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Carcass composition and meat quality parameters of Ghungroo pigs

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ABSTRACT

The study was part of a programme to improve pig production in India and the information on carcass composition and meat quality is very much essential towards the development of a suitable breeding plan for this pig breed. Gilts (16) and barrows (26) from Ghungroo breed were slaughtered at the age of 10 months for evaluating the different parameters. Complete dissection of carcass indicated a meat:bone ratio of 2.54 and fat:lean ratio of 0.29 for this breed. The carcass length ranged from 65.5 – 77 cm, while that of the loin eye area varied from 2.4 – 4.3 in^2. Back fat thickness at three-quarters of the length of the transverse section of the exposed *M. longissimus thoracis et lumborum* between the 10th and 11th ribs was in the range of 2.3 - 3.85 cm. Moisture:protein ratio varied from 3.17 to 3.65 with an average of 3.45 and no significant difference was observed between gilts and barrows. The objective of the present study was to investigate the detailed carcass and meat quality parameters of Ghungroo pigs.

Key words: Back fat thickness, Carcass composition, Ghungroo, Indigenous pig, Loin eye area

The breeding tracts of Ghungroo, the first registered pig breed of indigenous origin in India (accession number - INDIA_PIG_2100_GHUNGROO_09001; National Bureau of Animal Genetic Resources, http: //www.nbagr.res.in/nbagr.html), include West Bengal, Asom and Sikkim in India. The Ghungroo is medium size pig with large drooping ears and colour predominantly black with scanty hairs and bristles. The breed has a typical bulldog type head with folded skin at face and neck. Ghungroo has not only the highest litter size at birth among the indigenous pig breeds of India but also has the good mothering ability. It has got a long barrel in comparison to other indigenous pig breeds and its physical conformation indicates the potential for its use in the commercial pig production in the country. The production and reproduction traits of Ghungroo breed were studied in detail at the centre and the different traits are well documented (Banik *et al.* 2012, Naskar *et al.* 2014, Barman *et al.* 2015, Gokuldas *et al.* 2015). The objective of the present study was to investigate the detailed carcass and meat quality parameters of Ghungroo pigs. The present study reports yields of carcass, by-products, primal and sub-primal cuts; selected meat quality parameters, proximate composition and cholesterol content in pork. The information is very much important towards the development of a suitable breeding plan for this pig breed, which is crucial for the development of the pig production sector in India.

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MATERIALS AND METHODS

The experiment was conducted with 42 Ghungroo pigs (16 gilts and 26 barrows) reared at the research farm of the institute. The pigs were taken for slaughter at their pre-determined slaughter age of 10 months, as per the institute's slaughter policy for the indigenous breeds. Pigs were slaughtered in the R&D Pork Processing Plant of the institute. Pigs were electrically stunned (head-only) by low voltage current, shackled on the left leg and exsanguinated in the vertical position on the over head rail. Thereafter, the pigs were scalded at 65°C, followed by hair removal on an automatic dehairing machine. Following slaughter, carcasses were scraped, washed, split, eviscerated and chilled according to standard commercial practices. After chilling for 18 h at 2±1°C, the carcasses were again weighed to assess the chilled carcass weight. The left side of each carcass was ribbed between 10th and 11th rib position prior to fabrication. Loin eye area and fat depth measurements (three-quarters of the length of the transverse section of the exposed *M. longissimus thoracis et lumborum*) were taken between the 10th and 11th rib. Carcass measurements were taken by the same individual throughout the trial. The carcasses were fabricated into trimmed standard pork cuts, viz. ham, loin, belly, spare ribs, picnic shoulder, butt and jowl. Each standard cut was further weighted and dissected into soft tissues (muscle, fat and trimmings) and inedible parts (skin and bone). A block of loin between ribs 8 and 11 was taken from the left side of each carcass, samples were identified and frozen at –20±1°C until analysis of other parameters. Before being measured, samples were thawed at room temperature overnight.

