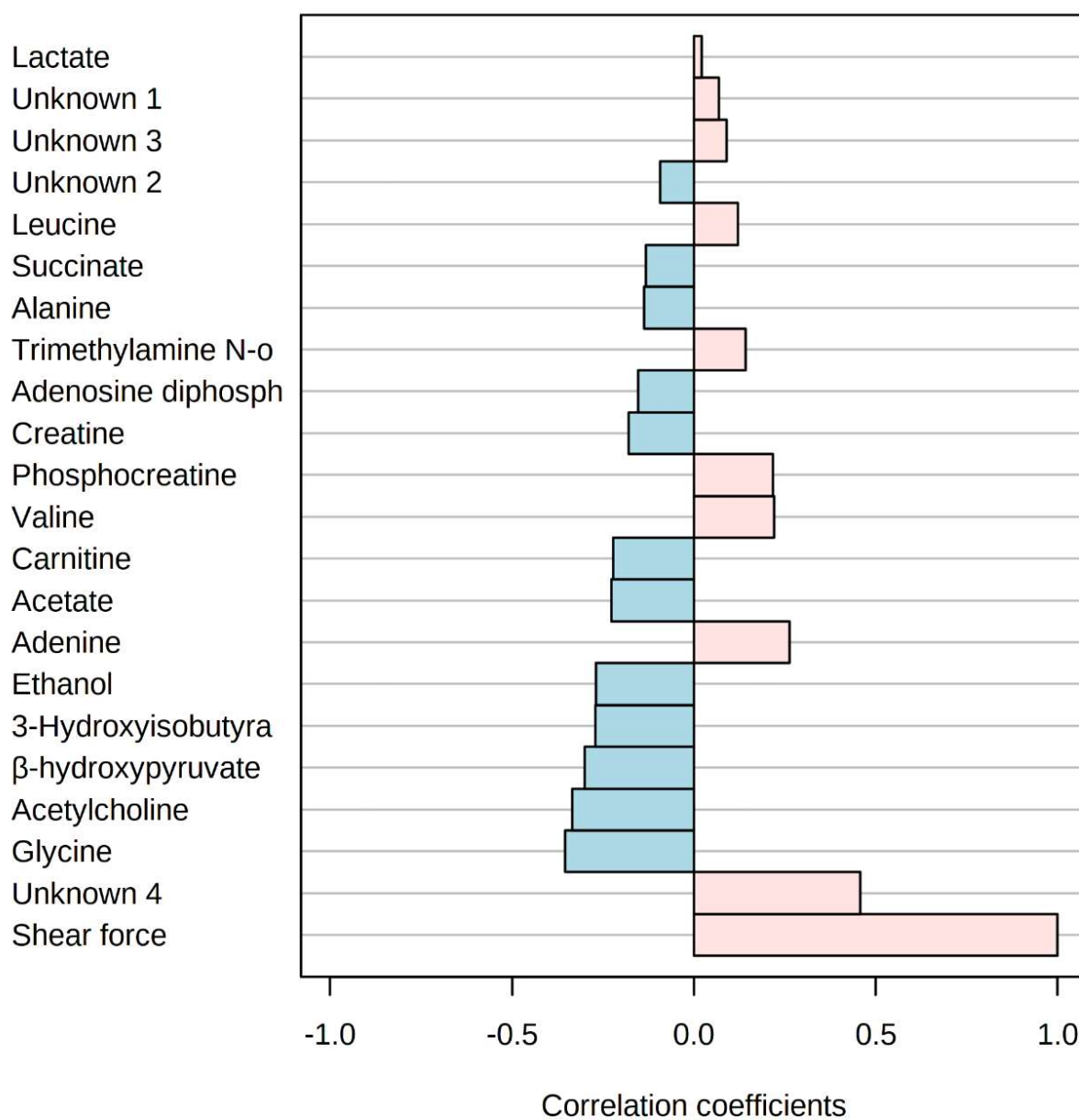
