Results

4.1 Morphological authentication of the pig breeds

Table 4.1. Morphological differences between Doom and Ghungroo pigs

Trait	Doom Pig	Ghungroo Pig
Appearance	Resembles to wild pig with small head	Resembles a bulldog with distinctive folded skin on neck and face
Ears	Small, erect, and vertical	Large, heart-shaped
Snout	Short and concave	Upwardly curved
Belly	Short, small, and straight	Cylindrical and barrel-shaped
Number of Teats	Five	Six

4.2. Molecular characterization of Doom and Ghungroo breeds

Molecular characterization of Doom and Ghungroo pig breeds were performed using '*cytochrome b*' gene as a molecular marker.

4.2.1. DNA Quantification

The quantity observed for the isolated DNA ranged from 152 - 320 µg/mL. In 6 samples (three sample of Doom and three of Ghungroo), the A_{260}/A_{280} ratio was found to be ≥ 1.8 depicting that the isolated DNA is pure, while other 18 samples showed a ratio in between 1.5 or 1.7 indicating that the isolated DNA consist of impurities which can be RNA or protein in DNA.

4.2.2. PCR Amplification and agarose gel electrophoresis:

The image of the PCR products, run on 1.8-2% agarose gel (Figure 4.a.).

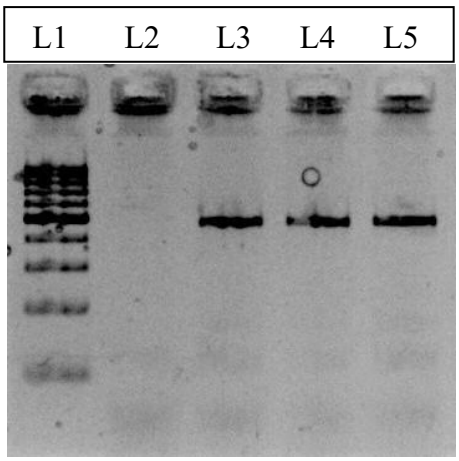

Figure 4.a. Agarose gel image showing PCR products. L1 = 100 bp DNA ladder, L2 = negative control, L3 = positive control, L4 and L5 = 437 bp PCR products.

4.2.3. *Cytochrome b* gene sequences of 437 bp of Doom and Ghungroo pig

The FASTA results of the 437 bp *cytochrome b* gene of Doom and Ghungroo pig is provided in sections 4.2.3.1 and 4.2.3.2.

4.2.3.1. 437 bp *cytochrome b* gene of Doom pig

Doom pig
>TACGGTCATCACAAATCTAATATCAGCTATCCCTTATATCGGAACAGACCT
CGTAGAATGAATCTGAGGGGGCTTTTCCGTCGACAAAGCAACCCTCACAC
GATTCTTCGCCTTTCACTTTATCCTGCCATTCATCATTACCGCCCTCGCAGC
CGTACATCTCCTATTCCTGCACGAAACCGGATCCAACAACCCTACCGGAAT
CTCATCAGACATAGACAAAATTCCATTTCACCCATACTACACTATTAAAGAC
ATTCTAGGGGCCTTATTTATAATACTAATCCTACTAATCCTTGTACTATTCTCA
CCAGACCTACTAGGAGACCCAGACAACTACACCCCAGCAAACCCACTAAA
CACCCCACCCCATATTAAACCAGAATGATATTTCTTATTCGCCTACGCTATCC
TACGTTCAATCCCTAACAAACCTA

4.2.3.2. 437 bp *cytochrome b* gene of Ghungroo pig

Ghungroo pig
>ATATCATTCTGAGGAGCTACGGTCATCACAAATCTACTATCAGCTATCCCT
TATATCGGAACAGACCTCGTAGAATGAATCTGAGGGGGCTTTTCCGTCGAC
AAAGCAACCCTCACACGATTCTTCGCCTTTCACTTTATCCTGCCATTCATC
ATTACCGCCCTCGCAGCCGTACATCTCCTATTCCTGCACGAAACCGGATCC
AACAACCCTACCGGAATCTCATCAGACATAGACAAAATTCCATTTCACCCA
TACTACACTATTAAAGACATTCTAGGGGCCTTATTTATAATACTAATCCTACT
AATCCTTGTACTATTCTCACCAGACCTACTAGGAGACCCAGACAACTACAC
CCCAGCAAACCCACTAAACACCCCACCCCATATTAAACCAGAATGATATTT
CTTATTCGCCTACGCTATCCTACGTTC

4.2.4. Submission of *cytochrome b* gene to NCBI

The 437 bp *cytochrome b* gene sequences of Doom and Ghungroo pig were submitted to NCBI (National Center for Biotechnology Information) to generate accession number. The accession number of Doom and Ghungroo pig are presented in Table 4.2. and the submitted gene of Doom and Ghungroo including details of author and affiliation address are provided in Appendix – VI.

Table 4.2. Accession number of Doom and Ghungroo pig breeds

Sl. No.	Pigs	NCBI Accession numbers
1.	Doom pig	PP951122
2.	Ghungroo pig	PP968767

4.2.5. BLAST similarity score of *cytochrome b* gene

Basic Local Alignment Search Tool for Nucleotide (BLASTN) was performed to obtain the similarity score of the *cytochrome b* gene sequences of Doom and Ghungroo pig breeds. The *cytochrome b* gene sequences of this study, obtained from Doom and Ghungroo pig generated a homology of 99 % with 25 domestic pig breeds. Among the 25 domestic breeds, Doom and Ghungroo breeds already documented in the NCBI database are also included. 5 wild boars around the world were too retrieved from gene-bank (BLAST report - Figures 4.b. and 4.c.). After generating the BLAST similarity scores, indigenous pig breeds and wild boars were selected according to their closest similarity score to generate variation position/sites (Table 4.3.) by Clustal W at MEGA 11. A total of 11 indigenous pigs were selected from 25 domestic pigs, based on closest similarity. The 11 indigenous pig breeds are from India, China, Japan, and European countries were selected including 5 wild boars from Asia and European countries. The same indigenous pigs and wild boars were also used for generating genetic-distances (Table 4.4.) and phylogenetic tree (Figure 4.d.) to ensure a comprehensive understanding of their genetic relationships with the samples of the current study.

The closest similarity score observed for the samples of this study are five (5) indigenous pigs of India. They are Tenyi Vo (accession no. OM386979), Niang Megha (accession no. MZ703185), Zovawk (accession no. OM453834), Doom (MZ846190) and Ghungroo pig (OM634652). While other indigenous pigs that too showed close similarity are from Japan viz., ohmini miniature pig (accession no. AB015078) and Satsuma (accession no. AB015076); China viz., Ya Cha (accession no. KJ746665) and Ma Shen (accession no. KJ746662) and from European countries i.e., Pietran (accession no. KC469587) and Mangalica (accession no. KJ746666). Additionally, 5 wild boars viz., Indian wild pig (accession no. PP951121), Lanyu Wild Boar (accession no. DQ518915), Ryukyu Wild Boar (accession no.), Yunnan Wild Boar (accession no. AB015073) and

Description	Scientific Name	Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
Sus scrofa domesticus haplotype IDP-2 cytochrome b (cytb) gene, partial cds; mitochondrial	Sus scrofa dom...	802	802	99%	0.0	100.00%	434	PP951122.1
Sus scrofa domesticus breed Tenyi Vo mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16691	OM386979.1
Sus scrofa domesticus breed Nei jiang mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16661	KJ746663.1
Sus scrofa domesticus breed Gannan wild Tibetan pig mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16710	MW534270.1
Sus scrofa domesticus mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16690	ON715893.1
Sus scrofa domesticus isolate Niang Megha 1 mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16691	MZ703185.1
Sus scrofa domesticus breed Min mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16728	KF971862.1
Sus scrofa domesticus mitochondrial cytb gene for cytochrome b, complete cds, isolate: Meishan 1	Sus scrofa dom...	785	785	99%	0.0	99.31%	1140	AB015077.1
Sus scrofa domesticus breed Ghungroo mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16690	OM634652.1
Sus scrofa domesticus breed Lumsniang mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16691	OM468891.1
Sus scrofa domesticus breed Pen zhou shan di mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16619	KJ746664.1
Sus scrofa domesticus mitochondrion, complete genome	Sus scrofa dom...	785	785	99%	0.0	99.31%	16508	MN025258.1
Sus scrofa domesticus mitochondrial cytb gene for cytochrome b, complete cds, isolate: Ohmini miniature ...	Sus scrofa dom...	780	780	99%	0.0	99.08%	1140	AB015078.1
Sus scrofa domesticus mitochondrial cytb gene for cytochrome b, complete cds, isolate: Satsuma 28	Sus scrofa dom...	780	780	99%	0.0	99.08%	1140	AB015076.1
Sus scrofa domesticus breed Ma shen mitochondrion, complete genome	Sus scrofa dom...	780	780	99%	0.0	99.08%	16677	KJ746662.1
Sus scrofa domesticus breed Chinese Jinhua pig mitochondrion, complete genome	Sus scrofa dom...	780	780	99%	0.0	99.08%	16610	KC469586.1

Figure 4.b. BLAST results of 437 bp of Doom pig

Description	Scientific Name	Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
Sus scrofa domesticus breed Tenyi Vo mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16691	OM386979.1
Sus scrofa domesticus breed Nei jiang mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16661	KJ746663.1
Sus scrofa domesticus breed Gannan wild Tibetan pig mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16710	MW534270.1
Sus scrofa domesticus mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16690	ON715893.1
Sus scrofa domesticus isolate Niang Megha 1 mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16691	MZ703185.1
Sus scrofa domesticus breed Min mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16728	KF971862.1
Sus scrofa domesticus mitochondrial cytb gene for cytochrome b, complete cds, isolate: Meishan 1	Sus scrofa dom...	819	819	99%	0.0	99.78%	1140	AB015077.1
Sus scrofa domesticus breed Ghungroo mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16690	OM634652.1
Sus scrofa domesticus breed Lumsniang mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16691	OM468891.1
Sus scrofa domesticus breed Pen zhou shan di mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16619	KJ746664.1
Sus scrofa domesticus mitochondrion, complete genome	Sus scrofa dom...	819	819	99%	0.0	99.78%	16508	MN025258.1
Sus scrofa domesticus mitochondrial cytb gene for cytochrome b, complete cds, isolate: Ohmini miniature ...	Sus scrofa dom...	813	813	99%	0.0	99.55%	1140	AB015078.1
Sus scrofa domesticus mitochondrial cytb gene for cytochrome b, complete cds, isolate: Satsuma 28	Sus scrofa dom...	813	813	99%	0.0	99.55%	1140	AB015076.1
Sus scrofa domesticus breed Ma shen mitochondrion, complete genome	Sus scrofa dom...	813	813	99%	0.0	99.55%	16677	KJ746662.1
Sus scrofa domesticus breed Chinese Jinhua pig mitochondrion, complete genome	Sus scrofa dom...	813	813	99%	0.0	99.55%	16610	KC469586.1
Sus scrofa domesticus isolate Ghungroo2 mitochondrion, complete genome	Sus scrofa dom...	813	813	99%	0.0	99.55%	16690	MZ703184.1

Figure 4.c. BLAST results of 437 bp of Ghungroo pig

European Wild Boar (accession no. FJ237003) were also selected that showed 99 % similarity with the samples of current study i.e., Doom and Ghungroo. (Note: The Doom and Ghungroo pigs with accessions numbers MZ846190 and OM634652 respectively, are retrieved from NCBI, which are not our samples).

4.2.6. Nucleotide variation sites/positions

For determining the variation position or sites of sequences of *cytochrome b* gene of Doom and Ghungroo pigs, the nucleotide sequences of the current samples including sequences retrieved from NCBI were run for multiple sequence alignment and pairwise sequence alignment using CLUSTAL W at MEGA 11. The nucleotide variable positions/sites of 437 bp of *cytochrome b* gene is shown in Table 4.3. The complete genome mitochondrial sequence of *Sus scrofa domesticus* (accession no. ON715893) was taken as a reference to generate the number of nucleotide positions. In the Table "." (dots) represents identical nucleotides. A highly variable region was found between 15924 and 16357 sites. There was a total of 18 polymorphic sites that were identified with no observed insertions and deletions in *cytochrome b* gene. The sample of the current study i.e., Doom pig (DB-S1; accession no. PP951122) was found to have similar nucleotides with Indian wild boar (accession no. PP951121) at six positions (15940, 16344, 16350, 16355, 16356, 16357). These positions have substitutions of A in place of C at 15940, C in place of T at three positions 16344, 16350 and 16355, T in place of A at 16356 and A in place of G at 16357. Doom pig sample of the present study also showed identical nucleotide with Ryukyu wild boar (RWB; accession no. AB015073) at one position (16350) where T is substituted by C. Other sample of the current study, Ghungroo pig (GB-S2; accession no. PP968767) showed identical nucleotides at only two positions with Indian wild boar at site 16344 and with Ryukyu wild boar at site 16350.

At position 16344, T is substituted C and at position 16350, again T is substituted by C. In addition to this, the Doom pig sequences retrieved from gene-bank showed similar nucleotides with the Asian i.e., Indian wild pig (accession no.), Lanyu wild boar, Ryukyu wild boar, Yunan wild boar and European wild boar at 4 positions 16110, 16185, 16218 and 16332. At position 16110, C is substituted by T, at position 16185, G is substituted by A, at position 16218, T is substituted by C and at 16332, C is substituted by T. On the other hand, the Ghungroo pig sequences retrieved from NCBI did not show

Table 4.3. Nucleotide variable positions/sites of 437 bp of *cytochrome b*.

	Nucleotide positions																	
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	9	9	9	0	0	1	1	1	2	2	2	3	3	3	3	3	3	3
	2	3	4	0	3	1	8	9	1	2	7	2	3	4	5	5	5	5
	4	6	0	0	5	0	5	9	8	2	7	3	2	4	0	5	6	7
Animals																		
Reference	G	T	C	G	T	C	G	T	T	C	T	C	C	T	T	T	A	G
DB – S1	.	.	A	.	.	.	.	.	.	.	.	.	.	C	C	C	T	A
GB – S2	.	.	.	.	.	.	.	.	.	.	.	.	.	C	C	.	.	.
Wild boars																		
IWP	.	.	A	.	.	T	A		.	.	.	T	T	C	C	C	T	A
LWB	.	.	.	.	.	T	A	.	.	.	.	.	T	.	.	.	.	.
RWB	.	.	.	.	.	T	A	.	C	.	.	.	T	.	C	.	.	.
YWB	.	C	.	.	.	T	A	.	.	.	.	.	T	.	.	.	.	.
EWB	.	.	.	.	C	.	A	.	.	.	.	.	T	.	.	.	.	.
Indigenous pig breeds																		
G	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D	.	.	.	.	.	T	A		C	A	.	.	T	.	.	.	.	.
TV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NM	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Z	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.
YC	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.
MS	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OMP	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.
S	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P	.	.	.	.	C	.	A	.	.	.	.	.	T	.	.	.	.	.
M	.	.	.	.	C	.	A	.	.	.	C	.	T	.	.	.	.	.

DB-S1= Doom, GB–S2= Ghungroo, IWP = Indian wild Pig, LWB = Lanyu Wild Boar, RWB= Ryukyu Wild Boar, YWB= Yunnan Wild Boar, EWB= European Wild Boar, G = Ghungroo, D= Doom, TV= Tenyi Vo, NM= Niang Megha, Z= Zovawk, YC= Ya Cha, MS= Ma Shen, OMP= Ohmini Miniature Pig, S= Satsuma, P= Pietran, M= Mangalica.

any similar nucleotides with the current samples as well as other sequences of indigenous and wild boars.

4.2.7. Genetic distance analysis

Kimura 2-parameter model was used to generate the genetic distance of Doom and Ghungroo and other 16 sequences of domestic pigs and wild boars retrieved from NCBI (Tamura et al., 2021; Kimura, 1980). Table 4.4. shows the matrix output of Tamura & Nei genetic distance. In the table, the lower triangular matrix values depict the mean genetic distances and upper triangular matrix depicts the standard errors. The Tamura and Nei genetic distance depict the sample of the present study, Doom pig (DB-S1) showed a mean genetic distance of 0.0140±0.0059. The closest genetic distance to Doom pig (DB-S1) were Indian wild pig with a mean of 0.0238±0.0079, Lanyu wild boar with a mean of 0.0301±0.0014 and European wild boar with a mean of 0.0119±0.0009. In addition to these wild boars, three indigenous pigs showed close genetic distance to Doom pig, they are European breeds Pietran (mean, 0.0123±0.0009) and Mangalica (mean, 0.0123±0.0009) and Indian breed i.e., Doom pig (0.0104±0.0008) retrieved from gene-bank.

On the other hand, the sample Ghungroo pig (GB-S2) showed a mean genetic distance of 0.0045±0.0032. Closest distance to Ghungroo pig were Chinese and Japanese indigenous pigs namely; Satsuma (0.0044±0.0020), Ya Cha (0.0021±0.0003), Ma Shen (0.0020±0.0003), including 4 indigenous pig breeds from India, i.e., Zovawk (0.0016±0.0003), Tenyi Vo (0.0014±0.0003), Niang Megha (0.0014±0.0003) and Ghungroo pig (0.0002±0.0001) that was retrieved from gene-bank. Additionally, two Asian wild boars namely; Ryukyu (0.0098±0.0031) and Yunan wild boar (0.0098±0.0031) too showed close distance with Ghungroo pig (GB-S2).

The samples of the present study, Doom (DB-S1) and Ghungroo (GB-S2) showed far genetic distance from each other. It is also revealed that most of the indigenous pig breeds retrieved from gene-bank had that had close distance with Ghungroo pig showed far distance from Doom pig. The Ghungroo pig sequence retrieved from gene bank showed the farthest distance with the sample of the current study, i.e., Doom pig. The Indian wild pig depicted farthest distance from the Ghungroo pig.

Table 4.4. Matrix output of Tamura & Nei genetic distance.

	Ref.	DB-S1	GB-S2	IWP	LWB	RWB	YWB	EWB	G	D	TV	NM	Z	YC	MS	OMP	S	P	M	Bb (OG)
Ref.		0.0059	0.0032	0.0079	0.0014	0.0031	0.0031	0.0009	0.0001	0.0008	0.0003	0.0003	0.0003	0.0003	0.0003	0.0015	0.0020	0.0009	0.0009	0.0168
DB-S1	0.0140		0.0093	0.0119	0.0075	0.0076	0.0080	0.0076	0.0059	0.0083	0.0059	0.0059	0.0063	0.0064	0.0064	0.0064	0.0063	0.0076	0.0080	0.0301
GB-S2	0.0045	0.0023		0.0055	0.0052	0.0054	0.0059	0.0053	0.0032	0.0062	0.0032	0.0032	0.0039	0.0041	0.0039	0.0040	0.0039	0.0053	0.0057	0.0277
IWP	0.0238	0.0024	0.0049		0.0062	0.0063	0.0067	0.0072	0.0079	0.0071	0.0079	0.0079	0.0075	0.0083	0.0083	0.0082	0.0082	0.0072	0.0075	0.0303
LWB	0.0301	0.0213	0.0114	0.0164		0.0023	0.0024	0.0016	0.0014	0.0015	0.0014	0.0014	0.0014	0.0014	0.0014	0.0033	0.0033	0.0015	0.0015	0.0168
RWB	0.0098	0.0213	0.0114	0.0164	0.0062		0.0022	0.0033	0.0031	0.0030	0.0031	0.0031	0.0030	0.0030	0.0030	0.0031	0.0031	0.0033	0.0034	0.0167
YWB	0.0098	0.0238	0.0138	0.0189	0.0062	0.0053		0.0033	0.0031	0.0034	0.0031	0.0031	0.0030	0.0031	0.0031	0.0032	0.0032	0.0033	0.0034	0.0165
EWB	0.0119	0.0213	0.0114	0.0213	0.0365	0.0117	0.0117		0.0009	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010	0.0037	0.0038	0.0002	0.0003	0.0168
G	0.0002	0.0140	0.0045	0.0238	0.0302	0.0098	0.0098	0.0121		0.0009	0.0003	0.0003	0.0003	0.0004	0.0004	0.0015	0.0020	0.0009	0.0009	0.0168
D	0.0104	0.0262	0.0161	0.0213	0.0343	0.0098	0.0117	0.0112	0.0106		0.0009	0.0009	0.0009	0.0009	0.0009	0.0040	0.0040	0.0008	0.0008	0.0163
TV	0.0014	0.0140	0.0045	0.0238	0.0308	0.0098	0.0098	0.0121	0.0016	0.0111		0.0003	0.0003	0.0004	0.0004	0.0015	0.0020	0.0009	0.0009	0.0168
NM	0.0014	0.0140	0.0045	0.0238	0.0310	0.0098	0.0098	0.0121	0.0016	0.0113	0.0011		0.0003	0.0004	0.0004	0.0015	0.0020	0.0009	0.0009	0.0168
Z	0.0016	0.0164	0.0068	0.0213	0.0307	0.0089	0.0089	0.0118	0.0017	0.0109	0.0016	0.0018		0.0004	0.0004	0.0018	0.0022	0.0009	0.0009	0.0167
YC	0.0021	0.0164	0.0068	0.0263	0.0309	0.0098	0.0098	0.0131	0.0023	0.0115	0.0026	0.0028	0.0027		0.0003	0.0016	0.0020	0.0009	0.0010	0.0173
MS	0.0020	0.0164	0.0068	0.0263	0.0309	0.0098	0.0098	0.0128	0.0021	0.0112	0.0023	0.0025	0.0025	0.0019		0.0015	0.0020	0.0009	0.0009	0.0172
OMP	0.0026	0.0164	0.0068	0.0263	0.0117	0.0108	0.0108	0.0135	0.0026	0.0172	0.0026	0.0026	0.0035	0.0026	0.0026		0.0022	0.0037	0.0038	0.0170
S	0.0044	0.0164	0.0068	0.0263	0.0117	0.0108	0.0108	0.0154	0.0044	0.0172	0.0044	0.0044	0.0053	0.0044	0.0044	0.0053		0.0038	0.0040	0.0173
P	0.0123	0.0213	0.0114	0.0213	0.0358	0.0117	0.0117	0.0007	0.0125	0.0121	0.0126	0.0127	0.0124	0.0131	0.0128	0.0135	0.0154		0.0002	0.0168
M	0.0123	0.0238	0.0138	0.0238	0.0358	0.0126	0.0126	0.0012	0.0125	0.0122	0.0128	0.0128	0.0125	0.0131	0.0130	0.0144	0.0163	0.0010		0.0169
Bb (OG)	0.1696	0.1936	0.1735	0.1936	0.1663	0.1666	0.1651	0.1696	0.1696	0.1633	0.1696	0.1696	0.1681	0.1726	0.1726	0.1711	0.1726	0.1696	0.1711	

Ref. = Reference, DB-S1= Doom, GB–S2= Ghungroo, IWP = Indian wild Pig, LWB = Lanyu Wild Boar, RWB= Ryukyu Wild Boar, YWB= Yunnan Wild Boar, EWB= European Wild Boar, G = Ghungroo, D= Doom, TV= Tenyi Vo, NM= Niang Megha, Z= Zovawk, YC= Ya Cha, MS= Ma Shen, OMP= Ohmini Miniature Pig, S= Satsuma, P= Pietran, M= Mangalica, Bb (OG)= *Babyrousa babyrussa,* OG = Outgroup.