pH_{45} and pHu were measured at 45 min and 48 hr post-mortem in the *M. longissimus thoracis et lumborum* between 13th and 14th rib on the intact carcasses. Chops from the lumbar region of the loin were used for assessment of the following traits: marbling score using a 10 point scale (1: devoid to practically devoid and 10:abundant), lean firmness score using a 6 point scale (1:very soft and 6: very firm) and, belly leanness score on a 7 point scale (1: only fat/no visible lean and 7:only lean) (National Pork Producers Council 1991). The moisture, crude protein (N × 6.25), fat, ash and crude fibre contents were determined by the AOAC approved methods 925.10, 920.87, 920.85, 923.03 and 963.09, respectively (AOAC 2005). Water holding capacity (WHC) was determined at 24 h post mortem by the filter paper method (scoring and weighing, Kauffman *et al.* 1986). Drip loss of samples, taken approximately 30 h post mortem was measured according to the bag-method (Honikel 1998). Emulsifying capacity was determined at 24 h postmortem as per Swift *et al.* (1961), with minor modifications and expressed as the amount of oil (ml) emulsified by 1 g protein. Sarcomere length and muscle fibre diameter were determined on fresh *M. longissimus thoracis et lumborum* at 45 min post mortem as per Jermiah and Martin (1977) with minor modifications.

Cholesterol was extracted using the method of Maraschiello *et al.* (1996) and then quantified by HPLC. The colour of meat was measured at the 8th and 9th thoracic vertebra at 24 h post mortem using the Easy Match software of Hunter Lab with a 30 mm aperture set for illumination D 65/10° standard observer angle, after exposing the surface to the air for 30 min at 4°C. Five cm long cylindrical pieces (1 ×1 cm^2 cross section) were cut parallel to the direction of the muscle fibres 24 h post mortem, and subsequently sheared perpendicular to the muscle fibre direction with a 3 mm thick Warner-Bratzler shear blade attached to a TA-XT-2 Texture Analyser equipped with a 500 kg load cell and a crosshead speed of 2 mm/sec.

The experiments were replicated a minimum of 3 times and the data collected for different carcass and meat quality parameters were subjected to statistical analysis using SPSS, version 14.0. The data were subjected to least significant difference (Snedecor and Cochran 1995) for comparing the means to find the effects between the groups and their interaction for various parameters. The smallest difference (D5%) for 2 means to be significantly different ($P<0.05$). Mean, standard error of mean (SEM), t-values, minimum (Min) and maximum (Max) values are reported.

RESULTS AND DISCUSSION

At 10 months of age, live weight of the Ghungroo pigs was in the range of 73 - 91.5 kg, and the barrows had significantly ($P<0.01$) higher weight than the gilts. The yields of carcass components and different by-products are mentioned in Table 1. Hot carcass weight ranged from 52.5 - 66.25 kg with an average of 60.65 kg, while the chilled carcass weight ranged from 51.3 - 64.7 kg. Similarly, the dressing percentage varied from 70.4% - 74.6% with an average of 72.5%. Yield of removable blood at the time of

Table 1. Yield of carcass components and by-products from Ghungroo pigs

Parameter	Gilts (n_1) (mean ±SEM)	Barrows (n_2) (mean ±SEM)	t-value	Combined (n_3) (mean ±SEM)	Min.	Max.
Live weight (kg)	79.84 ±1.08	85.60 ±1.68	37.83**	84.00 ±1.51	73.00	91.50
Hot carcass weight (kg)	58.37±0.96	62.19±1.03	22.77**	60.65±0.16	52.50	66.25
Chilled carcass weight (kg)	56.48±0.82	61.93±0.87	34.33**	59.90±1.02	51.30	64.70
Dressing percentage (%)	72.08±0.37	72.79±0.10	2.91	72.50±0.19	70.40	74.60
Head (kg)	5.40±0.44	5.81±0.50	8.90	5.70±0.59	5.10	6.20
Feet (kg)	2.27±0.39	2.48±0.43	4.16	2.40±0.46	2.10	2.70
Heart (kg)	0.15±0.13	0.15±0.14	1.00	0.15±0.14	0.12	0.17
Liver (kg)	0.97±0.37	1.01±0.38	2.00	1.00±0.40	0.80	1.30
Kidney (kg)	0.20±0.10	0.20±0.14	0.00	0.20±0.14	0.16	0.23
Spleen (kg)	0.10±0.14	0.10±0.10	0.49	0.10±0.14	0.09	0.14
Lungs (kg)	0.51±0.23	0.50±0.25	0.37	0.50±0.28	0.41	0.65
Leaf fat (kg)	1.58±0.52	1.47±0.40	9.52	1.50±0.42	1.10	1.70
Removable blood (kg)	2.79±0.77	2.92±0.71	3.99	2.90±0.73	2.60	4.10
Tail (kg)	0.15±0.10	0.15±0.10	0.00	0.15±0.10	0.13	0.16
Stomach-with contents (kg)	2.47±0.48	2.41±0.50	3.57	2.43±0.51	2.10	2.90
Stomach-without contents (kg)	0.46±0.24	0.43±0.21	3.41	0.45±0.26	0.39	0.57
Small intestine-with contents (kg)	1.15±0.37	1.09±0.39	8.00	1.10±0.40	0.95	1.45
Small intestine-without contents (kg)	0.72±0.29	0.69±0.30	3.78	0.70±0.30	0.55	0.85
Large intestine-with contents (kg)	2.15±0.45	2.07±0.38	9.96	2.10±0.43	1.90	2.50
Large intestine-without contents (kg)	1.13±0.43	1.08±0.36	4.72	1.10±0.40	0.85	1.35
Length of small intestine (m)	18.15±0.73	17.95±1.02	8.13	18.10±0.89	16.80	19.40
Length of large intestine (m)	4.30±0.47	4.22±0.51	3.78	4.25±0.53	3.80	4.70