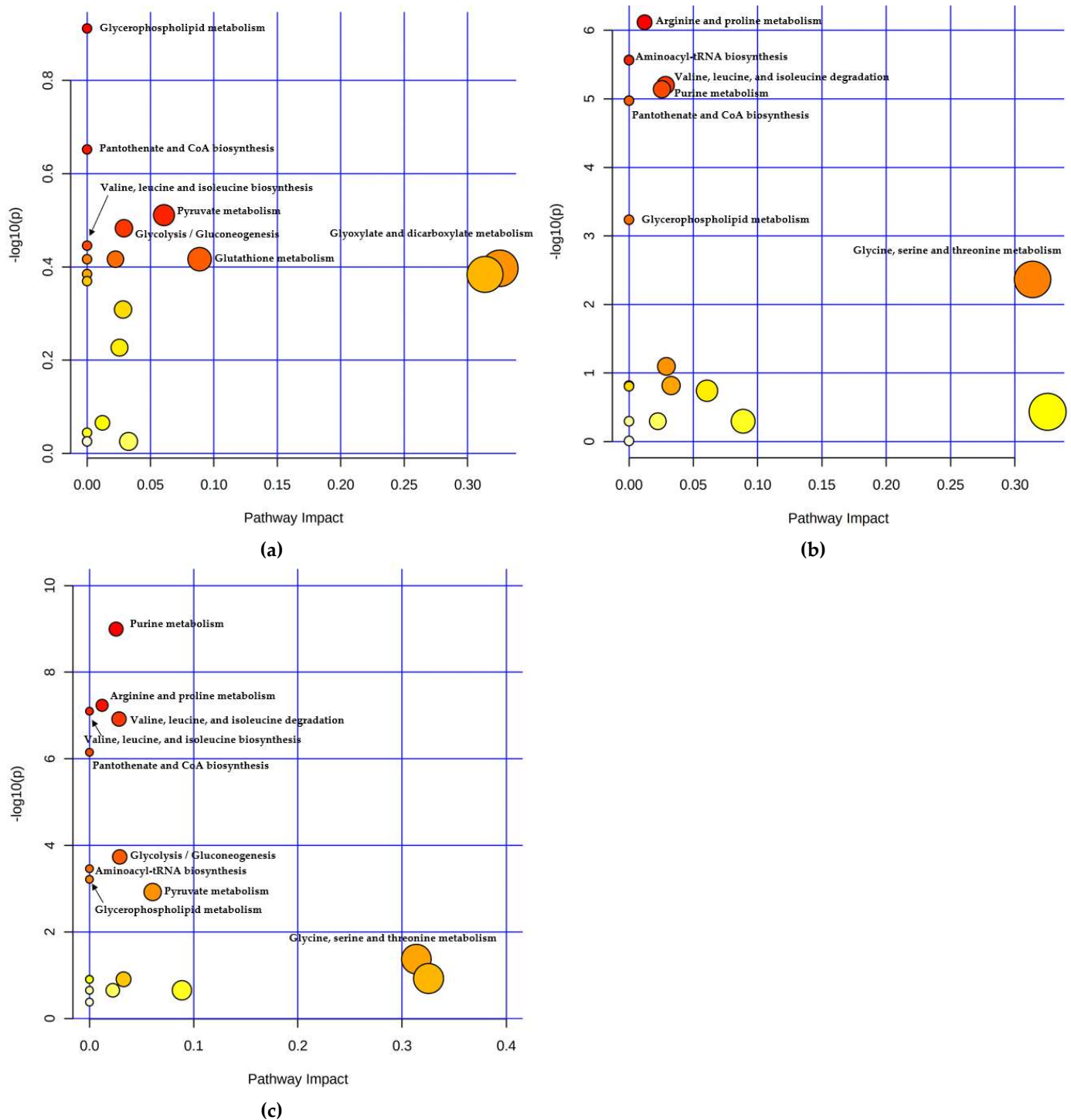