4.2.8. Phylogenetic analysis

Neighbour-Joining (NJ) method was applied for construction of phylogenetic tree, bootstrapping at 1000 replications using Kimura-2 parameter using MEGA 11 (Figure 4.d.). The *Babyrousa babyrussa* (Bb) was taken as an outgroup for the construction of phylogenetic tree.

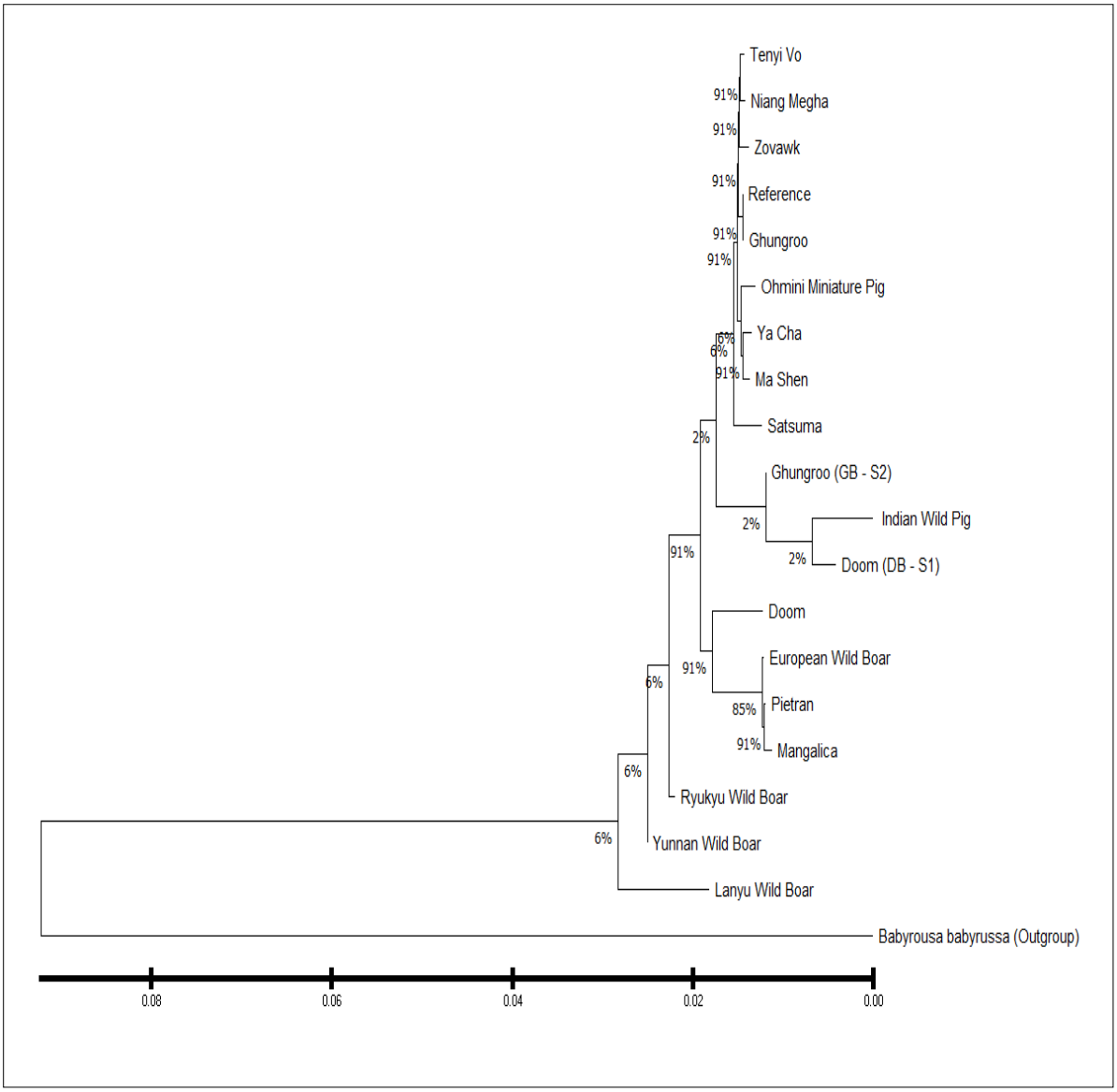

Figure 4.d. Phylogenetic tree construction on the basis of partial fragment of *Cytochrome b* gene underlining the phylogenetic relationship of Doom (DB-S1) and Ghungroo pig (GB-S2) using Neighbour-Joining (NJ) tree model. The abbreviated name of the wild and indigenous pig breeds generated from NCBI is given after the GenBank (NCBI) accession number.

The NJ phylogenetic tree revealed that upper clusters consist of domestic pig breeds of Indian, Japanese and Chinese origin, while the other or lower clusters of phylogenetic tree consists of wild pigs and boars. The samples of the current study Doom and Ghungroo pigs including the Indian wild pig (IWP) are confined to one cluster, placed next to Asian indigenous pig breeds. Within this cluster, Ghungroo pig formed a single separate clade, while Doom pig and Indian wild pig formed a single clade showing their close relationship. The Doom breed (retrieved from gene bank) forms a clade along with European indigenous pigs (Pietran and Mangalica). Ghungroo pig (retrieved from NCBI) formed cluster with reference sample, originating from domestic pigs from northeast India. Next to this clade is the Asian indigenous clade, formed by Ohmini miniature pig (OMP), Ya Cha and Ma Shen and within this cluster single clade formed by Satsuma pig (S) of Japan is observed with low bootstrap value. At the level of the European clade, the Ryukyu wild boar (RWB) with 91% bootstrap probability, Yunan and Lanyu wild boar both with low bootstrap value are designated as an isolated clade.

The northeast Indian pigs, included Tenyi Vo and Niang Megha with 91% bootstrap probability (Figure 4.d.). Within the northeast Indian pigs, Zovawk indigenous pig breed is inclined in a separate cluster, with bootstrap value of 91%. The minor clade included Ghungroo and complete genome of *Sus scrofa domesticus* (reference) that generated bootstrap probability of 91%.

4.3. Body weight and other growth parameters under a control and trial diet.

4.3.1. Weaner stage: The measurement taken at the pre-weaned period, taken when piglets were 15 days old (Table 4.5.).

Table 4.5. Growth parameters of Doom and Ghungroo pig at pre-weaned stage

(n = 12, average)	**Pre-weaned age (15 days old)**	
	Doom piglets	**Ghungroo piglets**
Body weight (kg)	1.14±0.11	3.85±0.15
Chest girth (cm)	25.83±0.37	34.29±0.43
Height at wither (cm)	14.73±0.30	23.44±0.38
Paunch girth (cm)	27.03±0.29	35.29±0.35
Body length (cm)	19.63±0.25	32.62±0.33

Values are expressed in mean ± standard error of mean (SEM)

4.3.2. Grower stage: In growing stage (i.e., 62 to 153 days), the measurement was taken two times (Tables 4.6. and 4.7.). First measurement taken at grower stage was recorded, at 8th day, after acclimatizing the piglets for 7 days. Second measurement was again taken after completion of grower stage at 154th day, here the pigs were supplied with experimental diet, containing control and trial diets.

Table 4.6. Growth parameters of Doom and Ghungroo pigs taken at 8th day grower stage

(n = 12, average)	Grower stage ((after 7 days of acclimatizing period)		P-value
	Doom piglets	Ghungroo piglets	
Body weight (kg)	6.88±0.28	9.15±0.11	<0.0001
Chest girth (cm)	32.98±0.37	39.35±0.26	<0.0001
Height at wither (cm)	23.14±0.27	26.89±0.18	<0.0001
Paunch girth (cm)	33.90±0.33	40.50±0.47	<0.0001
Body length (cm)	33.49±0.35	34.00±0.30	0.0006

Values are expressed in mean ± standard error of mean (SEM)

Table 4.7. Growth parameters of Doom and Ghungroo pig taken at 154th day of grower stage.

	Grower stage (after feeding experimental diets)					
	Doom Control	Ghungroo Control	P-value	Doom Trial	Ghungroo Trial	P-value
Body weight (kg)	32.36±0.55	39.26±0.32	<0.0001	34.65±0.87	41.69±0.15	<0.0001
Chest girth (cm)	75.48±0.44	90.83±0.40	<0.0001	75.83±0.28	91.68±1.32	<0.0001
Height at wither (cm)	53.47±0.52	59.67±0.33	<0.0001	53.76±0.41	59.00±0.20	<0.0001
Paunch girth (cm)	76.86±0.47	93.66±0.39	<0.0001	76.32±0.12	94.99±0.56	<0.0001
Body length (cm)	70.51±0.31	98.45±0.41	<0.0001	71.54±0.52	99.95±0.36	<0.0001

Values are expressed in mean ± standard error of mean (SEM)

4.3.3. Finisher stage: In the finisher stage (i.e., 154 to 244 days age), the measurement were taken once the pigs has completed the finisher stage (Table 4.8.). In this stage too, the experimental pigs were provided with experimental diets.

Table 4.8. Growth parameters of Doom and Ghungroo pig taken at 244th days of finisher stage

(n = 12, average)	Doom Control	Ghungroo Control	P-value	Doom Trial	Ghungroo Trial	P-value
Body weight (kg)	49.27±0.29	61.25±0.46	<0.0001	49.78±0.46	63.23±0.54	<0.0001
Chest girth (cm)	83.20±0.24	107.28±0.65	<0.0001	84.27±0.36	108.76±0.44	<0.0001
Height at wither (cm)	57.52±0.41	63.77±0.32	<0.0001	57.99±0.78	63.76±0.43	<0.0001
Paunch girth (cm)	84.75±0.24	119.77±0.49	<0.0001	85.66±0.21	120.32±0.14	<0.0001
Body length (cm)	77.09±0.50	121.39±0.57	<0.0001	77.32±0.43	121.87±0.11	<0.0001

Values are expressed in mean ± standard error of mean (SEM)

4.3.4. Statistical comparisons of growth parameters between the two populations: The independent t-test at a 95% confidence level revealed differences in body weight, chest girth, height at withers, paunch girth and body length between the two pig populations. All the measured growth parameters showed statistically significant differences ($P < 0.0001$) between the two pig breeds, with Ghungroo pigs outperforming Doom pigs under both dietary regimens at both the grower and finisher stage.

4.4. Biochemical analysis

4.4.1. Proximate composition of kitchen waste

The proximate content determined in the kitchen waste were moisture, dry matter, protein, fat, ash, total carbohydrate, calorie and alcohol content (Table 4.9.). Calorie (370.58 %), dry matter (91.02 %) and carbohydrate (83.72 %) showed the highest values among the proximate content. Moisture (8.98 %) and protein (6.54 %) concentration were at moderate level, while the parameters with the lowest percentage included alcohol (3.10 %), fat (1.65 %) and ash (0.74 %) content. The standard graph of alcohol (ethanol v/v %) is presented in Figure 4.e.

Table 4.9. Proximate composition of kitchen waste

Moisture	Dry matter	Protein	Fat	Ash	Total carbohydrate	Calorie	Alcohol
8.98±0.13 %	91.02±0 .31%	6.54±0. 65 %	1.65±0. 09 %	0.74±0. 01 %	83.72±0.40 %	370.58±7.5 7 kcal/100g	3.10±0.25 %

Values are expressed in mean

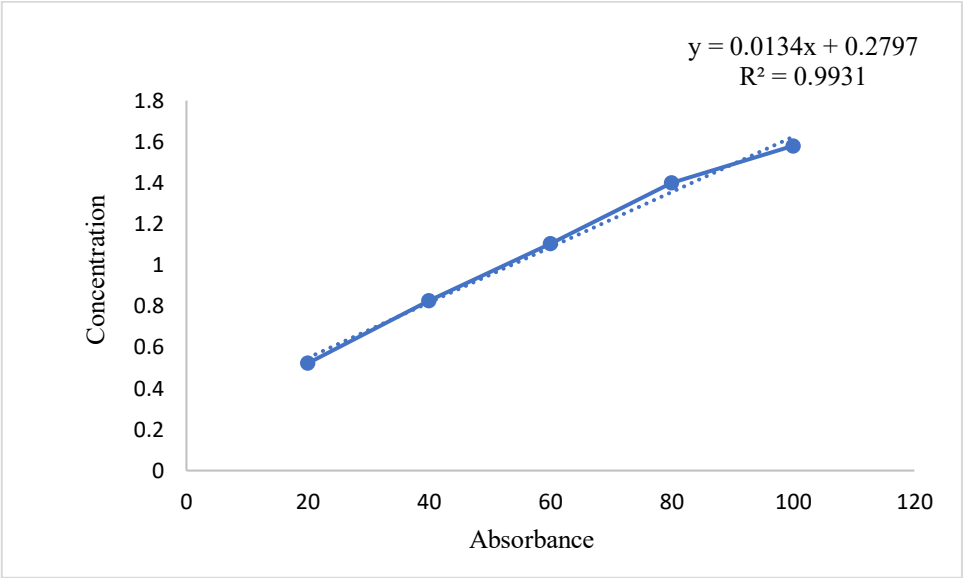

Figure 4.e. Standard graph of alcohol (ethanol v/v %)

4.4.2. Amino acid content of kitchen waste

The amino acid content of kitchen waste is presented in Table 4.10. Among the essential amino acids (EAA), the content of isoleucine was the highest with a mean of 2.27 g/100g. Valine exhibited a concentration of 1.88 g/100g. Another EAA methionine was about 1.51 g/100 and the lowest was recorded for phenylalanine with a mean of 0.20 g/100g. The total EAA's was relatively low with a mean of 5.86 g/100g than NEAA's that depicted comparably high content with a mean of 7.09 g/100g.

Among the NEAA's, aspartic and glutamic acid were the highest with a mean of 3.24 g/100g and 3.47 g/100g respectively. Alanine and tryptophan were recorded having the lowest concentrations with a mean of 0.12 and 0.26 g/100g.

Table 4.10. Amino acid content of kitchen waste

Amino acids	g/100g
Valine	1.88±0.05
Isoleucine	2.27±0.08
Methionine	1.51±0.04
Phenylalanine	0.20±0.02
Total EAA's	**5.86±0.19**
Glycine	ND
Aspartic acid	3.24±0.66
Glutamic acid	3.47±1.06
Alanine	0.12±0.05
Tryptophan	0.26±0.02
Total NEAA's	**7.09±1.79**

Values are expressed in mean ± standard error of mean (SEM)

4.4.3. Fatty acid content of kitchen waste

Fatty acid composition of kitchen waste is depicted in Table 4.11. Among the fatty acid determined, mono-unsaturated fatty acids (MUFA's) were the highest, with a mean of 14.92 %. Oleic acid was the most abundant MUFA's observed in kitchen waste. Alpha-linolenic

Table 4.11. Fatty acid content of kitchen waste

Fatty acids	Percentage (%)
Palmitic acid	3.04±0.67
Stearic acid	1.34±0.08
Lauric acid	0.43±0.05
Myristic acid	1.45±0.03
Total SFA's	**4.93±0.83**
Oleic acid	14.92±0.09
Palmitoleic acid	ND
Total MUFA's	**14.92±0.09**
Alpha Linolenic acid-ALA	2.82±0.34
Arachidonic acid (ARA)	5.88±0.24
Total PUFA's	**8.70±0.58**

Note: SFA's = Saturated fatty acids, MUFA's = Monounsaturated fatty acids, PUFA's = Polyunsaturated fatty acids

acid (ALA) and arachidonic acid (ARA) were the two PUFA's detected in kitchen waste. Low ALA content with a mean of 2.82 % and comparably high ARA content with a mean of 5.88 % was observed among the PUFA's. Saturated fatty acids (SFA's) were the lowest with a total SFA's of 4.93 %. Among the SFA's, palmitic acid was the most abundant with a mean of 3.04 % and lowest was found for lauric acid with a mean 0.43 %. Chromatogram of fatty acid of kitchen waste is provided in Appendix-VII.

4.4.4. Mineral content of kitchen waste

The following minerals namely; macro- and micro-, trace both non-toxic and potentially toxic were analysed in kitchen waste (Table 4.12.). Kitchen waste resulted in high concentration of potassium (K - 23.47 mg/kg) and calcium (Ca – 21.84 mg/kg) among the macro-elements. Concentration of magnesium (Mg) was the lowest among macro-elements. Among the micro-elements iron (Fe – 2.33 mg/kg) and manganese (Mn – 2.24 mg/kg)

Table 4.12. Mineral composition of kitchen waste

Macro-elements	**mg/kg**
K	23.47±0.51
Na	11.21±0.61
Mg	8.93±0.39
Ca	
Micro-elements	21.84±0.30
Cu	0.014±0.00
Zn	0.59±0.08
Fe	2.33±0.27
Mn	2.24±0.44
Trace elements	
Se	ND
Cr	0.005±0.00
Potentially Toxic trace elements	
As	0.013±0.00
Cd	0.006±0.00
Pb	0.057±0.00
Ni	ND

Values are expressed in mean ± standard error of mean (SEM)

concentrations were highest in kitchen waste. Among the trace elements, highest concentration was noted for Cr (0.005 mg/kg) in kitchen waste. Among the potentially toxic elements, lead (Pb - 0.057 mg/kg) was found highest in kitchen waste, followed by arsenic (0.013 mg/kg). Lowest was observed for cadmium (0.006 mg/kg). Selenium (Se) and nickel (Ni) which are trace and potentially toxic trace elements, respectively, were not detected for kitchen waste in this study.

4.5. Meat quality of muscles and viscera of Doom and Ghungroo pigs

4.5.1. pH (pH_{45} and pH_u) in muscles

The pH was measured in two different time period (pH_{45} and pH_u) in six muscles of Doom and Ghungroo pig breeds (Tables 4.13. and 4.14.). The pH measured within 45 mins of slaughter ranged from 6.11 to 6.62 for control diet. And for trial diet, it ranged from 6.14 to 6.87. There was no significant difference between control and trial diet muscles. The final pH measured post-mortem at 24 hours ranged from 5.18 to 5.77 for control diet. And for trial diet final pH ranged from 5.20 to 5.78. The pH measured at post 24^{th} hour was slightly

Table 4.13. Measurement of pH (pH_{45} and pH_u) levels in muscles of Doom pig.

Muscles	**pH_{45}**			**pH_u**		
	Control diet	**Trial diet**	**P – value**	**Control diet**	**Trial diet**	**P – value**
Triceps brachii	6.45±0.03	6.32±0.03	0.8156	5.30±0.21	5.49±0.74	0.6252
Latissimus dorsi	6.21±0.52	6.14±0.83	0.9841	5.21±0.11	5.39±0.83	0.2328
Biceps femoris	6.57±0.17	6.76±0.32	0.3628	5.18±0.54	5.78±0.73	0.8278
Tensor fasciae latae	6.12±0.32	6.32±0.47	0.4413	5.65±0.37	5.20±0.22	0.3049
Gracilis	6.62±0.21	6.87±0.29	0.4446	5.33±0.19	5.78±0.47	0.9071
Longissimus dorsi	6.11±0.49	6.34±0.21	0.3290	5.77±0.28	5.33±0.64	0.2259

Values are expressed in mean ± standard error of mean (SEM)

low than that of measurement taken at 45 min. For Ghungroo pig, similar results were found in the six muscles like that of Doom pig. For control diet the pH level for 45 min ranged from

6.21 to 6.75 and trial diet ranged from 6.11 to 6.56. The final pH measured post 24 hours for control diet ranged from 5.13 to 5.75 and trial diet ranged from 5.14 to 5.76. pH level measured after 24 hours were slightly lower than that of 45 minutes.

Table 4.14. Measurement of pH (pH_{45} and pH_u) levels in muscles of Ghungroo pig.

Muscles	**pH_{45}**			**pH_u**		
	Control diet	**Trial diet**	**P-value**	**Control diet**	**Trial diet**	**P-value**
Triceps brachii	6.35±0.03	6.43±0.03	*0.0225	5.22±0.21	5.26±0.74	0.8171
Latissimus dorsi	6.27±0.52	6.18±0.43	0.6338	5.54±0.11	5.46±0.83	0.1784
Biceps femoris	6.43±0.17	6.45±0.22	0.2179	5.42±0.41	5.14±0.73	0.1972
Tensor fasciae latae	6.75±0.32	6.56±0.17	0.6433	5.13±0.37	5.21±0.22	0.8166
Gracilis	6.21±0.45	6.32±0.27	0.9159	5.59±0.19	5.26±0.47	0.6769
Longissimus dorsi	6.28±0.41	6.11±0.51	0.1825	5.63±0.21	5.76±0.64	0.4452

Values are expressed in mean ± standard error of mean (SEM); *P < 0.05

4.5.2. pH (pH_{45} and pH_u) in viscera

The pH levels of six viscera of Doom and Ghungroo pig breeds analysed at two different time points are tabulated in Tables 4.15. and 4.16. For the control diet, pH_{45} ranged from 6.51 to 6.85, while for the trial diet, it ranged from 6.34 to 6.84. No significant differences were observed between the control and trial diet groups in terms of pH_{45}. The final pH (pH_u) measured 24 hours post-mortem showed a range of 5.23 to 5.81 for the control diet and 5.37 to 5.69 for the trial diet. Again, no significant differences were found between the two dietary groups.