**P<0.01; n_1, 16; n_2, 26; n_3, 42.

sticking ranged from 2.6 - 4.1 kg. The yield of leaf fat was in the range of 1.1 - 1.7 kg. Also, no significant (P>0.05) difference was found for any of the observed parameters among gilts and barrows, except for hot and chilled carcass weights (Table 1).

The yield of standard pork cuts and their dissection details are mentioned in Table 2. Yield of different cuts, viz. ham, loin, spare ribs, bacon, shoulder, butt and jowl

Table 2. Yield of standard pork cuts from Ghungroo pigs and their dissection details

Parameter	Gilts (n_1) (mean ±SEM)	Barrows (n_2) (mean ±SEM)	t-value	Combined (n_3) (mean ±SEM)	Min.	Max.
Yield of standard pork cuts						
Ham (kg)	15.49±0.11	16.64±0.13	11.30*	16.35±0.13	15.50	18.10
Loin (kg)	14.12±0.09	14.76±0.11	4.06	14.54±0.10	12.90	15.20
Spare ribs (kg)	5.10±0.05	5.17±0.06	1.14	5.12±0.06	4.30	5.60
Bacon (kg)	3.77±0.05	3.69±0.05	8.00	3.73±0.05	3.20	4.10
Picnic shoulder (kg)	10.11±0.07	10.32±0.10	6.20	10.25±0.09	8.90	10.80
Boston butt (kg)	8.21±0.07	8.37±0.05	23.20*	8.30±0.06	7.30	8.60
Jowl (kg)	1.64±0.03	1.61±0.03	1.76	1.63±0.03	1.10	1.90
Percentage of ham in the carcass (%)	27.15±0.10	27.36±0.06	21.00*	27.28±0.07	26.80	28.20
Weight of four primal cuts (kg)	48.19±0.53	50.18±0.47	24.41*	49.44±0.52	43.40	56.30
Percentage of four primal cuts to carcass weight (%)	82.12±0.41	82.93±0.44	21.13*	82.51±0.43	76.30	85.10
Yield of individual components from entire carcass						
Lean meat (kg)	26.89±0.30	27.93±0.26	41.50**	27.61±0.29	23.15	30.20
Separable fat (kg)	7.80±0.08	8.61±0.07	48.50**	8.11±0.08	6.25	10.10
Bone (kg)	10.12±0.10	10.98±0.13	23.00*	10.84±0.11	8.75	11.30
Skin (kg)	11.69±0.15	11.45±0.18	8.00	11.51±0.16	9.80	15.65
Trimmings and fascia (kg)	1.73±0.03	1.70±0.04	7.00	1.72±0.04	1.25	2.55
Meat:Bone ratio	2.53±0.01	2.56±0.01	4.16	2.54±0.01	2.31	2.63
Fat:Lean ratio	0.32±0.02	0.28±0.02	5.37	0.29±0.02	0.24	0.33