**Figure S1.** Correlation heatmaps between relative metabolite concentrations and beef quality: TN, Thai native beef; BT, Brahman × Thai native beef; CB, Charolaise × Brahman beef. Metabolites data were pareto scaled and analyzed with Pearson correlation in MetaboAnalyst 5.0 software. The top-right color key on the map indicates the expression values where the highly negative correlations are represented by dark blue, highly positive ones by dark red.

## Compounds correlated with the Shear force



**Figure S2.** Top 21 shear force-associated metabolites using Pearson correlation in MetaboAnalyst 5.0 software.



**Figure S3.** Metabolic pathways mapping of beef metabolites between TN and BT (**a**,  $p > 0.05$ ), TN and CB (**b**,  $p < 0.05$ ), and BT and CB (**c**,  $p < 0.05$ ) revealed by *Bos taurus* (KEGG) library-based analysis using the MeatboAnalyst 5.0 software. The mapping displays the different pathways that were compared based on their  $p$  values in the topological and enrichment analyses. The larger and darker bubble plot shows the higher  $p$  values.

**Table S1.** Major metabolic pathways ( $p < 0.05$ ) uncovered by *Bos taurus* (KEGG) library-based analysis.

Pathway Name	Match Status	$p$	$-\log(p)$	Holm $p$	FDR	Impact
<i>TN vs BT</i> <sup>a</sup>						
-						
<i>TN vs CB</i>						
Arginine and proline metabolism	2/38	$7.63 \times 10^{-7}$	6.12	$1.45 \times 10^{-5}$	$1.45 \times 10^{-5}$	0.01
Valine, leucine, and isoleucine biosynthesis	2/8	$2.70 \times 10^{-6}$	5.56	$4.86 \times 10^{-5}$	$1.73 \times 10^{-5}$	0.00
Aminoacyl-tRNA biosynthesis	4/48	$2.73 \times 10^{-6}$	5.56	$4.86 \times 10^{-5}$	$1.73 \times 10^{-5}$	0.00
Valine, leucine, and isoleucine degradation	3/40	$6.34 \times 10^{-6}$	5.19	$1.01 \times 10^{-4}$	$2.75 \times 10^{-5}$	0.03
Purine metabolism	2/66	$7.24 \times 10^{-6}$	5.14	$1.09 \times 10^{-4}$	$2.75 \times 10^{-5}$	0.03
Pantothenate and CoA biosynthesis	1/19	$1.06 \times 10^{-5}$	4.97	$1.49 \times 10^{-4}$	$3.35 \times 10^{-5}$	0.00
Glycerophospholipid metabolism	1/36	$5.80 \times 10^{-4}$	3.24	0.007	0.0015	0.00
Glycine, serine, and threonine metabolism	3/34	0.0043	2.36	0.052	0.0102	0.31
<i>BT vs CB</i>						
Purine metabolism	2/66	$1.01 \times 10^{-9}$	8.99	$1.92 \times 10^{-8}$	$1.92 \times 10^{-8}$	0.03
Arginine and proline metabolism	2/38	$5.83 \times 10^{-8}$	7.23	$1.05 \times 10^{-6}$	$5.05 \times 10^{-7}$	0.01
Valine, leucine, and isoleucine biosynthesis	2/8	$7.97 \times 10^{-8}$	7.09	$1.36 \times 10^{-6}$	$5.05 \times 10^{-7}$	0.00
Valine, leucine, and isoleucine degradation	3/40	$1.21 \times 10^{-7}$	6.92	$1.94 \times 10^{-6}$	$5.74 \times 10^{-7}$	0.03
Pantothenate and CoA biosynthesis	1/19	$7.07 \times 10^{-7}$	6.15	$1.06 \times 10^{-5}$	$2.69 \times 10^{-6}$	0.00
Glycolysis / Gluconeogenesis	3/26	$1.85 \times 10^{-4}$	3.73	0.0025	$5.85 \times 10^{-4}$	0.03
Aminoacyl-tRNA biosynthesis	4/48	$3.46 \times 10^{-4}$	3.46	0.0045	$9.39 \times 10^{-4}$	0.00
Glycerophospholipid metabolism	1/36	$6.09 \times 10^{-4}$	3.22	0.0073	0.0014	0.00
Pyruvate metabolism	2/22	0.0012	2.92	0.0131	0.0025	0.06
Glycine, serine, and threonine metabolism	3/34	0.0423	1.37	0.4239	0.0805	0.31

FDR, False recovery rate; TN, Thai native beef; BT, Brahman × Thai native beef; CB, Charolaise × Brahman beef

<sup>a</sup>Nineteen pathways were analyzed, and none of them showed statistical significance ( $p > 0.05$ ).