Table 4.15. Measurement of pH (pH_{45} and pH_u) levels in viscera of Doom pig.

Viscera	pH_{45}			pH_u		
	Control diet	Trial diet	P-value	Control diet	Trial diet	P-value
Kidney	6.85±0.03	6.72±0.03	0.3672	5.71±0.21	5.37±0.74	0.0844
Small intestine	6.67±0.22	6.73±0.83	0.1951	5.81±0.11	5.69±0.32	0.2799
Spleen	6.56±0.14	6.34±0.12	0.5372	5.66±0.12	5.43±0.33	0.1272
Liver	6.76±0.62	6.54±0.17	0.6868	5.23±0.87	5.61±0.32	0.1081
Heart	6.78±0.41	6.57±0.21	0.4008	5.55±0.11	5.48±0.27	0.2610
Large intestine	6.51±0.79	6.84±0.51	0.8616	5.60±0.21	5.43±0.34	*0.0091

Values are expressed in mean ± standard error of mean (SEM); *P < 0.05

For Ghungroo pig too, similar pH level was observed like that of Doom pig. For control diet the pH_{45} ranged from 6.13 to 6.55 and that of trial diet ranged from 6.21 to 6.74. The final pH ranged from 5.14 to 5.53 for control diet and that of trial diet ranged from 5.11 to 5.63. No significant differences were found in both the diets.

Table 4.16. Measurement of pH (pH_{45} and pH_u) levels in viscera of Ghungroo pig.

Viscera	pH_{45}			pH_u		
	Control diet	Trial diet	P-value	Control diet	Trial diet	P-value
Kidney	6.32±0.03	6.44±0.11	0.7590	5.32±0.44	5.63±0.25	0.7388
Small intestine	6.53±0.24	6.21±0.24	0.1001	5.53±0.11	5.11±0.31	0.2304
Spleen	6.55±0.14	6.43±0.12	0.4780	5.44±0.12	5.42±0.15	0.2398
Liver	6.13±0.11	6.74±0.17	0.1815	5.14±0.14	5.24±0.44	0.5427
Heart	6.35±0.41	6.24±0.21	0.4655	5.14±0.11	5.43±0.43	0.3691
Large intestine	6.19±0.47	6.74±0.54	0.3909	5.42±0.21	5.45±0.31	0.3938

Values are expressed in mean ± standard error of mean (SEM)

4.5.3. Proximate composition in muscles and viscera

The muscles and viscera are analysed based on two types of experimental diets i.e., control diet and trial diet.

4.5.3.1 Proximate composition in muscles of Doom pig breed:

Control diet: The proximate content in muscles of control diet fed of Doom is tabulated in Table 4.17. The moisture content of Doom pigs ranged from 70.00 to 72.66 %, noted lowest in *tensor fasciae latae* and highest for *longissimus dorsi* muscles. The protein content ranged from18.72 to 21.57 %, lowest in *biceps femoris* and highest was in *tensor fasciae latae*. The fat percentage ranged from 2.79 % in *triceps brachii* to 3.55 % in *tensor fasciae latae*. Ash content ranged from 0.63 to 0.77 % lowest in *gracilis* and high in *tensor fasciae latae*. The total carbohydrate percentage of the muscle samples ranged from 1.28 % for *gracilis* to 6.21 % for *triceps brachii*. Calorie content expressed in kcal/100g was found to be highest in *tensor fasciae latae* with 144.38 kcal/100g and lowest in *triceps brachii* with 116.82 kcal/100g.

Trial diet: The proximate content in muscles of trial diet fed of Doom is tabulated in Table 4.17. The moisture content of Doom pigs ranged from 72.41 to 78.77 %, where the lowest was found in *longissimus dorsi* and highest in *biceps femoris* muscles. *Triceps brachii* had the highest amount of protein content (22.30 %) and lowest was found in *biceps femoris* (18.53 %) muscle. Fat content ranged from 1.79 % (*longissimus dorsi*) to 3.09 % (*gracilis*). Ash content was found to be highest in *tensor fasciae latae* (0.83 %) and lowest in *longissimus dorsi* (0.70 %) muscle. Total carbohydrate content was found high in *longissimus dorsi* (3.20 %) and low in *biceps femoris* (1.57 %). Calorie content was found highest in *triceps brachii* with 123.49 kcal/100g and lowest in *biceps femoris* 107.29 kcal/100g.

The statistical comparison (P-values) of proximate composition between control and trial diets in muscles of Doom pig are depicted in Table 4.18.

4.5.3.2. Proximate composition in viscera of Doom pig breed

Control diet: The proximate content in viscera of Doom is tabulated in Table 4.19. The moisture content ranged from 50.67 to 68.47 %, where the lowest was found for liver and highest for spleen. Protein content ranged from 6.85 % in large intestine to 22.36 % in liver. The fat content ranged from 0.47 % in spleen to 9.85 % in large intestine. Ash content was

Table 4.17. Proximate composition in muscles of Doom pig

Parameters	***Triceps brachii***	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
			Control diet			
Moisture (%)	71.33±1.76	71.33± 1.45	72.00± 1.15	70.00± 0.57	70.66 ±1.45	72.66±1.20
Protein (%)	18.92±0.86	19.90± 0.82	18.72± 0.76	21.57± 0.87	19.84± 0.88	19.66± 0.88
Fat (%)	2.79±0.22	2.96±0.16	3.35±0.58	3.55±0.28	2.82±0.27	3.32±0.49
Ash (%)	0.69±0.86	0.75±0.04	0.64±0.01	0.77±0.01	0.63±0.01	0.71±0.00
Total Carbohydrate (%)	6.21 ±0.01	5.04± 0.02	5.28 ±0.05	2.84± 0.53	1.28 ±0.02	3.62 ±0.17
Calorie (kcal/100g)	116.82±2.86	127.74± 1.43	133.51± 1.73	124.38± 2.38	122.27± 0.87	123.1± 7.22
			Trial diet			
Moisture (%)	75.37±1.22	73.57±0.62	78.77±0.43	76.79±0.67	74.84±1.73	72.41±0.56
Protein (%)	22.30±0.68	19.85±1.16	18.53±0.62	21.23±1.05	20.00±0.52	21.19±0.39
Fat (%)	2.50±0.44	2.88±0.24	2.98±0.52	2.58±0.40	3.09±0.44	1.79±1.18
Ash (%)	0.79±0.00	0.76±0.02	0.82±0.02	0.83±0.02	0.72±0.00	0.70±0.01
Total Carbohydrate (%)	2.94±1.09	3.13±1.50	1.57±0.44	3.08±0.92	2.64±0.34	3.20±1.13
Calorie (kcal/100g)	123.49±10.34	117.85±1.40	107.29±3.04	120.41±3.95	118.17±1.68	116.60±1.59

Values are expressed in mean

Table 4.18. Statistical comparison (P-values) of proximate composition between control and trial diets in muscles of Doom pigs.

Parameters	***Triceps brachii***	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
Moisture (%)	0.1335	0.2289	0.2054	0.1016	0.1381	0.8579
Protein (%)	*0.0377	0.9754	0.8595	0.8161	0.8861	0.0806
Fat (%)	0.5896	0.7885	0.6656	0.1203	0.6352	*0.0439
Ash (%)	*0.0480	0.9532	*0.0012	0.1064	0.1023	0.6388
Total Carbohydrate (%)	0.3208	0.3826	0.2100	0.8357	0.1266	0.7325
Calorie (kcal/100g)	0.5681	*0.0078	0.3017	0.3066	0.0973	0.4295

*P-value < 0.05

found highest in liver with 1.19 %, and the lowest was found in large intestine with 0.16 %. The total carbohydrate among the viscera ranges from 10.18 % in spleen to 24.65 % in liver. The calorie content was the most abundant among the proximate content, highest observed in large intestine with 189.65 kcal/100g and lowest was in spleen with 124.22 kcal/100g.

Trial diet: The proximate content in viscera of Doom is tabulated in Table 4.19. The moisture content ranged from 51.65 % in liver to 68.30 % in spleen. Liver had the highest protein amount with a mean of 22.03 % and lowest was observed in large intestine with a mean of 5.95 %. The fat content ranged from 0.50 % in spleen to 8.45 % in large intestine. Ash content was found to be highest in liver of 1.42 % and lowest in large intestine of 0.17 %. The total carbohydrate was found highest in small intestine with an average of 25.65 % and lowest was found in spleen with 10.03 %. The calorie content ranged from 125.30 kcal/100g in spleen to 196.77 kcal/100g in large intestine.

The statistical comparison (P-values) of proximate composition between control and trial diets in viscera of Doom pig are depicted in Table 4.20.

4.5.3.3. Proximate composition in muscles of Ghungroo pig breed

Control diet: The proximate content in muscles of Ghungroo pig is tabulated in Table 4.21. The control diet fed Ghungroo pig's moisture content ranged from 72.13 to 79.33 %, with lowest in *longissimus dorsi* and highest in *biceps femoris* muscles. The protein content ranged from 20.10 to 22.62 %, with lowest in *gracilis* and highest in *longissimus dorsi* muscle. The

Table 4.19. Proximate composition in viscera of Doom pig

Parameters	Kidney	Small Intestine	Spleen	Liver	Heart	Large Intestine
Control diet						
Moisture (%)	61.93±1.43	64.72±2.18	68.47±0.99	50.67±1.22	55.25±1.57	64.11±1.26
Protein (%)	20.93±0.118	10.12±0.40	19.83±0.11	22.36±0.52	18.23±0.48	6.85±0.48
Fat (%)	2.28±0.28	0.58±0.03	0.47±0.02	1.12±0.17	1.16±0.56	9.85±0.51
Ash (%)	0.78±0.18	0.51±0.02	1.04±0.07	1.19±0.09	0.75±0.13	0.16±0.00
Total Carbohydrate (%)	14.06±0.94	24.05±1.83	10.18±1.05	24.65±1.03	24.59±1.98	19.02±1.13
Calorie (kcal/100g)	133.54±21.14	176.92±28.01	124.22±3.57	169.28±24.19	181.80±3.58	189.65±8.65
Trial diet						
Moisture (%)	64.93±1.75	63.75±1.75	68.30±0.59	51.65±1.07	54.05±1.16	61.12±1.24
Protein (%)	20.67±0.38	9.45±0.74	20.15±0.36	22.03±1.36	19.23±0.61	5.95±0.46
Fat (%)	1.82±0.22	0.59±0.01	0.50±0.02	0.95±0.04	1.06±0.47	8.45±0.67
Ash (%)	0.91±0.06	0.54±0.01	1.00±0.04	1.42±0.29	0.85±0.03	0.17±0.00
Total Carbohydrate (%)	11.66±1.86	25.65±1.02	10.03±0.66	23.93±1.94	24.73±1.78	24.08±0.61
Calorie (kcal/100g)	145.79±6.96	145.79±6.96	125.30±2.54	193.10±4.66	185.73±4.21	196.77±7.58

Values are expressed in mean

Table 4.20. Statistical comparison (P-values) of proximate composition between control and trial diets in viscera of Doom pigs.

Parameters	Kidney	Small Intestine	Spleen	Liver	Heart	Large Intestine
Moisture (%)	0.2569	0.7474	0.8926	0.5796	0.5741	0.1686
Protein (%)	0.5693	0.4752	0.4436	0.8312	0.2700	0.2494
Fat (%)	0.2732	0.8197	0.3097	0.4118	0.8987	0.1732
Ash (%)	0.5273	0.5102	0.6745	0.4933	0.5213	0.3453
Total Carbohydrate (%)	0.3153	0.4887	0.9099	0.7622	0.9607	*0.0173
Calorie (kcal/100g)	0.6215	0.3415	0.8170	0.3884	0.5445	0.5695

*P-value < 0.05

fat percentage ranged from 3.03 % in *longissimus dorsi* to 4.25 % in *gracilis* muscles. The total carbohydrate percentage ranged from 0.44 % in triceps brachii to 5.43 % in *tensor fasciae latae*. Calorie content expressed in kcal/100g ranged from 144.38 to 116.82 kcal/100g.

Trial diet: The proximate content in muscles of Ghungroo pig is tabulated in Table 4.21. Trial diet fed Ghungroo pig's moisture content ranged from 71.18 to 79.50 %, where the lowest for *longissimus dorsi* and highest was for *biceps femoris* muscles. Protein content ranged from 19.33 to 22.17 % with lowest in *biceps femoris* and highest in *longissimus dorsi*. Fat content ranged from 2.47 to 3.22 % noted in *triceps brachii* and *gracilis* muscles. Ash content was the lowest among the proximate content ranging from 0.73 to 0.82 %. The total carbohydrate ranged from 4.72 % in *longissimus dorsi* to 2.50 % in *biceps femoris*. The calorie content was found highest in *tensor fasciae latae* with 133.24 kcal/100g and lowest in *gracilis* muscle with 120.49 kcal/100g.

The statistical comparison (P-values) of proximate composition between control and trial diets in muscles of Ghungroo pig are depicted in Table 4.22.

4.5.3.4. Proximate composition in viscera of Ghungroo pig breed

Control diet: The proximate content in viscera of Ghungroo pigs is tabulated in Table 4.23. The moisture content of the viscera ranged from 50.07 to 66.90 %, where the lowest was noted

Table 4.21. Proximate composition in muscles of Ghungroo pig

Parameters	***Triceps brachii***	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
			Control diet			
Moisture (%)	76.00±2.08	77.00±2.08	79.33±2.90	78.33±1.76	73.66±1.76	72.13±1.14
Protein (%)	20.47±0.44	21.58±0.27	20.13±0.22	21.99±0.38	20.10±0.45	22.62±0.80
Fat (%)	3.13±0.08	3.40±0.24	3.99±0.07	3.42±0.23	4.25±0.22	3.03±0.08
Ash (%)	0.84±0.02	0.81±0.02	0.81±0.02	0.84±0.02	0.75±0.00	0.76±0.03
Total Carbohydrate (%)	0.44±0.01	2.77±0.02	3.84±0.05	5.43±0.16	1.28±0.02	1.43±0.37
Calorie (kcal/100g)	116.82±2.86	127.74±1.43	133.51±1.73	144.38±2.38	122.27±0.87	123.58±4.32
			Trial diet			
Moisture (%)	77.66±0.88	74.24±1.44	79.50±0.42	77.79±0.88	73.51±0.94	71.18±0.81
Protein (%)	21.63±0.98	21.08±0.98	19.33±0.62	21.12±0.57	19.70±0.25	22.17±0.87
Fat (%)	2.47±0.46	3.08±0.40	2.85±0.41	3.18±0.49	3.22±0.49	3.16±0.53
Ash (%)	0.80±0.01	0.78±0.01	0.81±0.02	0.81±0.02	0.82±0.02	0.73±0.01
Total Carbohydrate (%)	3.20±1.78	2.77±1.33	2.50±1.09	3.97±0.30	3.16±1.28	4.72±0.98
Calorie (kcal/100g)	121.57±15.16	123.17±1.97	113.04±8.02	133.24±5.29	120.49±2.75	123.74±4.75

Values are expressed in mean

Table 4.22. Statistical comparison (P-values) of proximate composition between control and trial diets in muscles of Ghungroo pigs.

Parameters	***Triceps brachii***	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
Moisture (%)	0.5019	0.3079	0.9558	0.7965	0.9426	0.5345
Protein (%)	0.3410	0.6501	0.2919	0.8162	0.4869	0.2774
Fat (%)	0.2321	0.5323	0.0521	0.6917	0.1549	0.0824
Ash (%)	0.2458	0.3395	0.8964	0.5734	0.1841	0.2269
Total Carbohydrate (%)	0.1967	0.9981	0.2881	*0.0135	0.2194	*0.0356
Calorie (kcal/100g)	0.7734	0.1344	0.0672	0.1275	0.5703	0.9817

*P-value < 0.05

In liver and highest in large intestine. Protein content ranged from 5.51 to 23.29 %, lowest in large intestine and highest in liver. The fat content ranged from 0.41 to 10.05 % with lowest in spleen and high in large intestine. Ash ranged from 0.22 to 1.27 %. The total carbohydrate among the viscera ranged from 11.92 to 25.88 % lowest in kidney and high in small intestine. The calorie content ranged from 136.43 to 200.41 kcal/100g, lowest in spleen and high in liver.

Trial diet: The proximate content in viscera of Ghungroo pigs is tabulated in Table 4.23. Moisture content was highest in kidney with a mean of 63.17 % and lowest in liver with a mean of 55.01 %. Protein percentage was found highest in liver (23.83 %) and lowest was in large intestine (4.17 %). Fat content in viscera ranged from 0.80 to 8.58 %. Ash content was found to be highest in liver of 1.45 % and lowest in large intestine of 0.17 %. Total carbohydrate ranged from 12.59 to 27.36 %. The calorie content ranged from 150.31 kcal/100g in spleen to 178.13 kcal/100g in liver.

The statistical comparison (P-values) of proximate composition between control and trial diets in muscles of Ghungroo pig are depicted in Table 4.24.

4.5.4. Statistical analysis of proximate contents based on two experimental diets

To compare the proximate composition between the two experimental diets of Doom and Ghungroo pig breeds, 'independent samples T-test' was performed using SPSS software (version 21.0). At 95 % confidence interval of the difference, both the experimental diets, did

Table 4.23. Proximate composition in viscera of Ghungroo pig

Parameters	Kidney	Small Intestine	Spleen	Liver	Heart	Large Intestine
			Control diet			
Moisture (%)	62.60±1.18	63.92±1.42	65.13±1.65	50.07±0.80	53.64±0.77	66.90±1.43
Protein (%)	22.47±0.66	8.99±0.39	18.99±0.55	23.29±0.42	18.88±0.58	5.51±0.73
Fat (%)	1.88±0.17	0.68±0.03	0.41±0.03	1.02±0.02	0.81±0.34	10.05±0.42
Ash (%)	1.12±0.16	0.52±0.02	1.27±0.23	1.10±0.06	0.55±0.05	0.22±0.02
Total Carbohydrate (%)	11.92±1.94	25.88±1.54	14.17±1.86	24.49±1.01	26.10±0.55	17.3±1.59
Calorie (kcal/100g)	154.54±4.24	145.16±5.16	136.43±7.44	200.41±3.03	187.29±2.26	181.74±3.69
			Trial diet			
Moisture (%)	63.17±0.48	62.45±1.02	62.30±1.17	55.01±1.65	57.88±0.82	60.90±1.83
Protein (%)	21.63±0.36	8.44±0.74	20.66±0.32	23.83±0.48	18.63±0.80	4.17±0.47
Fat (%)	1.64±0.21	1.29±0.35	0.74±0.11	0.80±0.13	1.35±0.37	8.58±0.46
Ash (%)	0.94±0.04	0.60±0.04	1.04±0.01	1.45±0.05	0.87±0.00	0.17±0.01
Total Carbohydrate (%)	12.59±0.97	27.36±0.86	15.24±1.59	18.90±1.26	21.25±0.62	19.16±1.52
Calorie (kcal/100g)	151.72±1.05	154.87±4.78	150.31±4.28	178.13±6.96	171.69±2.08	170.64±7.66

Values are expressed in mean

Table 4.24. Statistical comparison (P-values) of proximate composition between control and trial diets in viscera of Ghungroo pigs.

Parameters	Kidney	Small Intestine	Spleen	Liver	Heart	Large Intestine
Moisture (%)	0.6788	0.4511	0.2350	0.0548	*0.0200	0.6903
Protein (%)	0.3366	0.5483	0.0601	0.4544	0.8144	0.1999
Fat (%)	0.4302	0.1618	0.0568	0.1823	0.3595	0.0809
Ash (%)	0.3617	0.2073	0.3851	*0.0159	*0.0056	0.1596
Total Carbohydrate (%)	0.7715	0.4507	0.6849	*0.0263	*0.0044	0.4451
Calorie (kcal/100g)	0.5550	0.2400	0.1811	*0.0427	*0.0072	0.2618

*P-value < 0.05

not show significant differences in the proximate composition, meaning both the diets had similar outputs. Therefore, since no significant differences were observed in the results of proximate analysis with the feeding of two different experimental diets, the biochemical analysis i.e., fatty acid content, amino acid content and mineral content in muscles and viscera of Doom and Ghungroo pig breeds were continued only with one experimental diet (i.e., trial diet).

4.5.5. Comparing the proximate content of pigs with other red meats

As mentioned earlier in the materials and method part, six muscles were dissected from three regions of Doom and Ghungroo pig's carcass namely, shoulder (*triceps brachii* and *latissimus dorsi*), ham (*biceps femoris*, *tensor fasciae latae* and *gracilis*) and loin (*longissimus dorsi*). Therefore, proximate values of two muscles namely; *triceps brachii* and *latissimus dorsi* were taken as they were dissected from shoulder region to compare with shoulder region of goat, sheep and beef. Shoulder region was taken here, as data were not available for other regions of goat, sheep and beef. In the subsequent sections, the proximate composition, essential amino acids, fatty acids, and mineral content of the shoulder region of Doom and Ghungroo pigs will be compared with those of goat, sheep, and beef.

4.5.5.1. Comparison of muscle proximate composition: Doom and Ghungroo pigs vs. Goat, Sheep and Beef.

Proximate content of muscles of Doom and Ghungroo are compared with proximate content of other red meats (goat, sheep and beef) (Figure 4.f.). The data for goat, sheep, and beef were sourced from the Indian Food Composition Database (2017) published by the Indian Council of Medical Research (ICMR), Department of Health Research, Ministry of Health and Family Welfare, India (Longvah et al., 2017). The moisture content of Doom and Ghungroo pig were higher than goat sheep and beef. The protein content was similar in all the analysed animals, except for sheep which was slightly low. Ash content in Doom and Ghungroo pig were low compared to goat, sheep and beef. The data for calorie and carbohydrate content for goat, sheep and beef were not available.

