08	5.72±0.03	0.12
Back fat thickness(mm)	16.58±1.13	19.96±0.93	0.05*
Fat depth(10thrib) (mm)	17.00±1.00	23.33±2.91	0.11
Loin Eye Area(cm ²)	19.33±1.33	38.00±0.58	0.01*
Estimated lean meat	43.35±2.19	54.66±1.61	0.02*
On fresh meat basis			
CP(%)	20.27±0.32	21.05±0.63	0.30
Fat(%)Fresh meat	5.31±0.63	5.76±0.33	0.54
Ash(%)Fresh meat	1.01±0.03	0.98±0.05	0.55
On dry meat basis			
Crude protein (%DM)	69.25±1.94	68.43±0.45	0.70
Fat(%DM)	17.93±1.79	18.70±0.78	0.70
Ash(%DM)	3.46±0.13	3.17±0.10	0.11
Dry Matter(%)	29.33±0.60	30.75±0.83	0.20
Moisture(%)	70.67±0.56	69.25±0.33	0.05*

Means within same row for any parameter with p value<0.05 differ significantly at 5% level.

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