**P<0.01, *P<0.05; n_1, 16; n_2, 26; n_3, 42.

Table 3. Selected carcass and meat quality parameters of Ghungroo pigs

Parameter	Gilts (n_1) (mean ±SEM)	Barrows (n_2) (mean ±SEM)	t-value	Combined (n_3) (mean ±SEM)	Min.	Max.
Carcass length (cm)	72.55±0.48	73.16±0.56	17.09*	73.0±0.51	65.50	77.0
Loin eye area (in^2)	3.46±0.05	3.51±0.09	6.05	3.50±0.09	2.40	4.30
Number of ribs	14.0±0.00	14.0±0.00	0.00	14.0±0.00	14.0	14.0
Back fat thickness (BFT) at 10^{th} rib (cm)	2.69±0.06	2.72±0.09	5.50	2.70±0.07	2.30	3.85
Av. BFT at three points (cm)	2.38±0.06	2.42±0.07	4.00	2.40±0.07	2.10	3.70
Carcass muscling score (1-3 scale)	2.49±0.08	2.21±0.08	17.12*	2.40±0.08	2.00	3.00
Lean colour (1-6 scale)	3.41±0.12	3.64±0.11	20.79*	3.46±0.12	2.00	5.00
Lean firmness (1-6 scale)	3.34±0.10	3.37±0.15	9.80	3.36±0.13	2.00	4.00
Marbling (1-10 scale)	3.05±0.12	3.25±0.12	0.94	3.11±0.12	2.00	4.00
Belly leanness (1-7, 1=only fat, 7= only meat)	2.70±0.15	2.79±0.11	1.12	2.74±0.13	1.00	4.00
pH_{45}	6.61±0.01	6.62±0.01	5.00	6.62±0.01	6.49	6.89
pHu	5.78±0.01	5.77±0.01	5.00	5.78±0.01	5.58	5.91
Drip loss (%)	1.78±0.03	1.75±0.04	0.76	1.76±0.03	1.42	2.08
Water holding capacity (%)	74.81±0.19	73.15±0.17	5.68	74.50±0.19	68.20	87.4
Emulsifying capacity (ml of oil/g of protein)	122.0±1.89	118.3±1.48	24.09*	119.0±1.56	102.5	144.5
Sarcomere length (μ)	2.25±0.02	2.26±0.03	1.28	2.26±0.02	2.00	2.40
Muscle fibre diameter (μ)	12.60±0.14	12.67±0.17	8.00	12.65±0.17	9.00	13.50
WB shear force (N)	54.76±0.89	51.85±0.73	0.98	52.27±0.75	42.18	58.70
Work of shear (Ns)	283.58±3.88	280.43±3.19	134.00**	281.69±3.72	227.74	315.22

**P<0.01, *P<0.05; n_1, 16; n_2, 26; n_3, 42.

Table 4. Proximate composition and cholesterol contents of *M. longissimus thoracis et lumborum* of Ghungroo pigs

Parameter	Gilts (n_1) (mean ±SEM)	Barrows (n_2) (mean ±SEM)	t-value	Combined (n_3) (mean ±SEM)	Min.	Max.
Proximate composition						
Moisture (%)	73.83±0.19	73.16±0.14	21.71*	73.21±0.17	71.93	75.91
Dry matter (%)	26.57±0.15	26.85±0.18	2.82	26.79±0.16	24.09	28.07
Crude protein (%)	21.37±0.14	21.25±0.13	6.20	21.28±0.14	20.42	23.86
Crude fat (%)	3.13±0.17	3.29±0.19	18.16*	3.16±0.19	1.98	4.85
Crude fibre (%)	1.21±0.13	1.20±0.16	1.25	1.21±0.15	0.86	1.33
Total ash (%)	0.85±0.03	0.82±0.04	3.50	0.84±0.03	0.71	1.38
Moisture:Protein ratio	3.45±0.02	3.44±0.03	1.38	3.45±0.02	3.17	3.65
Cholesterol (mg/100g)	59.17±0.76	60.38±0.88	62.00**	59.84±0.82	42.22	71.06