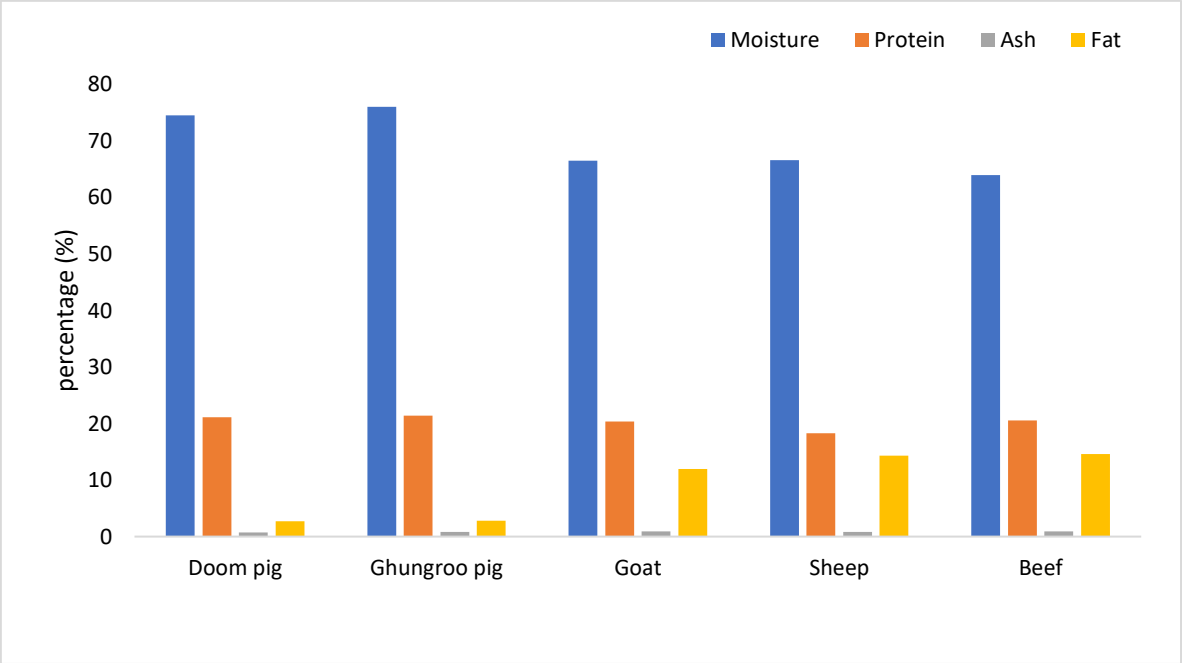

Figure 4.f. Comparison of Doom and Ghungroo pig's proximate content with goat, sheep and beef based on shoulder regions.

4.5.5.2. Comparison of viscera's proximate composition: Doom and Ghungroo pigs vs. Goat, Sheep and Beef.

The proximate content (moisture, protein, ash, fat and calorie) of viscera of Doom and Ghungroo are compared with proximate content of other red meats (goat, sheep and beef),

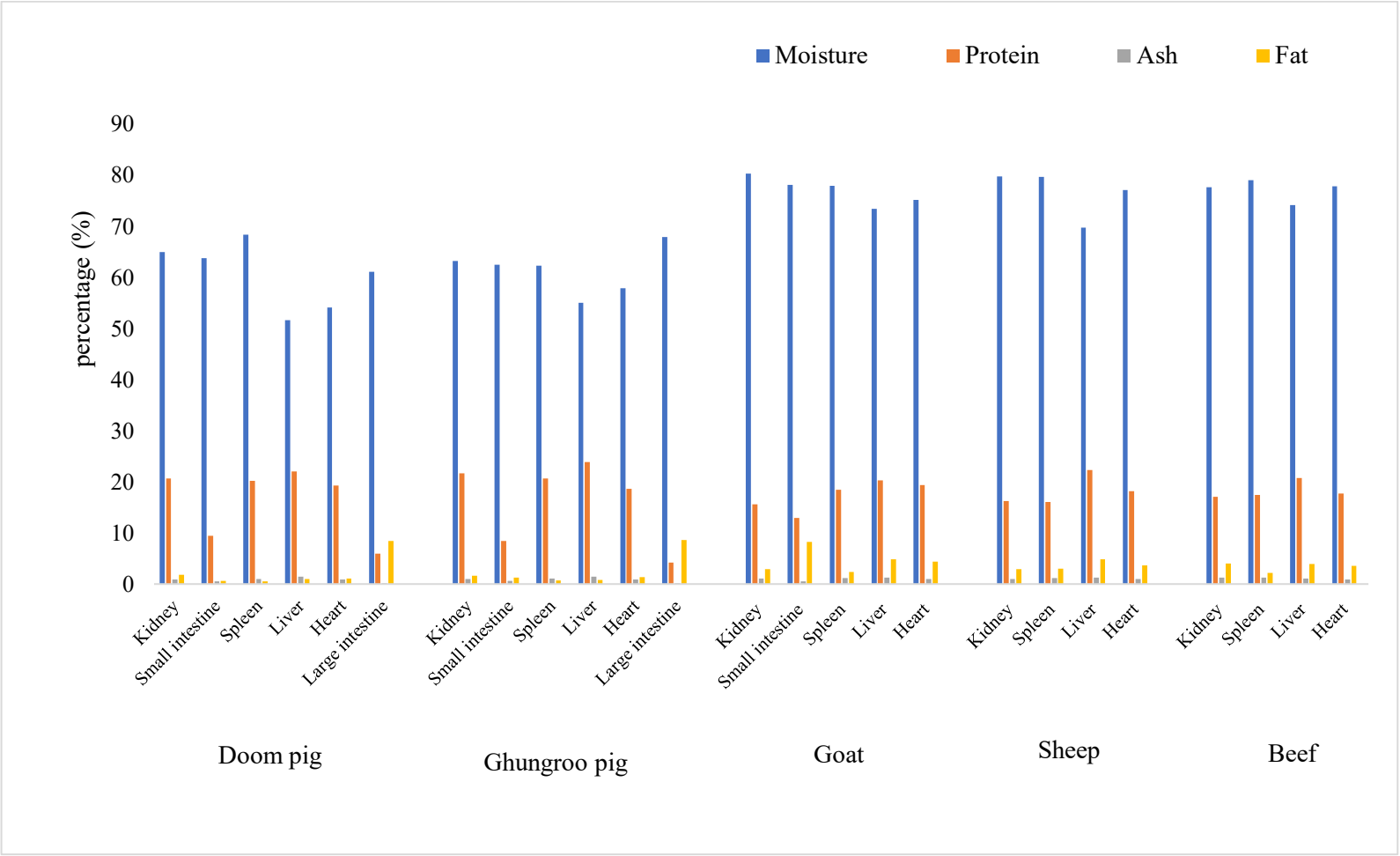

Figure 4.g. Comparison of Doom and Ghungroo pig's proximate content with goat, sheep and beef in viscera. (Note: Proximate content of large intestine of goat was not available, including small intestine and large intestine of sheep and beef).

depicted in Figure 4.g. In case of viscera, the overall moisture content of Doom and Ghungroo pig were slightly lower than those of goat, sheep and beef. The overall protein content was similar among all the analyzed animals. Overall ash content in viscera of Doom and Ghungroo pig was slightly lower than goat, sheep and beef. The overall fat content of Doom and Ghungroo pig too was slightly lower than goat, sheep and beef.

4.5.6. Amino acid content in muscles and viscera

4.5.6.1. Amino acid content in muscles of Doom pig breed

The amino acid composition of Doom pig breed of trial fed diet is given in Table 4.25. The essential amino acids (EAA) analysed in the muscles of Doom pig are valine, isoleucine, methionine, phenylalanine and tryptophan. Among the EAA, methionine and phenylalanine were the highest ranging from 1.28 to 3.83 g/100g and from 2.64 to 5.36 g/100g, respectively. The overall highest total essential amino acids (TEAA) content was observed in *longissimus dorsi* muscle, and the lowest was noted in *gracilis* muscle. Alanine was found to contain the highest total non-essential amino acid (TNEAA) in the muscles of Doom ranging from 1.10 g/100g in *longissimus dorsi* to 1.75 g/100g in *gracilis* muscle.

Table 4.25. Amino acid content (g/100g) in six muscles of Doom pig.

	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
Valine	0.55±0.05	0.86±0.01	0.87±0.02	1.05±0.03	0.45±0.01	0.33±0.02
Isoleucine	0.34±0.01	0.50±0.02	0.53±0.03	0.34±0.01	0.44±0.01	0.95± 0.03
Methionine	1.62±0.16	1.90±0.20	1.28±0.04	1.86±0.36	1.47±0.10	3.83±0.30
Phenylalanine	3.18±0.54	4.19±0.41	2.64±0.22	3.55±0.41	2.70±0.52	5.36±0.35
Tryptophan	0.81±0.01	1.18±0.03	1.24±0.03	0.85±0.02	1.08±0.04	1.26± 0.03
TEAA	**6.50±0.77**	**8.63±0.67**	**6.56±0.34**	**7.65±0.84**	**6.14±0.68**	**11.73±0.73**
Glycine	0.73±0.10	0.48±0.01	0.77±0.03	1.20±0.04	0.58±0.01	0.63±0.02
Aspartic acid	0.31±0.01	0.74±0.01	0.94±0.02	0.41±0.03	0.59±0.01	0.62±0.02
Glutamic acid	1.42±0.10	0.91±0.01	1.21±0.02	1.05±0.02	1.83±0.32	0.94±0.02
Alanine	1.18±0.28	1.49±0.07	1.53±0.02	1.38±0.32	1.75±0.10	1.10±0.23
TNEAA	**3.64±0.49**	**3.62±0.10**	**4.45±0.09**	**4.04±0.41**	**3.21±0.27**	**4.83±0.46**

Values are expressed in mean ± standard error of mean (SEM)

4.5.6.2. Amino acid content in viscera of Doom pig:

The composition of amino acids in six viscera of Doom pig is presented in Table 4.26. Among the EAA's, isoleucine and phenylalanine were the highest in all analysed viscera of Doom pig. Isoleucine ranged from 0.05 to 11.25 g/100g and phenylalanine ranged from 0.05 to 14.22 g/100g. While other EAA's, like valine, methionine and tryptophan were in the range of moderate values. Valine ranged from 0.06 g/100g in spleen to 4.83 g/100g in heart. Methionine ranged from 0.03 g/100g (heart) to 1.40 g/100g (spleen). Tryptophan ranged from 0.29 g/100g (small intestine) to 2.43 g/100g (liver). The overall highest TEAA was observed in viscera was spleen (23.38 g/100g) and lowest was in heart (6.61 g/100g). While for NEAA's glutamic acid was to be the highest ranging from 0.24 g/100g to 25.19 g/100g observed in heart and liver. Alanine was found the lowest ranging from 0.02 g/100g to 4.04 g/100g. Among the viscera, the TNEAA's was observed highest in liver (47.95 g/100g) and lowest in heart (10.11 g/100g).

Table 4.26. Amino acid content (g/100g) in six viscera of Doom pig.

	Kidney	Small intestine	Spleen	Liver	Heart	Large intestine
Valine	0.16±0.00	6.26±0.01	0.06±0.01	0.19±0.02	4.83±0.00	1.02±0.00
Isoleucine	11.25±0.33	7.74±0.33	6.72±0.00	0.33±0.01	0.05±0.01	11.20±0.30
Methionine	0.24±0.02	0.04±0.01	1.40±0.01	0.36±0.01	0.03±0.00	0.34±0.01
Phenylalanine	1.88±0.02	6.48±0.01	14.22±0.14	9.65±0.01	0.05±0.01	0.73±0.02
Tryptophan	0.55±0.00	0.29±0.01	0.98±0.00	2.43±0.31	1.65±0.03	0.53±0.02
TEAA	**14.08±0.37**	**20.81±0.37**	**23.38±0.16**	**12.96±0.36**	**6.61±0.05**	**13.82±0.35**
Glycine	3.69±0.02	4.02±0.33	2.23±0.30	1.34±0.12	6.99±0.01	6.98±0.01
Aspartic acid	1.93±0.01	6.96±0.02	1.10±0.03	17.38±0.01	2.86±0.02	2.36±0.00
Glutamic acid	13.12±0.02	15.92±0.02	3.84±0.04	25.19±0.32	0.24±0.00	2.55±0.04
Alanine	0.04±0.00	0.03±0.00	3.97±0.01	4.04±0.07	0.02±0.01	0.08±0.01
TNEAA	**18.78±0.05**	**26.93±0.37**	**11.14±0.38**	**47.95±0.52**	**10.11±0.04**	**11.97±0.06**

Values are expressed in mean ± standard error of mean (SEM)

4.5.6.3. Amino acid content in muscles of Ghungroo pig:

The amino acid composition of Ghungroo pig breed is given in Table 4.27. Among the essential amino acids, phenylalanine and methionine were the highest ranging from 2.87 to 8.72 mg/100g and 1.59 to 3.41 mg/100g, respectively. Both the essential amino acids (EAA) phenylalanine and methionine were noted highest in *longissimus dorsi* muscle. Valine ranged from 0.29 to 1.10 g/100g. Another EAA, isoleucine ranged from 0.45 to 0.80 g/100g. While tryptophan ranged from 0.55 to 1.30 g/100g. Among the muscle *longissimus dorsi* (14.07 g/100g) showed the highest concentration of overall TEAA's and lowest was observed in gracilis (7.03 g/100g) muscle. Among the total non-essential amino acids (TNEAA), alanine was the highest of all ranging from 1.51 to 3.25 g/100g with lowest observed in *gracilis* and highest in *latissimus dorsi* muscles. Other than alanine, glutamic acid ranged from 0.92 to 2.20 g/100g and aspartic acid ranged from 0.38 to 0.94 g/100g. Glycine was observed highest in *triceps brachii* (9.78 g/100g) and lowest in *longissimus dorsi* (0.45 g/100g). Among the muscles, *triceps brachii* (14.76 g/100g) muscle was found with the highest concentration of NEAA's and lowest was observed in *gracilis* (3.70 g/100g) muscle.

Table 4.27. Amino acid content (g/100g) in six muscles of Ghungroo pig.

	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
Valine	0.64±0.06	0.90±0.02	0.91±0.04	1.10±0.03	0.51± 0.04	0.29±0.09
Isoleucine	0.51±0.04	0.69±0.03	0.73±0.00	0.45±0.01	0.60± 0.02	0.80±0.02
Methionine	1.95±0.25	1.70±0.33	1.59±0.39	2.16±0.29	1.85± 0.36	3.41±0.38
Phenylalanine	4.19±0.36	5.58±0.37	3.60±0.41	4.52±0.36	2.87± 0.26	8.72±0.88
Tryptophan	1.20±0.14	0.55±0.01	1.30±0.06	0.67 0.02	1.20±0.02	0.85±0.03
EAA	**8.49±0.85**	**9.42±0.76**	**8.13±0.9**	**8.90±0.71**	**7.03±0.70**	**14.07±1.40**
Glycine	9.78±0.04	0.51±0.04	0.72±0.04	1.20±0.04	0.59±0.02	0.45±0.07
Aspartic acid	0.42±0.02	0.77±0.02	0.94±0.01	0.38±0.01	0.63±0.00	0.59±0.01
Glutamic acid	2.20±0.00	0.92±0.00	1.23±0.02	1.13±0.05	0.97±0.01	1.25±0.01
Alanine	2.36±0.59	3.25±0.59	1.59±0.05	1.97±0.33	1.51±0.49	1.99±0.31
NEAA	**14.76±0.65**	**5.45±0.65**	**4.48±0.12**	**4.68±0.43**	**3.70±0.52**	**4.28±0.40**

values are expressed in mean ± standard error of mean (SEM)

4.5.6.4. Amino acid content in viscera of Ghungroo pig

The amino acid content of six edible viscera of Ghungroo pig is tabulated in Table 4.28. Isoleucine concentration was observed highest among the EAA's ranging from 0.12

g/100g (heart) to 10.00 g/100g (spleen). Another EAA that was recorded with highest concentration was phenylalanine ranging from 1.22 to 11.05 g/100g. Valine content ranged from 0.09 to 5.80 g/100g. Methionine ranged from 0.36 to 1.63 g/100g and tryptophan ranged from 0.76 to 3.33 g/100g. Among the viscera, the overall TEAA's was noted high in spleen (22.76 g/100g) and lowest was observed in heart (8.34 g/100g).

Among the NEAA's the concentration of glutamic acid was found the highest ranging from 0.31 to 22.73 g/100g. Followed by aspartic acid ranging from 1.74 to 16.74 g/100g. Glycine and alanine were low compared to glutamic acid and other two, ranging from 1.13 to 8.06 g/100g and 0.14 to 2.94 g/100g. Among the viscera of Ghungroo pig, liver (43.54 g/100g) was found to have the highest concentration of overall TNEAA's and lowest was observed for spleen (9.50 g/100g).

Table 4.28. Amino acid content (g/100g) in six viscera of Ghungroo pig.

		Small				**Large**
	Kidney	**intestine**	**Spleen**	**Liver**	**Heart**	**intestine**
Valine	1.27±0.06	0.09±0.59	5.80±0.01	0.78±0.33	3.67±0.03	0.82±0.34
Isoleucine	9.76±0.33	5.68± 0.35	10.00±0.24	1.50±0.06	0.12±0.00	9.64±0.29
Methionine	0.98±0.03	0.36±0.02	1.09±0.59	1.63±0.26	0.64±0.00	1.39±0.07
Phenylalanine	3.83±0.11	7.14±0.35	2.54±0.06	11.05±0.10	1.85±0.09	1.22±0.00
Tryptophan	2.00±0.07	2.96±0.24	3.33±0.03	2.02±0.54	2.06±0.05	0.76±0.04
EAA	**17.84±0.60**	**16.23±1.55**	**22.76±1.56**	**16.98±1.20**	**8.34±0.17**	**13.83±0.74**
Glycine	4.16±0.27	4.79±0.23	1.91±0.81	1.13±0.44	8.06±0.29	6.25±0.06
Aspartic acid	3.19±0.34	7.92±0.37	1.74±0.01	16.74±0.28	2.58±0.06	3.50±0.05
Glutamic acid	13.48±0.33	16.42±0.33	3.05±0.27	22.73±0.34	0.31±0.02	2.15±0.25
Alanine	0.65±0.06	0.15±0.03	2.80±0.06	2.94±0.19	0.19±0.09	0.14±0.02
NEAA	**21.48±0.10**	**29.28±0.96**	**9.50±1.15**	**43.54±1.25**	**11.14±0.46**	**12.04±0.38**

values are expressed in mean ± standard error of mean (SEM)

4.5.6.5. Essential amino acid content in Doom and Ghungroo pig's muscles and its requirements for adults.

The recommendation intakes for essential acids by FAO/WHO, (1973) are tabulated in Tables 4.29. and 4.30. The composition of essential amino acid of muscles of Doom pig are presented in percentage by calculating its amino acid chemical score (AACS). The chemical

score of amino acid is used to determine the quality of protein of any food on the basis of their amino acid content, mainly when associated with the human dietary requirements. The chemical scores of the essential amino acids - methionine and phenylalanine in muscles of both the pig breeds were found to be high, along with their content measured in grams. The chemical score of all the individual muscles studied in both the pig breeds was found to meet the requirements recommended for adults by FAO/WHO, 1973.

Table 4.29. Essential amino acids content of muscles of Doom and its requirements for adults

Amino acid	**Chemical score (%)**						**Recommendation for adults (mg/kg per day)**
	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***	
Valine	22	34.4	34.8	42	18	13.2	10
Isoleucine	38	20	21.2	13.6	17.6	13.6	10
*Methionine plus cysteine	153.2	76	51.2	74.4	58.8	64.8	13
**Phenylalanine plus tyrosine	214.4	167.6	105.6	142	108	127.2	14
Tryptophan	50.4	47.2	49.6	34	43.2	32.4	3.5

*= values without addition of cysteine, **= values without addition of tyrosine; source of recommended intake of essential amino acids (EAA's) from FAO/WHO, 1973.

Table 4.30. Essential amino acids content of muscles of Ghungroo and its requirements for adults.

Amino acid	**Chemical score (%)**						**Recommendation for adults (mg/kg per day)**
	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***	
Valine	25.6	36	36.4	44	20.4	11.6	10
Isoleucine	32	27.6	29.2	18	24	20.4	10
*Methionine plus cysteine	136.4	68	63.6	86.4	74	78	13
**Phenylalanine plus tyrosine	348.8	223.2	144	180.8	114.8	167.6	14
Tryptophan	48	22	52	26.8	48	34	3.5

*= values without addition of cysteine, **= values without addition of tyrosine; source of recommended intake of essential amino acids (EAA's) from FAO/WHO, 1973.

4.5.6.6. Essential amino acid content in Doom and Ghungroo pig's viscera and its requirements for adults.

The daily recommended intake as suggested for EAA's for viscera is depicted in Tables 4.31. and 4.32. The chemical score for valine in the kidney, spleen and liver of Doom was observed to be lower than the suggested recommended intake, while small intestine, heart and large intestine met the suggested intakes. Chemical score of heart for isoleucine of Doom and Ghungroo was the lowest and did meet the allowed ranged, while others fulfilled the allowed intake. Chemical score of methionine, phenylalanine and tryptophan in all the viscera of Doom and Ghungroo pigs met with the daily intakes.

Table 4.31. Essential amino acids of viscera of Doom and its requirements for adults.

Amino acid	Chemical score (%)						Recommendation for adults (mg/kg per day)
	Kidney	Small intestine	Spleen	Liver	Heart	Large intestine	
Valine	6.4	250.4	2.4	7.6	192.2	40.8	10
Isoleucine	450	109.6	268.8	13.2	2	248	10
*Methionine plus cysteine	32.6	21.6	56	14.4	19.2	23.6	13
**Phenylalanine plus tyrosine	75.2	259.2	568.8	386	43	29.2	14
Tryptophan	22	11.6	39.2	97.2	66	21.2	3.5

*= values without addition of cysteine, **= values without addition of tyrosine; source of recommended intake of essential amino acids (EAA's) from FAO/WHO, 1973.

Table 4.32. Essential amino acids of viscera of Ghungroo and its requirements for adults.

Amino acid	Chemical score (%)						Recommendation for adults (mg/kg per day)
	Kidney	Small intestine	Spleen	Liver	Heart	Large intestine	
Valine	50.8	23.2	3.6	31.2	146.8	32.8	10
Isoleucine	390.4	400	227.2	60	4.8	185.6	10
*Methionine plus cysteine	39.2	14.4	43.6	65.2	25.6	35.6	13
**Phenylalanine plus tyrosine	153.2	285.6	101.6	442	74	48.8	14
Tryptophan	80	118.4	133.4	80.8	48.8	30.4	3.5

*= values without addition of cysteine, **= values without addition of tyrosine; source of recommended intake of essential amino acids (EAA's) from FAO/WHO, 1973.

4.5.6.7. Comparison of Essential amino acid of muscles: Doom and Ghungroo pigs vs. Goat, Sheep and Beef.

The essential amino acid (EAA's) compared based on shoulder region are depicted in Figure. 4.h. The valine and isoleucine content in the shoulder region of Doom and Ghungroo pig were low compared to shoulder region of goat, sheep and beef. The methionine content in shoulder region of Doom and Ghungroo was similar with that of shoulder region of goat, sheep and beef. The phenylalanine content in shoulder region of Doom and Ghungroo and was higher than that of shoulder region of goat, sheep and beef. Tryptophan content in shoulder region of Doom and Ghungroo pig was slightly higher than that of goat, sheep and beef. (Note: The isoleucine content of goat was not available).

4.5.6.8. Comparison of Essential amino acid of viscera: Doom and Ghungroo pigs vs. Goat, Sheep and Beef.

The essential amino acid (EAA's) of viscera of Doom and Ghungroo pig and that of Goat, Sheep and Beef are depicted in Figure. 4.i. The valine content in viscera of Doom and Ghungroo were on average two times lower than those of goat, sheep and beef. The overall

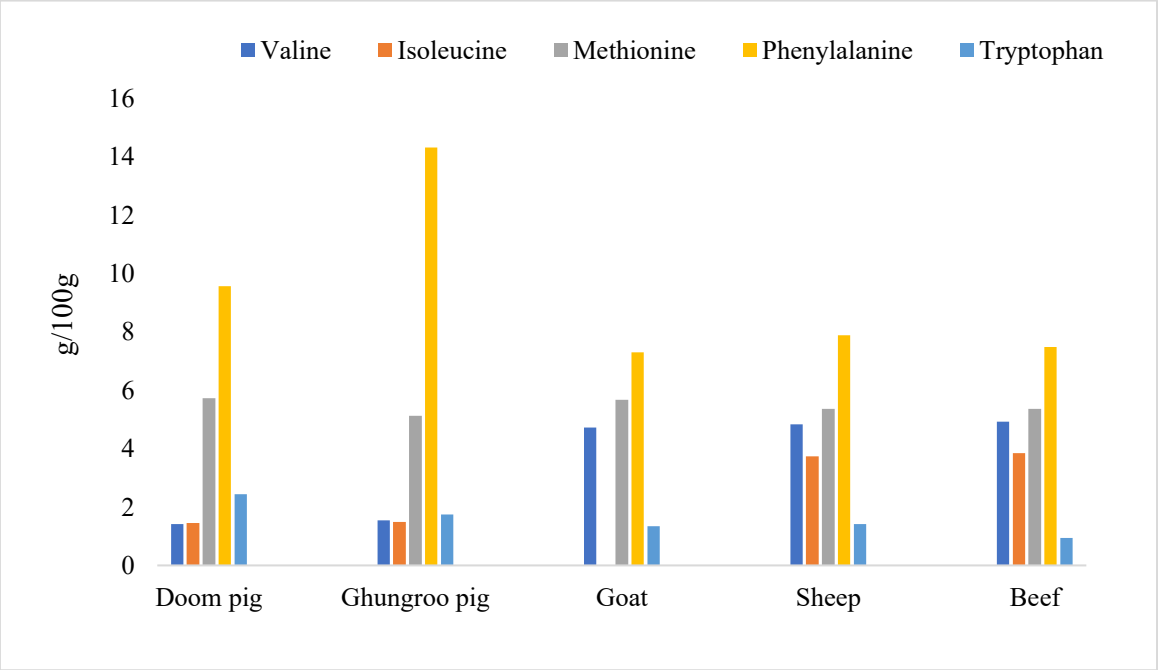

Figure 4.h. Essential amino acid (EAA's) of shoulder region of Doom and Ghungroo pig compared with goat, sheep and beef.

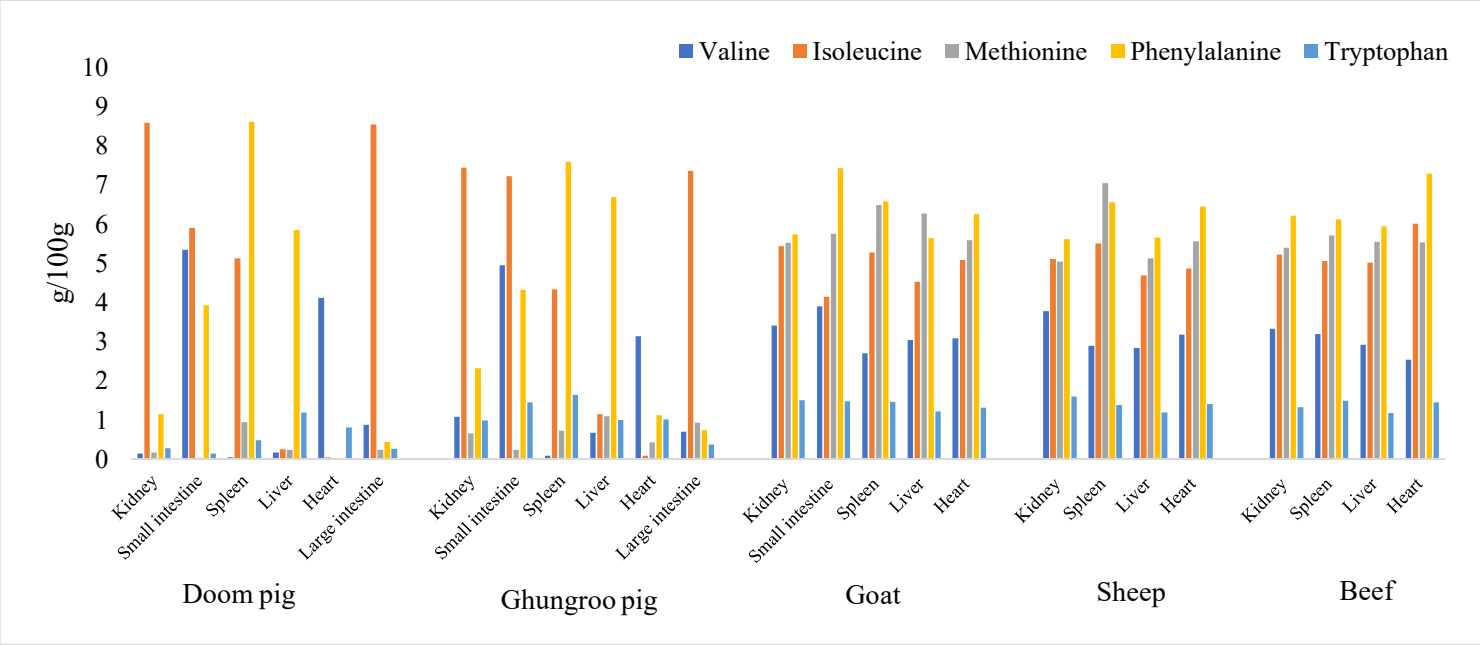

Figure 4.i. Essential amino acid (EAA's) of viscera of Doom and Ghungroo pig compared with goat, sheep and beef. Note: EAA value of large intestine of goat was not available, including small intestine and large intestine of sheep and beef.

isoleucine content for Doom and Ghungroo pigs high than goat, sheep and beef. In-case of methionine overall content of Doom and Ghungroo pigs were low, however that of goat, sheep and beef were high. The overall phenylalanine content in viscera of Doom pig was the lowest, while that of other red meats were highest. The overall tryptophan content in viscera of Doom and Ghungroo pig were the lowest, while goat, sheep and were the highest.

4.5.7. Fatty acid composition in muscles and viscera

The chromatogram of the fatty acids studied in muscles and viscera of Doom and Ghungroo pig breeds are provided in Appendix-VIII.

4.5.7.1. Fatty acid composition in muscles of Doom pig.

The percentage of saturated fatty acids (SFA's) were the highest, followed by monounsaturated fatty acid (MUFA's) and lowest was observed for polyunsaturated fatty acids (PUFA) (Table 4.33). Among the SFA's, palmitic acid content was the highest ranging from 14.61 to 22.43 %, lowest in *biceps femoris* and highest in *tensor fasciae latae*. Stearic acid

Table 4.33. Fatty acid composition (%) in muscles of Doom pig.

	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
Palmitic acid	19.95±0.80	17.88±2.74	14.61±2.15	22.43±1.17	15.66±2.18	21.52±1.86
Stearic acid	2.58±0.20	1.27±0.20	1.81±0.53	2.26±0.25	5.84±1.59	4.03±1.40
Lauric acid	2.84±0.21	3.26±0.20	2.27±0.50	4.55±0.33	3.51±0.04	3.80±1.36
Myristic acid	2.77±0.43	3.41±0.10	1.79±0.42	3.30±0.87	1.57±0.48	2.44±0.77
Total SFA's	**28.14±1.64**	**22.41±3.24**	**20.48±3.6**	**32.54±2.62**	**26.58±4.29**	**31.79±5.39**
Oleic acid	30.63±1.56	27.50±2.93	12.59±0.41	25.69±1.70	22.68±1.32	18.42±3.24
Palmitoleic acid	6.44±0.97	4.75±0.28	1.58±0.36	1.85±0.16	2.39±0.41	5.13±0.55
Total MUFA's	**37.07±2.53**	**32.25±3.21**	**14.17±0.77**	**27.54±1.86**	**25.07±1.73**	**23.55±3.79**
Alpha Linolenic acid-ALA	1.85±0.52	2.56±0.63	1.23±0.19	3.85±0.36	2.97±0.08	2.23±0.08
Arachidonic acid (ARA)	1.77±0.79	0.65±0.10	1.85±0.55	1.69±0.23	0.79±0.10	1.99±0.18
Total PUFA's	**3.62±0.70**	**3.21±0.73**	**3.08±0.67**	**5.54±0.59**	**3.76±0.18**	**4.22±0.87**

Note: SFA's = Saturated fatty acids, MUFA's = Monounsaturated fatty acids, PUFA's = Polyunsaturated fatty acids; values are expressed in mean

ranged from 1.27 to 5.84 %. Lauric acid ranged from 2.27 to 4.55%. Myristic acid ranged from 1.57 to 3.41 %. The total SFA's was observed highest for *tensor fasciae latae* and lowest for *biceps femoris* muscle. Among, the MUFA's, oleic acid was the highest of all ranging from 18.42 to 30.63 %. Another MUFA detected is the palmitoleic acid, ranging from 1.58 to 6.44 %. Total MUFA was noted high in *triceps brachii* and low in *biceps femoris* muscles. PUFA's detected were alpha linolenic acid (ALA) and arachidonic acid (ARA), ranging from 1.23 to 3.85 % and 0.65 to 1.99 %, respectively. *Longissimus dorsi* muscle was recorded for highest concentration of PUFA.

4.5.7.2. Fatty acid composition in viscera of Doom pig.

Saturated fatty acids (SFA's) percentage were the highest, while monounsaturated fatty acid (MUFA's) and polyunsaturated fatty acids (PUFA) percentage were low (Table 4.34). Among the SFA's analyzed the concentration of palmitic acid and stearic acid were found highest among others. The palmitic acid ranged from 13.26 to 23.57 %, lowest in liver and high in small intestine. Stearic acid ranged from 10.72 to 22.04 %. Lauric acid were low compared to palmitic and stearic acid, ranging from 1.07 to 4.29 %. Myristic acid ranged from 1.64 to

Table 4.34. Fatty acid composition (%) in viscera of Doom pig.

	Kidney	**Small intestine**	**Spleen**	**Liver**	**Heart**	**Large intestine**
Palmitic acid	17.68±1.12	23.57±0.76	20.41±0.38	13.26±0.55	16.67±1.42	22.74±1.62
Stearic acid	10.72±1.07	16.41±0.89	16.10±0.56	14.65±1.42	12.21±0.72	22.04±1.02
Lauric acid	2.04±0.08	4.29±0.56	2.67±0.27	2.00±0.10	1.07±0.21	1.98±0.06
Myristic acid	2.64±0.27	3.43±0.60	1.94±0.43	1.64±0.28	2.53±0.48	2.79±0.53
Total SFA's	**33.04±2.54**	**47.70±2.81**	**41.12±1.64**	**31.55±2.35**	**32.48±2.83**	**49.55±3.23**
Oleic acid	0.65±0.01	1.09±0.01	1.26±0.01	0.92±0.08	0.27±0.03	1.76±0.02
Palmitoleic acid	1.72±0.31	1.57±0.32	1.03±0.06	1.04±0.08	1.90±0.34	1.14±0.09
Total MUFA's	**2.37±0.32**	**2.66±0.32**	**2.29±0.07**	**1.96±0.16**	**2.17±0.37**	**2.90±0.11**
Alpha Linolenic acid-ALA	0.31±0.03	0.37±0.03	0.37±0.05	0.32±0.06	0.21±0.08	0.18±0.04
Arachidonic acid (ARA)	2.26±0.02	5.75±0.02	8.24±0.02	9.44±0.02	4.82±0.06	1.64±0.02
Total PUFA's	**2.57±0.05**	**6.12±0.05**	**8.61±0.07**	**9.76±0.08**	**5.03±0.14**	**1.82±0.06**

Note: SFA's = Saturated fatty acids, MUFA's = Monounsaturated fatty acids, PUFA's = Polyunsaturated fatty acids; values are expressed in mean

3.43 %. The total SFA's were observed high in large intestine and low for liver. Among, the MUFA's, oleic acid and palmitoleic acid was low compared to muscles, ranging from 0.27 to 1.26 % and 1.03 to 1.90 % respectively. Total MUFA's was recorded high for small intestine and low for liver. PUFA's i.e., alpha linolenic acid (ALA) and arachidonic acid (ARA), ranged from 0.18 to 0.37 % and 1.64 to 13.44 %, respectively. Total PUFA's were observed high for liver and low for large intestine.

4.5.7.3. Fatty acid composition in muscles of Ghungroo pig.

The fatty acid content in six muscles of Ghungroo pig is shown in Table 4.35. Among the saturated fatty acid (SFA's), palmitic acid was the highest ranging from 15.84 to 20.62 %, lowest in *tensor fasciae latae* and highest in *latissimus dorsi*. Myristic acid was the lowest among the SFA's ranging from 1.52 to 3.19 %. Total SFA's was noted high for *triceps brachii*

Table 4.35. Fatty acid composition (%) in muscles of Ghungroo pig.

	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
Palmitic acid	17.47±0.70	20.62±2.27	16.83±1.19	15.84±1.24	18.02±0.90	16.21±2.81
Stearic acid	8.24±0.52	3.12±0.79	4.16±1.16	5.01±1.18	2.53±0.50	3.66±1.63
Lauric acid	3.09±0.16	1.81±0.28	3.44±0.33	2.44±0.47	2.89±0.30	2.59±1.02
Myristic acid	2.04±0.03	2.84±0.39	1.68±0.34	3.19±0.46	1.52±0.33	2.41±0.27
Total SFA's	**30.84±1.41**	**28.39±3.73**	**26.11±3.02**	**26.48±3.35**	**24.96±2.03**	**24.87±5.73**
Oleic acid	22.34±0.49	19.31±1.05	21.02±0.42	22.26±0.16	20.16±0.16	23.78±1.76
Palmitoleic acid	1.87±0.12	2.86±0.37	2.02±0.04	1.83±0.17	2.53±0.31	1.74±0.20
Total MUFA's	**24.21±0.61**	**22.17±1.42**	**23.04±0.46**	**24.09±0.33**	**22.69±0.47**	**25.52±1.96**
Alpha Linolenic acid-ALA	2.66±0.27	2.86±0.33	1.06±0.19	6.90±0.37	2.2±0.56	4.83±0.28
Arachidonic acid (ARA)	2.10±0.06	0.85±0.01	2.27±0.02	0.79±0.04	1.16±0.02	2.46±0.18
Total PUFA's	**4.76±0.49**	**3.71±0.34**	**3.33±0.21**	**7.69±0.41**	**3.36±0.58**	**7.29±0.46**

Note: SFA's = Saturated fatty acids, MUFA's = Monounsaturated fatty acids, PUFA's = Polyunsaturated fatty acids; values are expressed in mean

and lowest was for *longissimus dorsi* muscle. Among, the MUFA's, oleic acid was the most abundant ranging from 19.31 to 23.78 %, while palmitoleic acid, ranged from 1.74 to 2.86 %. Total MUFA was found highest for *longissimus dorsi* and low for *latissimus dorsi* muscles. Two PUFA's were detected, they are alpha Linolenic acid (ALA) and arachidonic acid (ARA), ranging from 1.06 to 4.83% and 0.85 to 2.46 %, respectively. Muscle *tensor fasciae latae* showed the highest concentration of PUFA, while lowest was observed for *biceps femoris* muscle.

4.5.7.4. Fatty acid composition in viscera of Ghungroo pig.

Among the SFA's, palmitic acid and stearic acid were found highest among others (Table 4.36.). The palmitic acid ranged from 15.26 to 26.40 % and stearic acid ranged from 12.38 to 20.57 %. Lauric acid were low compared to palmitic and stearic acid, ranging from 1.60 to 3.19 %. Myristic acid ranged from 0.86 to 3.06 %. Total SFA's were found highest for large intestine and lowest for kidney. Among, the MUFA's, oleic acid and palmitoleic acid was

Table 4.36. Fatty acid composition (%) in viscera of Ghungroo pig.

	Kidney	**Small intestine**	**Spleen**	**Liver**	**Heart**	**Large intestine**
Palmitic acid	19.34±0.28	21.57±1.17	18.91±0.02	15.26±0.58	19.20±0.29	26.40±0.92
Stearic acid	12.38±0.13	18.74±0.11	14.33±1.14	18.62±0.01	14.81±0.14	20.57±1.31
Lauric acid	1.61±0.38	3.19±0.56	3.00±0.05	1.90±0.13	1.60±0.34	2.08±0.49
Myristic acid	1.60±0.28	2.57±0.01	1.34±0.20	0.86±0.11	1.76±0.32	3.06±0.02
Total SFA's	**34.93±1.07**	**46.07±1.85**	**37.58±1.41**	**36.64±0.83**	**37.37±1.09**	**52.11±2.74**
Oleic acid	0.85±0.02	2.08±0.01	2.57±0.32	0.86±0.02	0.71±0.03	1.07±0.34
Palmitoleic acid	0.90±0.04	2.25±0.02	0.96±0.07	0.72±0.25	1.23±0.01	1.34±0.24
Total MUFA's	**1.75±0.06**	**4.33±0.03**	**3.53±0.39**	**1.58±0.27**	**1.94±0.04**	**2.41±0.58**
Alpha Linolenic acid-ALA	0.35±0.04	0.77±0.02	0.26±0.02	0.62±0.05	0.38±0.18	0.21±0.05
Arachidonic acid (ARA)	2.26±0.02	5.76±0.02	9.90±0.88	10.77±0.72	4.82±0.02	1.65±0.02
Total PUFA's	**2.61±0.06**	**6.53±0.02**	**10.16±0.9**	**11.39±0.77**	**5.20±0.20**	**1.86±0.07**

Note: SFA's = Saturated fatty acids, MUFA's = Monounsaturated fatty acids, PUFA's = Polyunsaturated fatty acids; values are expressed in mean

low compared to muscles, ranging from 0.71 to 2.57 % and 0.72 to 2.25 % respectively. Total MUFA was recorded high for small intestine and low for liver. PUFA's i.e., alpha linolenic acid (ALA) and arachidonic acid (ARA), ranged from 0.21 to 0.77 % and 1.65 to 10.77 %, respectively. Total PUFA's were recorded high in liver and low for large intestine.

4.5.7.5. Fatty acid in Doom and Ghungroo pig's muscle and its requirements for adults.

All the determined muscles of Doom and Ghungroo pigs depicted higher concentrations of saturated fatty acids (SFA's) than the recommended intakes which is less than 10 % (Tables 4.37. and 4.38.). Mono-unsaturated fatty acids (MUFA's) were slightly

Table 4.37. Fatty acid content of muscles of Doom and its requirements for adults

	Results Obtained (%)						
Fatty acid	***Triceps brachii***	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***	**Recommendation for adults**
SFA's	28.14	25.82	20.48	32.54	26.58	31.79	*<10 %
MUFA's	37.07	32.25	14.17	27.54	25.07	23.55	**<20 %
n-6 PUFA	1.99	0.65	1.85	1.69	0.79	1.77	***2.5 – 9%
n-3 PUFA	1.85	2.56	1.23	3.85	2.97	2.23	***0.5 - 2%

*WHO (World Health Organization, 2010); **American Heart Association (2006); ***FAO (2010)

Table 4.38. Fatty acid content of muscles of Ghungroo and its requirements for adults

	Results Obtained (%)						
Fatty acid	***Triceps brachii***	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***	**Recommendation for adults**
SFA's	30.84	28.39	26.11	26.48	24.96	24.87	*<10 %
MUFA's	24.21	22.17	23.04	24.09	22.69	25.52	**<20 %
n-6 PUFA	2.46	0.85	2.27	0.79	1.16	2.1	***2.5 – 9%
n-3 PUFA	4.83	2.86	1.06	6.9	2.2	2.66	***0.5 - 2%

*WHO (World Health Organization, 2010); **American Heart Association (2006); ***FAO (2010)

higher than the recommended except for *biceps femoris* muscle dissected from ham region of Doom pig. Poly-unsaturated fatty acids (PUFA's) for Doom pig slightly less than the suggested intakes. PUFA's like arachidonic acid were lower than the recommended, however the values

of *triceps brachii* muscle (2.46 %), *biceps femoris* (2.27 %) and *longissimus dorsi* (2.1 %) muscle of Ghungroo dissected from shoulder and ham were close to the recommended intake (2.5 to 9 %).