**P<0.01, *P<0.05; n_1, 16; n_2, 26; n_3, 42.

were in the range of 15.5-18.1 kg; 12.9-15.2 kg; 4.3 –5.6 kg; 3.2 –4.1 kg; 8.9 -10.8 kg; 7.3 -8.6 kg and 1.1 -1.9 kg, respectively. Among the sexes, yield of ham, butt and 4 primal cuts together were significantly (P<0.05) higher in barrows compared to gilts, which contradicts with previous research (Lebret *et al.* 2001). However, Ellis *et al.* (1996) found that carcass yield was greater in gilts than in barrows**.** The discrepancies observed among the authors could be related to differences in the method used for trimming at the slaughter house**.** Complete dissection of the carcass, on an average yielded 27.61 kg lean meat, 8.11 kg separable fat, 10.84 kg bone, 11.51 kg skin and 1.72 kg trimmings and facia, while the yield of lean meat and separable fat were significantly (P<0.01) higher in barrows in comparison to gilts. The meat:bone ratio was in the range of 2.31 to 2.63, while fat:lean ratio varied from 0.24 to 0.33 and no significant (P>0.05) difference was observed for these parameters among the gilts and barrows.

The different carcass parameters of *Ghungroo* pigs are depicted in Table 3. At 10 months of age, the carcass length ranged from 65.5–77 cm, while that of the loin eye area varied from 2.4- 4.3 in^2. Back fat thickness at three-quarters of the length of the transverse section of the exposed *M. longissimus thoracis et lumborum* between the 10^{th} and 11^{th} rib was in the range of 2.3 - 3.85 cm, while the average back fat thickness calculated based on the corresponding back fat thickness at first thoracic, last thoracic and last lumbar vertebrae was in the range of 2.1 -3.7 cm. As expected, barrows had slightly fatter carcasses than gilts (Cisneros *et al.* 1996). Carcass length was significantly (P<0.05) higher in barrows while the carcass muscling score was significantly (P<0.05) higher in gilts. In India, loin eye area and back fat thickness are historically been important in commercial pig classification, but the carcass length and conformation has had little weighting. However, attention to carcass conformation is becoming more widespread in recent times, as its effects on meat yield and the shape of retail cuts are being recognized (Banik *et al.* 2012). Barrows had slightly more intramuscular fat (marbling) than gilts, which is in line with the higher carcass fat content observed for castrates, and agrees with Leach *et al.* (1996).

pH_{45} and pHu were in the range of 6.49–6.89 and 5.58–5.91, respectively (Table 3). Sex did not influence the pH of the meat as reported by Cisneros *et al.* (1996) and Leach *et al.* (1996). Water holding capacity varied from 68.2% to 87.4%, while the drip loss was in the range of 1.42% to 2.08%. However, differences in water holding capacity between sexes were not observed. Emulsifying capacity, expressed as the amount of oil (ml) emulsified by one gram of protein, was in the range of 102.5 –144.5 with an average of 119. WB shear force and the work of shear, determined 24 h post mortem, were in the range of 42.18 N – 58.7 N and 227.74 Ns-315.22 Ns, respectively. Gender did not affect Warner-Bratzler shear force which confirm previous observations by Hamilton *et al.* (2000)**.** Among the sexes, meat from the gilts had significantly (P<0.01) higher emulsifying capacity and work of shear compared to barrows (Table 4).

Proximate composition and cholesterol contents of *M. longissimus thoracis et lumborum* of *Ghungroo* pigs are mentioned in Table 4. Different proximate principles were in the following range: moisture, 71.93% - 75.91%; crude protein, 20.42–23.86%; crude fat, 1.98-4.85%; crude fibre, 0.86 - 1.33% and total ash, 0.71 - 1.38%. Among the sexes, meat from the gilts had significantly (P<0.05) higher moisture content, while that from the barrows had significantly (P<0.05) higher fat content. The trend of higher rate of fat deposition in the muscles of castrated male pigs was consistent with the reports of other workers. Huff-Lonergan *et al.* (2002) found higher intramuscular fat in hogs than boars at 91 kg body weight, while Essien (1988) reported significantly higher per cent fat in the muscles of barrows over those of gilts. Cholesterol content in the muscle was in the range of 42.22 –71.06 mg/100g, with an average of 59.84 mg/100g. Moisture:protein ratio varied from 3.17 to 3.65 with an average of 3.45 and no significant (P>0.05) difference was observed between gilts and barrows.

The present study was aimed to extend our knowledge of the Ghungroo pig breed and to evaluate the possibility of using Ghungroo breed for the production of pork for fresh consumption or processing. Results of this study help us to understand the details of carcass components and selected quality attributes of meat from this breed among

gilts and barrows. Such knowledge helps to under-build genetic choices for breeding purposes or in genetic selection.

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