4.5.7.6. Fatty acid in Doom and Ghungroo pig's viscera and its requirements for adults.

Like muscles, the SFA content of the viscera of both the pig breeds exceeds the suggested intakes. However, the MUFA content in viscera was less than 20 %, unlike muscles (Tables 4.39. and 4.40.). Omega-6 poly-unsaturated fatty acids (i.e., arachidonic acid) values in all the viscera of Doom and Ghungroo pigs falls under the suggested intakes, however in the liver, the n-6 PUFA concentration of both Doom and Ghungroo pig exceeds the recommended intake. Omega-3 poly-unsaturated fatty acids (i.e., alpha-linolenic acid, ALA) values of all the viscera were under the suggested intakes.

Table 4.39. Fatty acid content of viscera of Doom pig and its requirements for adults

Fatty acid	Results Obtained (%)						Recommendation for adults
	Kidney	Small intestine	Spleen	Liver	Heart	Large intestine	
SFA's	33.04	47.70	41.12	31.55	32.48	49.55	*<10 %
MUFA's	2.37	2.66	2.29	1.96	2.17	1.90	**<20 %
n-6 PUFA	2.26	5.75	8.24	13.44	4.82	1.64	***2.5 – 9%
n-3 PUFA	0.31	0.37	0.37	0.32	0.21	0.18	***0.5 - 2%

*WHO (World Health Organization, 2010); **American Heart Association (2006); ***FAO (2010)

Table 4.40. Fatty acid content of viscera of Ghungroo pig and its requirements for adults

Fatty acid	Results Obtained (%)						Recommendation for adults
	Kidney	Small intestine	Spleen	Liver	Heart	Large intestine	
SFA's	34.93	46.07	37.58	36.64	37.37	52.11	*<10 %
MUFA's	1.75	4.33	3.53	1.58	1.94	2.41	**<20 %
n-6 PUFA	2.26	5.76	9.9	10.77	4.82	1.65	***2.5 – 9%
n-3 PUFA	0.77	0.77	0.26	0.62	0.38	0.21	***0.5 - 2%

Note: *WHO (World Health Organization, 2010); **American Heart Association (2006); ***FAO (2010)

4.5.7.7. Comparison of fatty acids of muscles: Doom and Ghungroo pigs vs. Goat, Sheep and Beef

The SFA's of the shoulder part of Doom and Ghungroo pig were similar to shoulder part of goat but were lower compared to shoulder part of sheep and beef (Figure. 4.j.). Meat of sheep and beef showed higher saturated fatty acids than Doom and Ghungroo pig breeds. The MUFA's of shoulder region of beef was the highest followed by meat of Doom pig. The PUFA's of shoulder region of sheep was the highest followed by meat of beef, pigs (Doom and Ghungroo). PUFA percentage of goat was the lowest.

4.5.7.8. Comparison of fatty acids of viscera: Doom and Ghungroo pigs vs. Goat, Sheep and Beef

The fatty acid composition of viscera (kidney, small intestine, spleen, liver, heart and large intestine) of Doom and Ghungroo pigs are compared with fatty acid contents of other red meats is depicted in Figure 4.k. Total SFA's in the of Doom and Ghungroo pigs were found

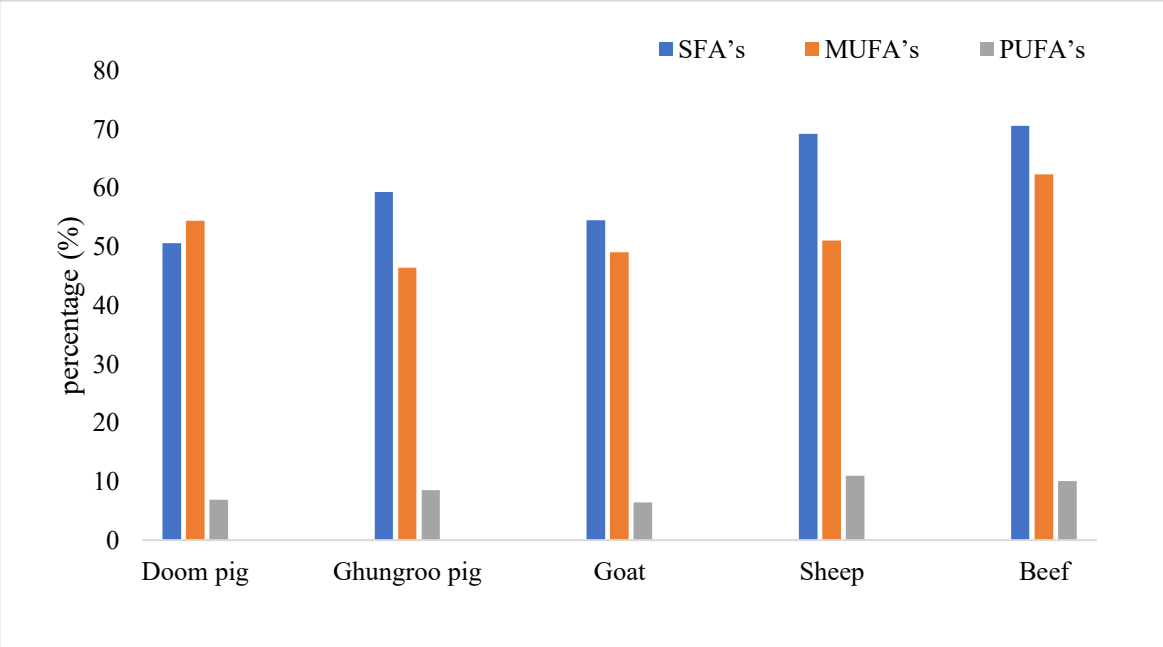

Figure 4.j. SFA (saturated fatty acids), MUFA (monounsaturated fatty acids), and PUFA (polyunsaturated fatty acids) in the shoulder region of Doom and Ghungroo pigs, compared with goat, sheep, and beef.

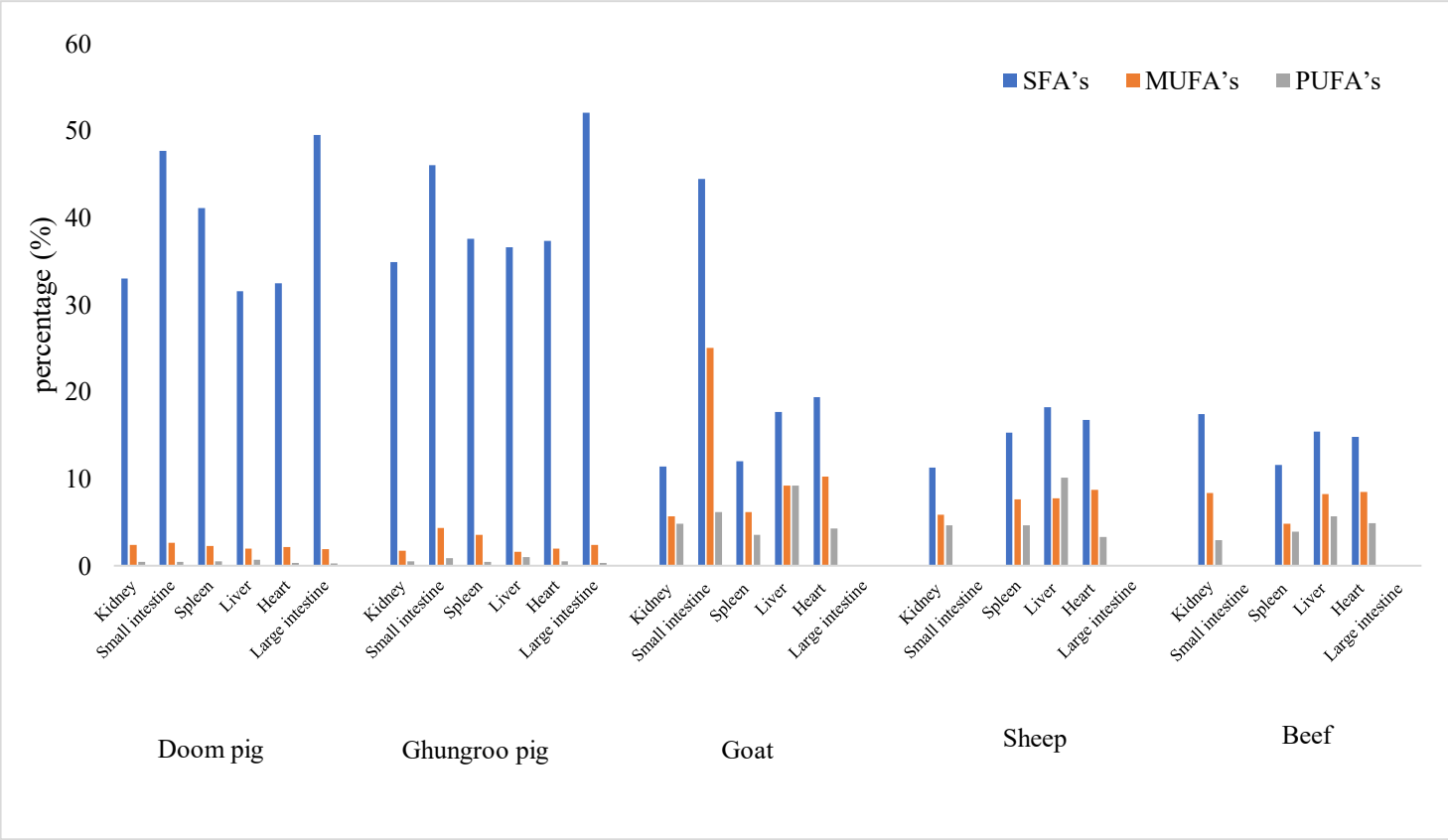

Figure 4.k. SFA (saturated fatty acids), MUFA (monounsaturated fatty acids), and PUFA (polyunsaturated fatty acids) of viscera of Doom and Ghungroo pig compared with goat, sheep and beef. Note: SFA's, MUFA's and PUFA's value of large intestine of goat was not available, including small intestine and large intestine of sheep and beef.

to be higher than those of goat, sheep and beef. While the MUFA's of viscera of Doom and Ghungroo pigs were lower than those of goat, sheep and beef. Similar to MUFA's, the PUFA's of viscera of Doom and Ghungroo pigs were found lower than goat, sheep and beef.

4.5.8. Mineral content

The following tables contains the minerals contents (macro-elements, trace-elements and potentially toxic trace elements) in drinking water and soil, including the muscles and viscera of Doom and Ghungroo pig. The elements analyzed in the above-mentioned samples are macro-elements; potassium (K), sodium (Na), magnesium (Mg) and calcium (Ca), micro-elements; copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn), trace elements; selenium (Se) and chromium (Cr) and lastly potentially toxic trace elements; arsenic (As), lead (Pb), cadmium (Cd) and nickel (Ni).

4.5.8.1. Concentration of minerals in drinking water and soil

Among the macro-elements, potassium was observed high in soil (18.46 mg/kg) and low in drinking water (9.22 mg/kg) (Table 4.41.). Sodium was observed high in drinking water (10.63 mg/kg) and low in soil (4.77 mg/kg). Other macro-elements studied were Magnesium (Mg) and calcium (Ca), Mg was recorded high in soil (15.21 mg/kg) and low in drinking water (0.86 mg/kg). Among the micro-elements iron (Fe - 60.98 mg/kg) and manganese (Mn - 9.67 g/100g) concentrations were both recorded highest in soil. Among the trace elements, highest concentration was noted for Cr for drinking water (0.044 mg/kg) and soil (0.029 mg/kg). Among the potentially toxic elements, lead (Pb) was found highest in drinking water (0.051 mg/kg), while that of nickel (Ni) was found highest in soil (0.129 mg/kg).

4.5.8.2. Mineral composition in muscles of Doom pig

The minerals content (macro- and micro-elements, trace and potentially toxic trace elements) in six muscles of Doom pig are tabulated in Table 4.42. Potassium content was the highest among the macro-elements, ranging from 152.88 to 215.14 mg/kg, with lowest found in *tensor fasciae latae* and highest in *triceps brachii* muscles. Sodium ranged from 17.70 to 22.68 mg/kg. Magnesium content ranged from 9.06 to 17.32 mg/kg. Among the micro-elements, zinc and iron were slightly higher than copper and manganese ranging from 2.36 to 6.29 mg/kg and 2.88 to 4.02 mg/kg. Trace elements Se and Cr ranged from 0.010 to 0.015 mg/kg and 0.002 to 0.017 mg/kg. Among the potentially toxic trace elements, concentration of

Table 4.41. Concentration of minerals (mg/kg) in drinking water and soil.

	Drinking water	Soil
	Macro-elements	
K	9.22±0.64	18.46±0.63
Na	10.63±0.32	4.77±0.27
Mg	0.86±0.05	15.21±0.86
Ca	3.84±0.26	4.71±0.82
	Micro-elements	
Cu	0.033±0.00	0.15±0.00
Zn	0.015±0.00	0.89±0.03
Fe	3.36±0.53	60.98±0.86
Mn	2.71±0.86	9.67±0.59
	Trace elements	
Se	0.012±0.00	0.002±0.00
Cr	0.044±0.00	0.029±0.00
	Potentially Toxic trace elements	
As	0.002±0.00	0.023±0.00
Cd	0.001±0.00	0.002±0.00
Pb	0.051±0.023	0.019±0.00
Ni	0.050±0.00	0.129±0.00

values are expressed in mean ± standard error of mean (SEM)

lead (0.013 to 0.030 mg/kg) was the highest compared to cadmium (0.008 to 0.015 mg/kg), arsenic (0.004 to 0.01 mg/kg) and nickel (0.013 to 0.030 mg/kg).

4.5.8.3. Mineral composition in viscera of Doom pig

The minerals content (macro- and micro-elements, trace and potentially toxic trace elements) in six viscera of Doom pig are tabulated in Table 4.42. Among, the macro-elements, potassium was observed high in liver (101.45 mg/kg) and low in small intestine (32.15 mg/kg). Sodium was found highest in spleen (122.84 mg/kg) and lowest in small intestine (29.88 mg/kg). Magnesium was noted high in liver (5.23 mg/kg) and low in heart (2.76 mg/kg). Another macro-element, calcium was found high in liver (7.81 mg/kg) and low in heart (2.76 mg/kg). Among, the micro-elements, iron was found the highest in liver (11.70 mg/kg) and lowest in heart (2.55 mg/kg).

Table 4.42. Concentration of minerals (mg/kg) in muscles of Doom pig.

	Triceps brachii	*Latissimus dorsi*	*Biceps femoris*	*Tensor fasciae latae*	*Gracilis*	*Longissimus dorsi*
			Macro-elements			
K	215.14±2.84	194.68±2.30	193.27±2.02	152.88±3.18	198.76±3.00	207.14±2.12
Na	21.02±0.02	18.70±0.30	17.70±0.30	20.60±0.30	22.68±0.36	17.96±0.03
Mg	9.06±1.11	14.60±0.93	17.32±0.57	13.77±0.57	15.33±0.63	10.13±0.61
Ca	4.46±0.60	3.29±0.36	3.54±0.17	4.14±0.21	3.93±0.34	4.26±0.48
			Micro-elements			
Cu	2.01±0.02	3.04±0.05	2.26±0.23	3.07±0.04	2.02±0.04	1.32±0.24
Zn	3.36±0.24	4.96±0.04	6.29±0.29	3.90±0.06	2.36±0.32	4.01±0.04
Fe	3.41±0.21	4.00±0.01	2.88±0.06	3.19±0.19	2.92±0.07	4.02±0.02
Mn	2.37±0.16	1.99±0.01	1.87±0.10	3.00±0.01	2.04±0.03	3.12±0.08
			Trace elements			
Se	0.009±0.00	0.015±0.00	0.010±0.00	0.015±0.00	0.01±0.00	0.015±0.00
Cr	0.004±0.00	0.005±0.00	0.017±0.01	0.006±0.00	0.002±0.00	0.005±0.00
			Potentially Toxic trace elements			
As	0.01±0.00	0.004±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.004±0.00
Cd	0.014±0.00	0.008±0.00	0.009±0.00	0.009±0.00	0.014±0.00	0.015±0.00
Pb	0.013±0.00	0.014±0.00	0.017±0.00	0.026±0.00	0.030±0.00	0.016±0.00
Ni	0.005±0.00	0.012±0.00	0.005±0.00	0.004±0.00	0.005±0.00	0.003±0.00

values are expressed in mean ± standard error of mean (SEM)

Zinc was found high in liver (1.87 mg/kg) and lowest in heart (0.32 mg/kg). Manganese was found high in small intestine (15.57 mg/kg) and lowest in liver (0.21 mg/kg). Among the trace elements, selenium (Se) was found high in kidney (0.056 mg/kg) and lowest in heart (0.010 mg/kg). Another trace element, chromium (Cr) was found high in small intestine (0.037 mg/kg) and lowest in kidney (0.006 mg/kg). Among, the potentially toxic trace elements (As, Cd, Pb and Ni), lead was the highest of all ranging from 0.029 to 0.140 mg/kg, found lowest in small intestine and highest in liver (Figure 4.l. showing partial least squares - discriminant analysis (PLS-DA) where it is observed that liver is easily discriminated from rest of the viscera, including the spleen). The Figure 4.m. depicts the hierarchical clustering of six muscles and six viscera of Doom pig depicting the similarity among the tissues as well as differences in concentration of elements.

Table 4.43. Concentration of minerals (mg/kg) in viscera of Doom pig.

	Kidney	Small Intestine	Spleen	Liver	Heart	Large Intestine
			Macro-elements			
K	78.56±0.88	32.15±0.61	60.20±0.92	101.45±0.87	52.76±0.55	34.20±0.84
Na	97.19±1.56	29.88±0.68	122.84±1.45	77.57±0.88	31.20±0.57	32.23±1.50
Mg	3.03±0.20	3.71±0.89	3.27±0.57	5.23±0.45	2.76±0.35	2.42±0.57
Ca	4.14±0.56	6.02±0.57	5.49±0.53	7.81±0.57	2.24±0.55	4.98±0.34
			Micro-elements			
Cu	0.60±0.05	0.04±0.00	0.03±0.00	0.15±0.02	0.09±0.00	0.007±0.00
Zn	1.70±0.31	1.72±0.27	0.73±0.12	1.87±0.14	0.32±0.12	0.72±0.16
Fe	7.35±0.53	2.63±0.44	9.59±0.22	11.70±0.47	2.55±0.51	0.89±0.12
Mn	0.72±0.29	15.57±0.50	0.42±0.18	0.21±0.06	0.59±0.22	2.88±1.30
			Trace elements			
Se	0.056±0.01	0.013±0.01	0.018±0.00	0.013±0.00	0.010±0.00	0.011±0.00
Cr	0.006±0.00	0.009±0.00	0.037±0.00	0.032±0.00	0.01±0.00	0.032±0.00
			Potentially Toxic trace elements			
As	0.005±0.00	ND	0.005±0.00	0.012±0.00	ND	ND
Cd	ND	ND	0.019±0.00	0.012±0.00	ND	0.015±0.00
Pb	0.108±0.00	0.029±0.00	0.016±0.00	0.140±0.04	0.115±0.01	0.036±0.00
Ni	0.023±0.00	0.049±0.00	0.040±0.00	0.064±0.00	0.028±0.00	0.055±0.00

values are expressed in mean ± standard error of mean (SEM)

4.5.8.4. Mineral composition in muscles of Ghungroo pig

The minerals content (macro- and micro-elements, trace and potentially toxic trace elements) in six muscles of Ghungroo pig are tabulated in Table 4.44. Among the macro-elements, potassium content was the highest in all the analyzed muscles. *Triceps brachii* (226.00 mg/kg) muscle showed the highest amount of K and lowest was observed in *tensor fasciae latae* (165.87 mg/kg) muscle. Sodium and magnesium ranged from 18.20 to 20.86 mg/kg and 10.94 to 15.18 mg/kg, respectively. Among the micro-elements, zinc and iron were slightly higher than copper and manganese ranging from 1.62 to 3.37 mg/kg and 1.54 to 2.02 mg/kg. Trace elements selenium and chromium ranged from 0.010 to 0.017 mg/kg and 0.002 to 0.009 mg/kg. Among the potentially toxic trace elements, lead was slightly higher than cadmium, arsenic and nickel ranging from 0.013 to 0035 mg/kg.

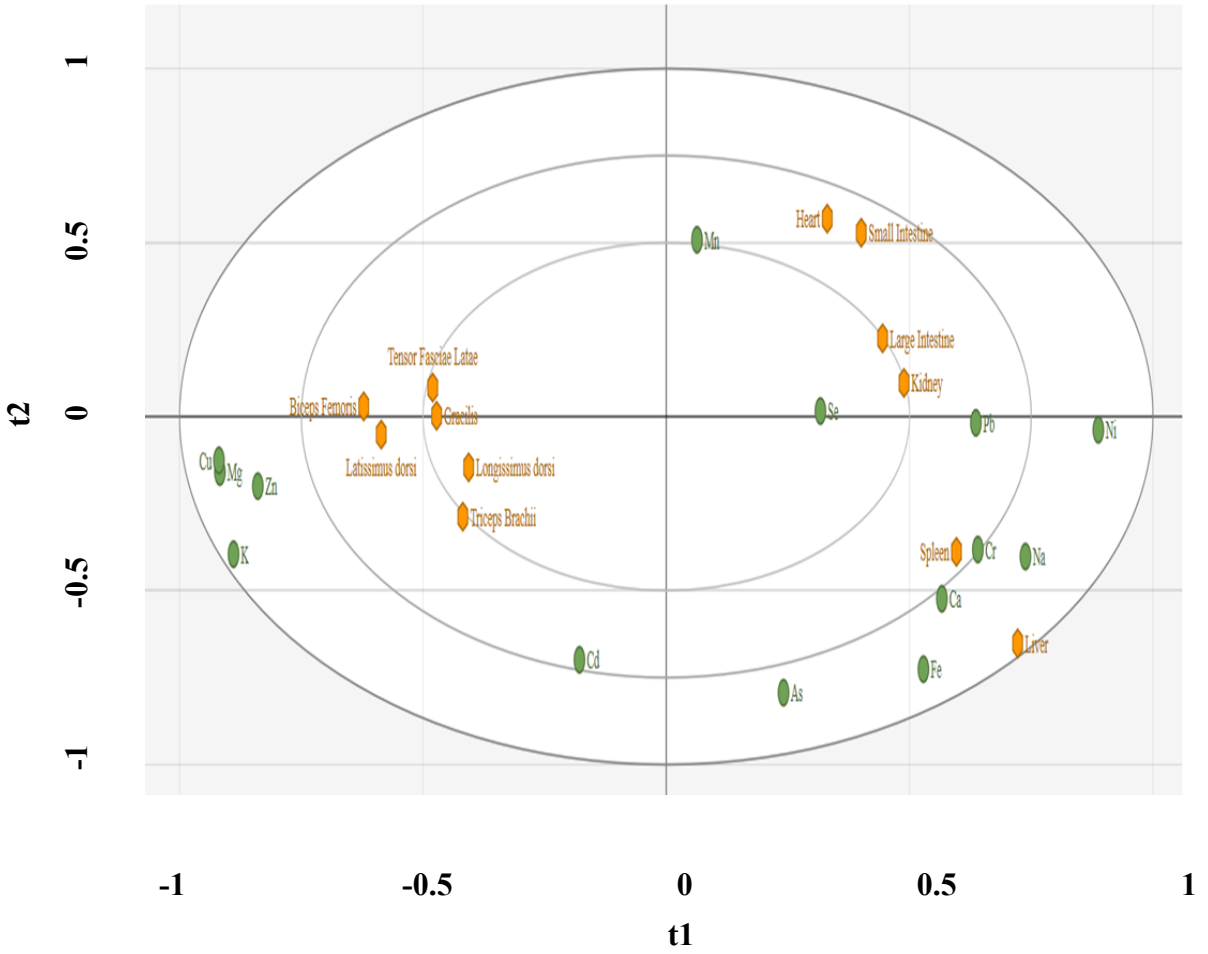

Figure 4.l. PLS-DA (partial least squares - discriminant analysis) score (R_2X = 0.86, R_2Y = 0.364 and Q_2 = 0.98) and loading plots of fourteen elements in the muscles and viscera of Doom pigs. Green represents the investigated elements and orange represent the tissues (six muscles and six viscera). t1 and t2 are the first and second latent variables (also called components) extracted by the model.

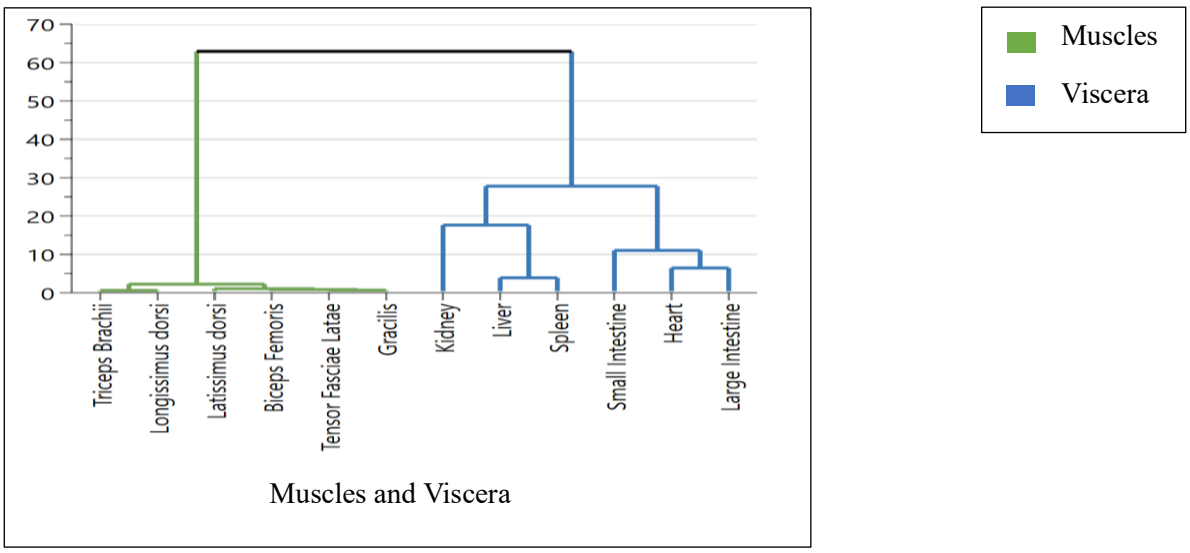

Figure 4.m. Hierarchical clustering of concentration of minerals in six muscles and six viscera of Doom pig.

Table 4.44. Concentration of minerals (mg/kg) in muscles of Ghungroo pig.

	Triceps brachii	*Latissimus dorsi*	*Biceps femoris*	*Tensor fasciae latae*	*Gracilis*	*Longissimus dorsi*
			Macro-elements			
K	226.00±14.00	213.90±2.11	177.67±5.78	165.87±5.20	185.16±1.56	218.87±1.26
Na	18.79±0.34	20.86±0.31	20.84±0.24	18.20±0.16	19.44±0.28	20.40±0.46
Mg	10.94±0.66	15.18±0.10	14.09±0.11	14.74±0.38	12.46±0.28	12.67±0.70
Ca	4.72±0.53	3.56±0.57	3.77±0.27	4.30±0.34	4.26±0.08	4.44±0.55
			Micro-elements			
Cu	0.13±0.00	0.05±0.01	0.13±0.01	0.04±0.01	0.06±0.02	0.06±0.01
Zn	1.62±0.30	2.56±0.15	3.37±0.23	1.96±0.07	1.65±0.27	2.04±0.40
Fe	1.63±0.30	1.79±0.21	1.68±0.26	1.72±0.38	1.54±0.33	2.02±0.29
Mn	0.07±0.02	0.11±0.00	0.09±0.20	0.09±0.02	0.04±0.00	0.05±0.03
			Trace elements			
Se	0.013±0.00	0.016±0.00	0.010±0.00	0.012±0.00	0.011±0.00	0.017±0.00
Cr	0.002±0.00	0.006±0.00	0.006±0.00	0.009±0.00	0.002±0.00	0.007±0.00
			Potentially Toxic trace elements			
As	0.012±0.00	0.005±0.00	ND*	ND*	ND*	0.005±0.00
Cd	0.012±0.00	0.007±0.00	0.009±0.00	0.011±0.00	0.015±0.00	0.019±0.00
Pb	0.013±0.00	0.014±0.00	0.014±0.00	0.029±0.00	0.035±0.00	0.015±0.00
Ni	0.007±0.00	0.011±0.00	0.005±0.00	0.005±0.00	0.005±0.00	0.006±0.00

Values are expressed in mean ± standard error of mean (SEM) ND* = Not Detected

4.5.8.5. Mineral composition in viscera of Ghungroo pig

The minerals content (macro- and micro-elements, trace and potentially toxic trace elements) in six viscera of Ghungroo pig are tabulated in Table 4.45. Among, the macro-elements, potassium was observed high in liver (106.46 mg/kg) and low in small intestine (33.82 mg/kg). Sodium was found highest in spleen (120.51 mg/kg) and lowest in small intestine (28.82 mg/kg). Magnesium was noted high in liver (4.56 mg/kg) and low in kidney (2.36 mg/kg). Another macro-element, calcium was found high in liver (8.21 mg/kg) and low in heart (2.74 mg/kg). Among, the micro-elements, iron was found the highest in spleen (10.59 mg/kg) and lowest in small intestine (2.97 mg/kg). Zinc was found high in kidney (2.03 mg/kg) and lowest in heart (0.43 mg/kg). Manganese was found high in small intestine (15.91 mg/kg) and lowest in liver (0.23 mg/kg). Among the trace elements, Se was found high in kidney (0.060

Table 4.45. Concentration of minerals (mg/kg) in viscera of Ghungroo pig.

	Kidney	Small Intestine	Spleen	Liver	Heart	Large Intestine
Macro-elements						
K	79.80±0.46	33.82±1.18	63.54±2.46	106.46±2.90	54.76±1.51	36.21±1.18
Na	95.53±1.06	28.82±0.80	120.51±1.50	75.74±1.30	32.47±0.82	29.63±0.91
Mg	2.36±0.15	2.72±0.45	2.61±0.36	4.56±0.28	3.43±0.36	3.09±0.19
Ca	4.47±0.32	6.35±0.33	5.89±0.28	8.21±0.28	2.74±0.22	5.31±0.04
Micro-elements						
Cu	0.642±0.03	0.049±0.00	0.039±0.00	0.197±0.03	0.093±0.00	0.010±0.00
Zn	2.03±0.36	1.10±0.04	0.67±0.06	1.95±0.09	0.43±0.07	0.79±0.11
Fe	8.02±0.34	2.97±0.18	10.59±0.43	10.37±0.96	2.89±0.28	0.97±0.14
Mn	0.83±0.25	15.91±0.28	0.56±0.13	0.23±0.04	0.79±0.04	3.55±0.67
Trace elements						
Se	0.060±0.00	0.015±0.00	0.018±0.00	0.016±0.00	0.011±0.00	0.012±0.00
Cr	0.007±0.00	0.009±0.00	0.037±0.00	0.033±0.00	0.011±0.00	0.034±0.00
Potentially Toxic trace elements						
As	0.006±0.00	ND	0.006±0.00	0.013±0.00	ND	ND
Cd	ND	ND	0.018±0.00	0.017±0.00	ND	0.016±0.00
Pb	0.111±0.00	0.030±0.00	0.016±0.00	0.144±0.03	0.120±0.00	0.036±0.00
Ni	0.023±0.00	0.050±0.01	0.041±0.02	0.074±0.03	0.025±0.01	0.056±0.01

Values are expressed in mean ± standard error of mean (SEM)

mg/kg) and lowest in heart (0.011 mg/kg). Another trace element, Cr was found high in spleen (0.037 mg/kg) and lowest in kidney (0.007 mg/kg). Among, the potentially toxic trace elements (As, Cd, Pb and Ni), lead (Pb) was the highest of all ranging from 0.016 to 0.144 mg/kg, found lowest in spleen and highest in liver (Figure 4.n. represents the partial least squares - discriminant analysis (PLS-DA) of Ghungroo pig where it is observed that kidney and heart had been easily discriminated while others were found within same radius. And Figure 4.o. shows the hierarchical clustering of six muscles and six viscera of Ghungroo pig).

4.5.8.6. Mineral in Doom and Ghungroo pig's muscles and its requirements for adults.

The mineral content of muscles of Doom and Ghungroo and its requirements for adults are depicted in Tables 4.46. and 4.47. Macro-elements (K, Na, Mg and Ca) values of

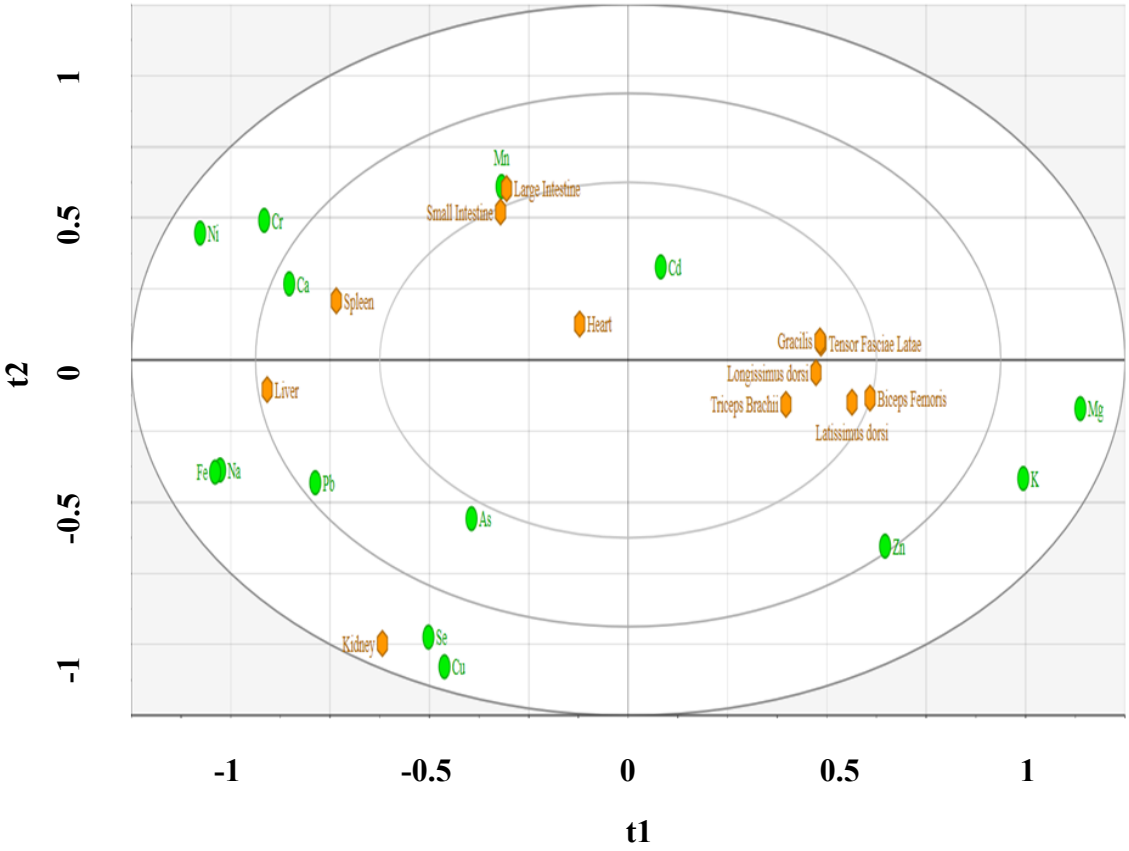

Figure 4.n. PLS-DA (partial least squares - discriminant analysis) score ($R_2X = 0.407$, $R_2Y = 0.207$ and $Q_2 = 0.45$) and loading plots of fourteen elements in the muscles and viscera of Ghungroo pig. Dark blue represents the investigated elements and orange represent the tissues (six muscles and six viscera). t1 and t2 are the first and second latent variables (also called components) extracted by the model.

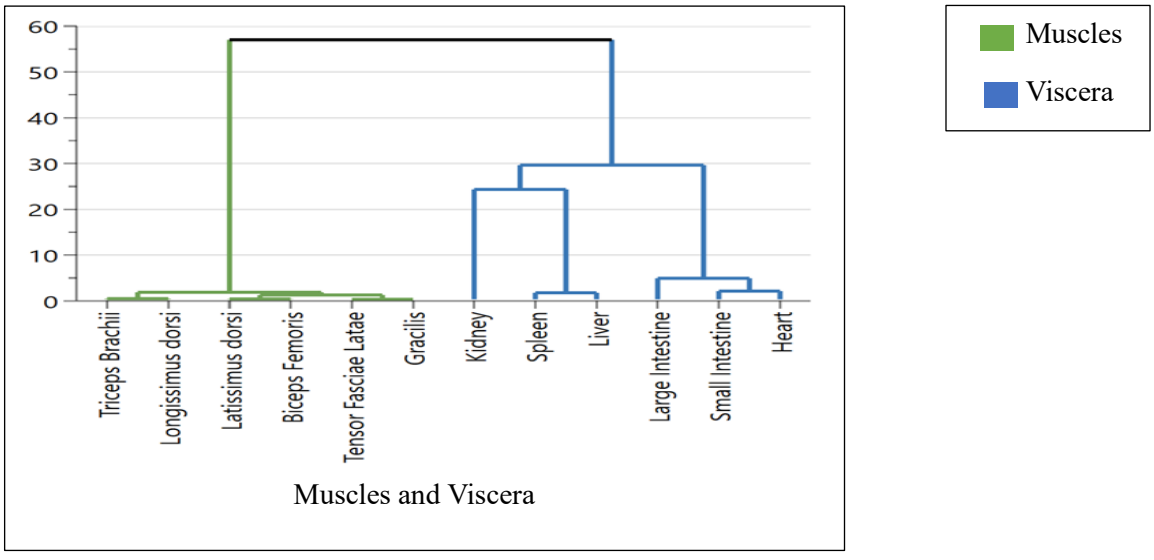

Figure 4.o. Hierarchical clustering of concentration of minerals in six muscles and six viscera of Ghungroo pig

Doom and Ghungroo pig were lower than the recommended intakes in all the analysed individual muscles. Among the micro-elements, Cu content of Doom pig was slightly higher than recommended intakes. Manganese (Mn) content of *tensor fasciae latae* and *longissimus dorsi* muscle of Doom pig fulfilled the recommended intake. The trace elements, selenium (Se) and chromium (Cr) in all the muscles of Doom and Ghungroo pig were lower than the recommended intakes for both male and female adults. Among the potentially toxic trace elements, arsenic content of *triceps brachii* muscle of Doom pig exceeds the recommended intake, while others were within the suggested intakes. Muscles *tensor fasciae latae* and *gracilis* of both Doom and Ghungroo pig were found to exceed the recommended intake of lead.

Table 4.46. Mineral contents of muscles of Doom and its requirements for adults

	Results Obtained (mg/kg)						**Recommendation for adults**
	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***	
				Macro-elements			
K	215.14	194.68	193.27	152.88	198.76	207.14	3500 mg/d
Na	21.02	18.70	17.7	20.59	22.68	17.96	2000 mg/d
Mg	9.06	14.60	17.32	13.77	15.33	10.13	420 mg/d (males) and 320 mg/d (females)
Ca	4.46	3.29	3.54	4.14	3.93	4.26	1000 – 1300 mg/d
				Micro-elements			
Cu	2.01	3.03	2.25	3.06	2.02	1.32	1.6 mg/d
Zn	3.36	4.95	6.28	3.93	2.36	4.01	11 mg/d (men) and 8 mg/d (women)
Fe	3.40	4.00	2.88	3.18	2.92	4.01	16–18 mg/d (males) and 12–16 mg/d (females)
Mn	2.36	1.98	1.87	3.00	2.04	3.11	3 mg/d
				Trace elements			
Se	0.009	0.015	0.010	0.015	0.01	0.015	55 µg/d

Cr	0.004	0.005	0.017	0.006	0.002	0.005	30 µg/d (men) and 25 µg/d (female)
				Potentially toxic trace elements			
As	0.01	0.004	0	0	0	0.004	9.89 µg/d (men) and 5.36 µg/d (female)
Cd	0.014	0.008	0.009	0.009	0.014	0.015	0.5 and 1 mg/kg
Pb	0.013	0.014	0.017	0.026	0.03	0.016	0.025 mg/kg
Ni	0.005	0.012	0.005	0.004	0.005	0.003	0.013 mg/kg body weight

Table 4.47. Mineral contents of muscles of Ghungroo and its requirements for adults

	Results Obtained (mg/kg)						
	Triceps brachii	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***	**Recommendation for adults**
				Macro-elements			
K	226.00	213.9067	177.67	165.87	185.16	218.87	3500 mg/d
Na	18.79	20.86	20.84	18.20	19.44	20.40	2000 mg/d
Mg	10.94	15.18	14.09	14.74	12.46	12.67	420 mg/d (males) and 320 mg/d (females)
Ca	4.72	3.56	3.77	4.30	4.26	4.44	1000 – 1300 mg/d
				Micro-elements			
Cu	0.13	0.05	0.13	0.04	0.06	0.06	1.6 mg/d
Zn	1.62	2.56	3.37	1.96	1.65	2.04	11 mg/d (men) and 8 mg/d (women)
Fe	1.63	1.79	1.68	1.72	1.54	2.02	16–18 mg/d (males) and 12–16 mg/d (females)
Mn	0.07	0.11	0.09	0.09	0.04	0.056	3 mg/d

Trace elements							
Se	0.013	0.016	0.010	0.012	0.011	0.017	55 µg/d
Cr	0.002	0.006	0.006	0.009	0.002	0.007	30 µg/d (men) and 25 µg/d (female)
Potentially toxic trace elements							
As	0.012	0.005	0	0	0	0.005	9.89 µg/d (men) and 5.36 µg/d (female)
Cd	0.012	0.007	0.009	0.011	0.015	0.019	0.5 and 1 mg/kg
Pb	0.013	0.014	0.014	0.029	0.035	0.015	0.025 mg/kg
Ni	0.007	0.011	0.005	0.005	0.005	0.006	0.013 mg/kg body weight

4.5.8.7. Mineral in Doom and Ghungroo pig's viscera and its requirements for adults

The mineral composition of viscera of Doom and Ghungroo and its requirements for adults are depicted in Tables 4.48. and 4.49. The macro-elements content of both the breeds determined in viscera (K, Na, Mg and Ca) were lower than the recommended intakes. Manganese (Mn) content of small intestine of both Doom and Ghungroo pig exceeds the recommended intake, while large intestine of Ghungroo pig fulfilled the suggested intake. The trace elements, selenium and chromium in all the muscles of Doom and Ghungroo pig were

Table 4.48. Mineral contents of viscera of Doom and its requirements for adults.

	Results Obtained (mg/kg)						**Recommendation for adults**
	Kidney	**Small intestine**	**Spleen**	**Liver**	**Heart**	**Large intestine**	
Macro-elements							
K	78.56	32.15	60.2	101.45	52.76	34.2	3500 mg/d
Na	97.19	29.88	122.84	77.57	31.2	32.23	2000 mg/d
Mg	3.03	3.71	3.27	5.23	2.76	2.42	420 mg/d (males) and 320 mg/d (females)
Ca	4.14	6.02	5.49	7.81	2.24	4.98	1000 – 1300 mg/d
Micro-elements							

Cu	0.6	0.04	0.03	0.15	0.09	0.007	1.6 mg/d
Zn	1.7	1.72	0.73	1.87	0.32	0.72	11 mg/d (men) and 8 mg/d (women)
Fe	7.35	2.63	9.59	11.7	2.55	0.89	16–18 mg/d (males) and 12–16 mg/d (females)
Mn	0.72	15.57	0.42	0.21	0.59	2.88	3 mg/d
Trace elements							
Se	0.056	0.013	0.018	0.013	0.01	0.011	55 µg/d
Cr	0.006	0.009	0.037	0.032	0.01	0.032	30 µg/d (men) and 25 µg/d (female)
Potentially toxic trace elements							
As	0.005	ND*	0.005	0.012	ND*	ND*	9.89 µg/d (men) and 5.36 µg/d (female)
Cd	ND*	ND*	0.019	0.012	ND*	0.015	0.5 and 1 mg/kg
Pb	0.108	0.029	0.016	0.14	0.115	0.036	0.025 mg/kg
Ni	0.023	0.049	0.04	0.064	0.028	0.055	0.013 mg/kg body weight

ND* = Not Detected

Table 4.49. Mineral contents of viscera of Ghungroo and its requirements for adults.

	Results Obtained (mg/kg)						**Recommendation for adults**
	Kidney	**Small intestine**	**Spleen**	**Liver**	**Heart**	**Large intestine**	
Macro-elements							
K	79.8	33.82	63.54	106.46	54.76	36.21	3500 mg/d
Na	95.53	28.82	120.51	75.74	32.47	29.63	2000 mg/d
Mg	2.36	2.72	2.61	4.56	3.43	3.09	420 mg/d (males) and 320 mg/d (females)
Ca	4.47	6.35	5.89	8.21	2.74	5.31	1000 – 1300 mg/d
Micro-elements							
Cu	0.642	0.049	0.039	0.197	0.093	0.01	1.6 mg/d
Zn	2.03	1.1	0.67	1.95	0.43	0.79	11 mg/d (men) and 8 mg/d (women)

Fe	8.02	2.97	10.59	10.37	2.89	0.97	16–18 mg/d (males) and 12–16 mg/d (females)
Mn	0.83	15.91	0.56	0.23	0.79	3.55	3 mg/d
Trace elements							
Se	0.06	0.015	0.018	0.016	0.011	0.012	55 µg/d
Cr	0.007	0.009	0.037	0.033	0.011	0.034	30 µg/d (men) and 25 µg/d (female)
Potentially toxic trace elements							
As	0.006	ND*	0.006	0.013	ND*	ND*	9.89 µg/d (men) and 5.36 µg/d (female)
Cd	ND*	ND*	0.018	0.017	ND*	0.016	0.5 and 1 mg/kg
Pb	0.111	0.03	0.016	0.144	0.12	0.036	0.025 mg/kg
Ni	0.023	0.05	0.041	0.074	0.025	0.056	0.013 mg/kg body weight

ND* = Not Detected

lower than the recommended intakes for male and female adults, however the concentration of kidney of Doom pig exceeds the recommended intake. Among the potentially toxic trace elements, arsenic content of liver of both Doom and Ghungroo pig exceeds the recommended intake. Small intestine of Doom and large intestine of both Doom and Ghungroo pig exceeds the suggested intakes of lead, while other were within the range of recommended intake. The nickel concentration in all the viscera of Doom and Ghungroo pig were found to exceed the recommended intakes.

4.5.8.8. Comparison of mineral of muscles: Doom and Ghungroo pigs vs. Goat, Sheep and Beef

The comparison values of minerals (macro- and micro-elements, trace and potentially toxic trace elements) of six muscles of Doom and Ghungroo pigs with other red meats i.e., goat, sheep and beef are in Figures 4.p. and 4.q. The K content in shoulder region of that of Doom and Ghungroo pig were slightly higher than those of goat, sheep and beef. Na content of Doom and Ghungroo pig were lower than of goat, sheep and beef. The micro-elements (Cu, Zn, Fe and Mn) concentration in shoulder region of Doom were found to be similar in all the analysed elements. Trace element, Se was higher in shoulder region of Doom, Ghungroo pig and sheep, while others exhibited low concentrations. High concentration of Cr was observed in shoulder region of sheep, while other were found to be similar. Arsenic (As) concentration in the shoulder region of goat, sheep and beef was found the highest than those

of shoulder region of Doom and Ghungroo pigs. Both Pb and Ni concentrations were higher in shoulder region of Doom and Ghungroo pig, while others showed low concentrations.

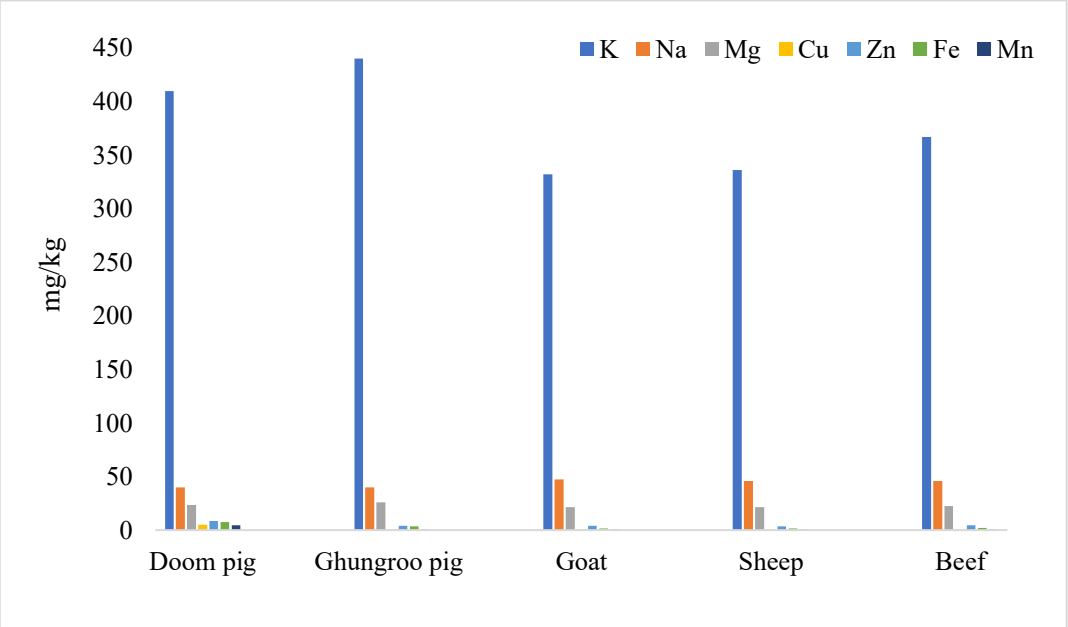

Figure 4.p. Macro- and micro-elements of shoulder region of Doom and Ghungroo pig compared with goat, sheep and beef.

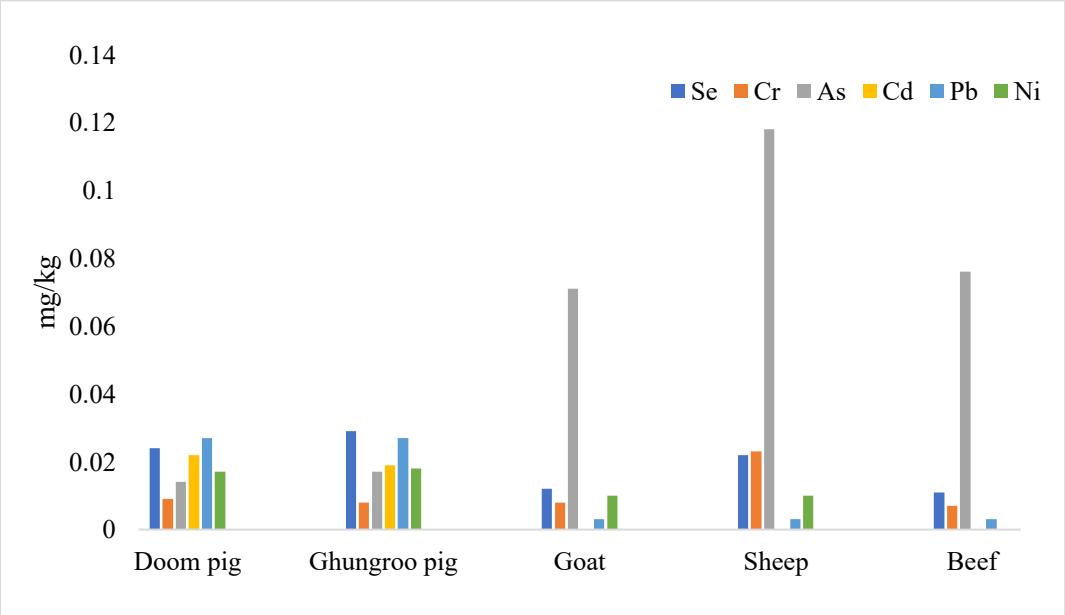

Figure 4.q. Trace and potentially toxic trace elements of shoulder region of Doom and Ghungroo pig compared with goat, sheep and beef.

4.5.8.9. Comparison of mineral of viscera: Doom and Ghungroo pigs vs. Goat, Sheep and Beef

The comparison values of minerals (macro- and micro-elements, trace and potentially toxic trace elements) of six muscles of Doom and Ghungroo pigs with other red meats i.e., goat, sheep and beef are tabulated in Figures 4.r. and 4.s. The macro-elements of Doom and Ghungroo pig were lower than goat, sheep and beef. The micro-elements too were found lower in Doom and Ghungroo pig breeds compared to goat, sheep and beef. The trace element, selenium was found low in all the analyzed viscera of Doom and Ghungroo pig breeds than goat, sheep and beef. While value of chromium was similar in all the viscera of animals including our samples. Arsenic, regarded as potentially toxic trace element was observed high in viscera of Doom and Ghungroo pig breeds than other analyzed animals. Cadmium was recorded high in the kidney of beef. Lead concentration was the highest, among the potentially toxic trace elements. Among the animals, kidney of beef has showed the highest concentration of lead.

4.5.9. Correlation of minerals composition between tissues (muscles and viscera) of both the pigs with feed, drinking water and soil.

4.5.9.1. Muscles of Doom and Ghungroo pig

The mineral content of muscles and viscera of Doom and Ghungroo pigs were correlated with that of the mineral composition of feed (kitchen waste), drinking water and soil. All the macro- and micro- elements and potentially toxic trace elements are presented in mg/kg.

The correlation matrix of minerals contents (macro- and micro-elements, trace and potentially toxic trace elements) between muscles (*triceps brachii*, *latissimus dorsi*, *biceps femoris*, *tensor fasciae latae*, *gracilis* and *longissimus dorsi*) of Doom and Ghungroo pig are tabulated in Table 4.50. Among the variables muscles of Doom pig showed highest correlation with feed ranging from 0.8066 to 0.9033. Lowest correlation was observed with drinking water ranging from 0.7011 to 0.7802. Muscle *gracilis* was observed with the highest spearman correlation coefficient (r). Likewise, that of muscles of Doom pig, the muscles of Ghungroo pig showed highest correlation with feed ranging from 0.8066 to 0.9033.

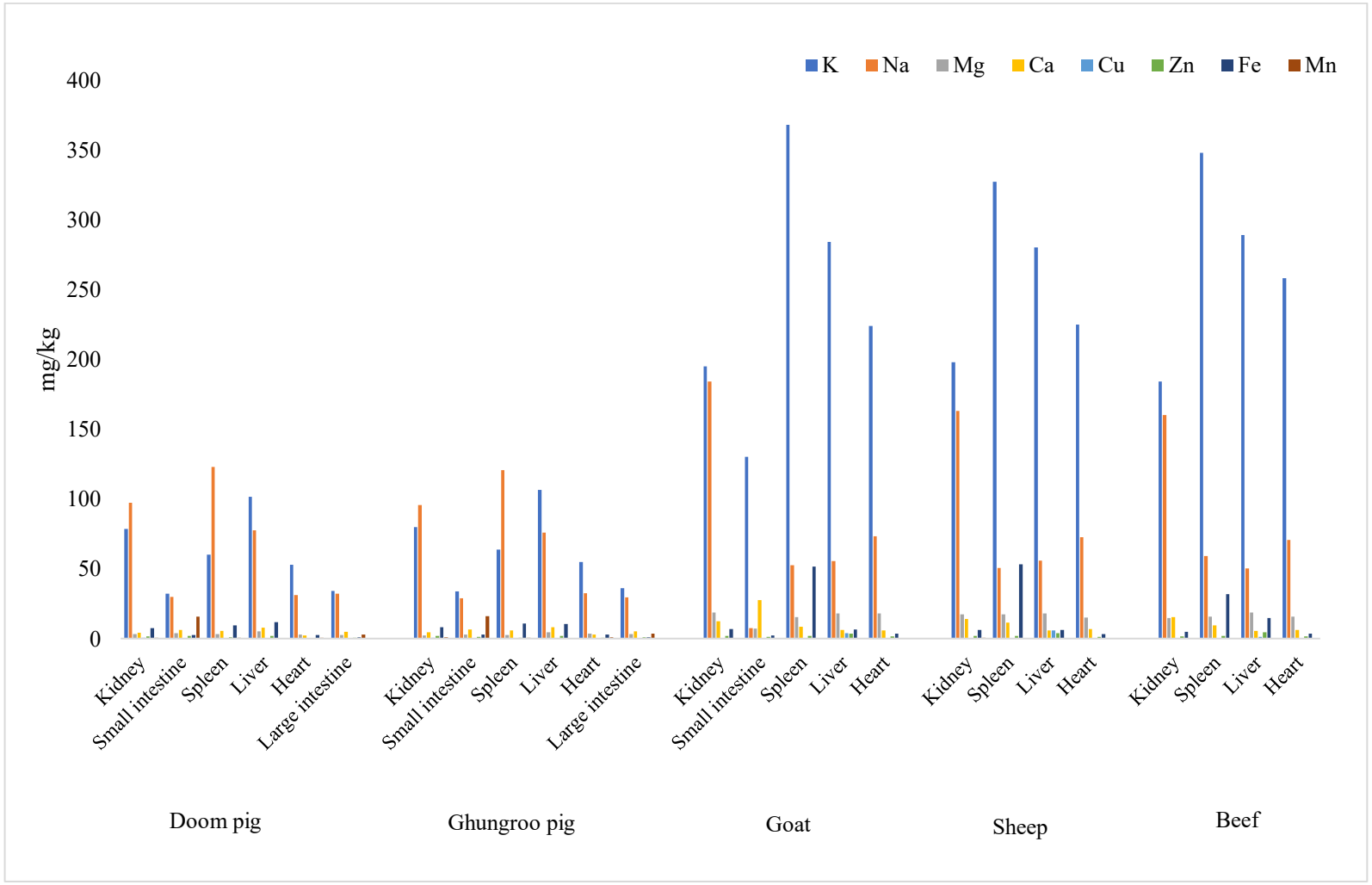

Figure 4.r. Macro- and micro-elements of viscera of Doom and Ghungroo pig compared with goat, sheep and beef.

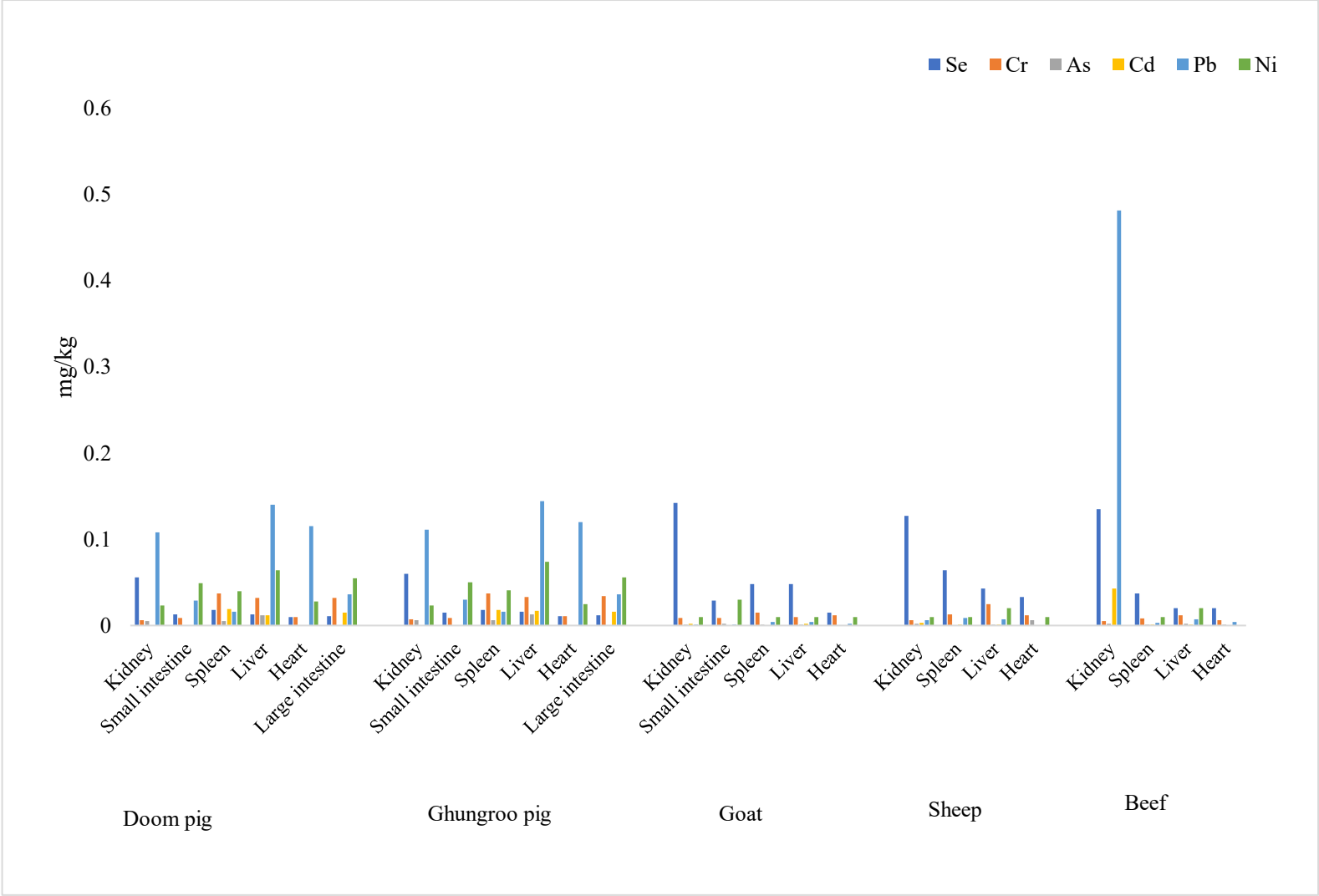

Figure 4.s. Trace and potentially toxic trace elements of viscera of Doom and Ghungroo pig compared with goat, sheep and beef.

Table 4.50. Correlation matrix of minerals composition between muscles of Doom and Ghungroo pig and feed, drinking water and soil.

Variables	***Triceps brachii***	***Latissimus dorsi***	***Biceps femoris***	***Tensor fasciae latae***	***Gracilis***	***Longissimus dorsi***
			Doom pig			
Feed (kitchen waste)	0.8989 (<0.0001)	0.8198 (0.0006)	0.8066 (0.0008)	0.8505 (0.0002)	0.9033 (<0.0001)	0.8735 (0.0001)
Drinking water	0.7055 (0.0063)	0.7011 (0.0067)	0.7231 (0.0047)	0.7319 (0.0040)	0.7802 (0.0015)	0.7591 (0.0023)
Soil	0.7758 (0.0017)	0.7846 (0.0014)	0.7802 (0.0015)	0.7451 (0.0031)	0.7890 (0.0013)	0.7789 (0.0016)
			Ghungroo pig			
Feed (kitchen waste)	0.8769 (<0.0001)	0.8725 (0.0001)	0.8505 (0.0002)	0.8681 (0.0001)	0.8769 (0.0001)	0.8154 (0.0007)
Drinking water	0.7275 (0.0043)	0.7626 (0.0022)	0.7319 (0.0040)	0.7538 (0.0027)	0.7275 (0.0043)	0.6703 (0.0107)
Soil	0.7626 (0.0022)	0.7846 (0.0014)	0.7451 (0.0031)	0.7626 (0.0022)	0.7451 (0.0031)	0.7275 (0.0043)

Values without parentheses are spearman correlation coefficient (r) at 95% confidence level; values in parenthesis are p-value >0.05

4.5.9.2. Viscera of Doom and Ghungroo pig:

The correlation matrix of minerals content (macro- and micro-elements, trace and potentially toxic trace elements) between viscera (kidney, small intestine, spleen, liver, heart and large intestine) of Doom and Ghungroo pig with feed (kitchen waste), drinking water and soil are tabulated in Table 4.51. The highest correlation found was feed ranging from 0.8418 to 9285 and lowest is the soil ranging from 0.7758 to 0.8813. Heart of Doom pig was found to have the highest correlation with feed. Similarly, with Ghungroo pig too, among the variables, feed (ranged, 0.8515 to 0.9297) was found with highest correlation than soil and water. Liver of Ghungroo pig was found to have highest correlation with feed.

Table 4.51. Correlation matrix of minerals composition between viscera of Doom and Ghungroo pig with feed, drinking water and soil.

Variables	Kidney	Small intestine	Spleen	Liver	Heart	Large intestine
			Doom pig			
Feed (kitchen waste)	0.8901 (<0.0001)	0.9285 (0.0001)	0.8418 (0.0003)	0.9209 (<0.0001)	0.9109 (<0.0001)	0.9077 (<0.0001)
Drinking water	0.8637 (0.0001)	0.8933 (<0.0001)	0.8286 (0.0005)	0.8857 (<0.0001)	0.8933 (<0.0001)	0.8945 (<0.0001)
Soil	0.8505 (0.0002)	0.8581 (0.0002)	0.8593 (0.0002)	0.8813 (<0.0001)	0.8757 (<0.0001)	0.7758 (0.0017)
			Ghungroo pig			
Feed (kitchen waste)	0.8901 (<0.0001)	0.9285 (<0.0001)	0.8515 (0.0002)	0.9297 (<0.0001)	0.9065 (<0.0001)	0.9077 (<0.0001)
Drinking water	0.8637 (0.0001)	0.9021 (<0.0001)	0.8295 (0.0004)	0.8769 (<0.0001)	0.8933 (<0.0001)	0.8945 (<0.0001)
Soil	0.8505 (0.0002)	0.8669 (0.0001)	0.8713 (0.0001)	0.8769 (<0.0001)	0.8757 (<0.0001)	0.7758 (0.0017)

Values without parentheses are spearman correlation coefficient (r) at 95% confidence level; values in parenthesis are p-value >0.05.