Widely targeted metabolome profiling of different highland raspberries and berry parts provides innovative insight into their antioxidant activities

Xiaoli Ren, Yangbo Song*
Agriculture and Animal Husbandry College, Qinghai University, Xining 810015, China

Introduction

Raspberries are considered worldwide as a functional berry due to their good nutritional value and strong antioxidant activities[1]. Several researchers reported that intake of whole raspberry and its parts favorably influence physiological functions via various biological metabolisms[2]. However, highland raspberries and phytochemicals present in whole berries and their different parts have been less reported than in other berries. To confirm the diversity and variability of metabolites in whole raspberry and berry parts and disclose critical metabolites and pathways contributing to differences in antioxidant activities, commercial raspberries and their puree andseed from two highland regions (Yunnan and Qinghai, China) were subjected to LC-MS/MS-based widely targeted metabolomics analysis.

Collectively, phytochemical compositions and antioxidant activity in whole raspberry, berry parts, and regions expand comprehensive exploitation and cultivation.



Methods


LC-MS/MS

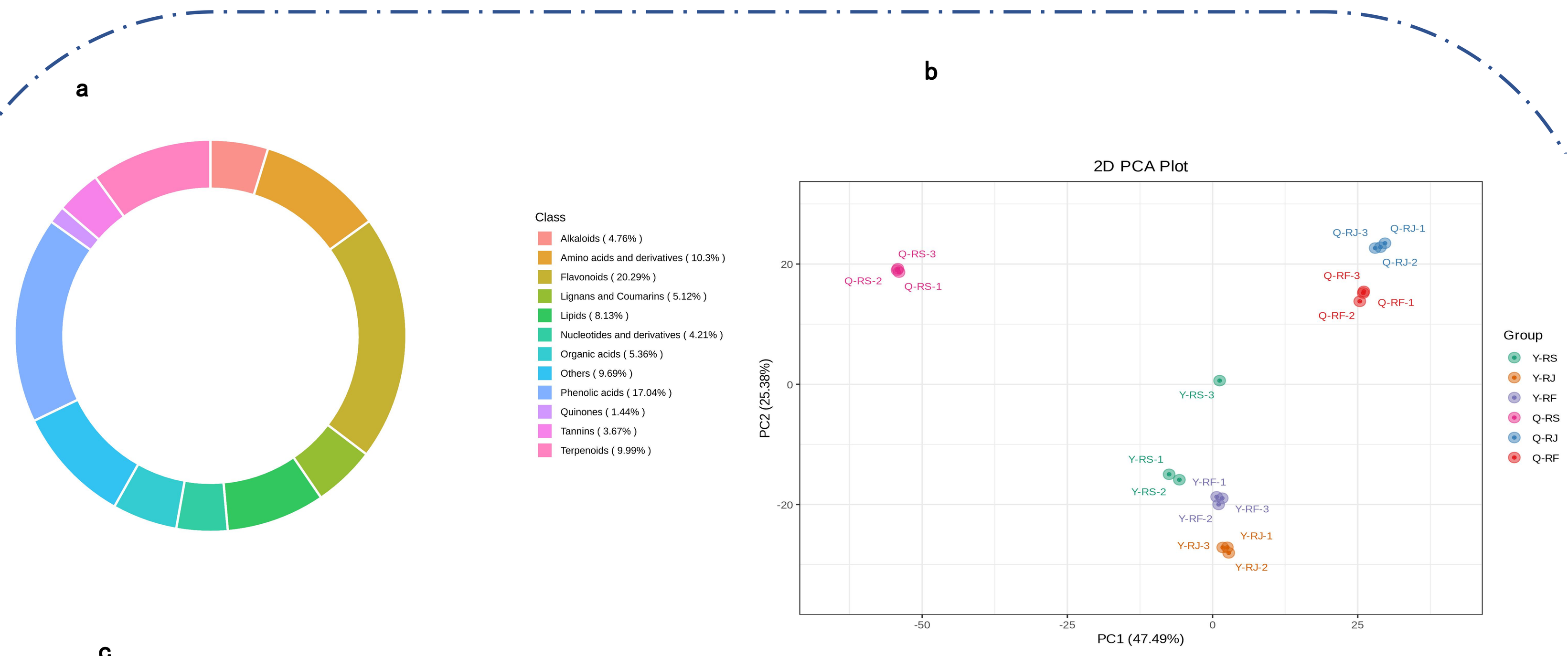
PCA, OPLS-DA

VIP, Fold Change, *P*-value

KEGG

DPPH, FRAP, ABTS, ORAC

Results



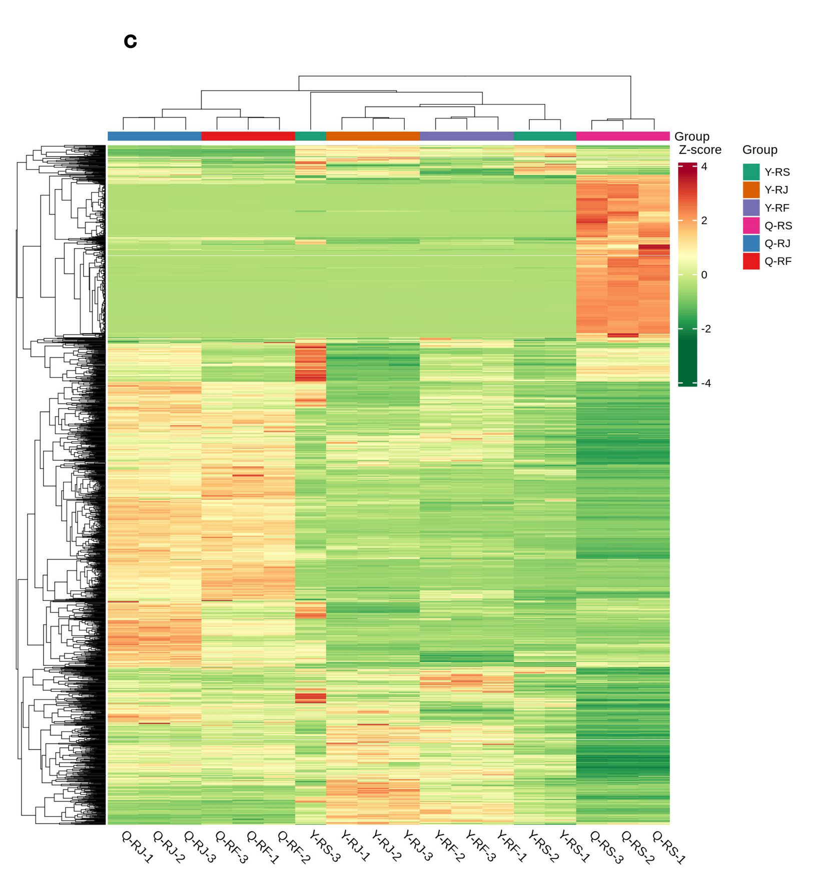


Fig. 1 Phenotype and metabolite characteristics of different tissues of Qinghai raspberry and Yunnan raspberry. (a) Classification of the 1661 identified metabolites in raspberry; (b) Principal component analysis (PCA) result showing metabolite profile differences between and within groups; and (c) Hierarchical cluster analysis (HCA) results exposing metabolites variation between and within groups.

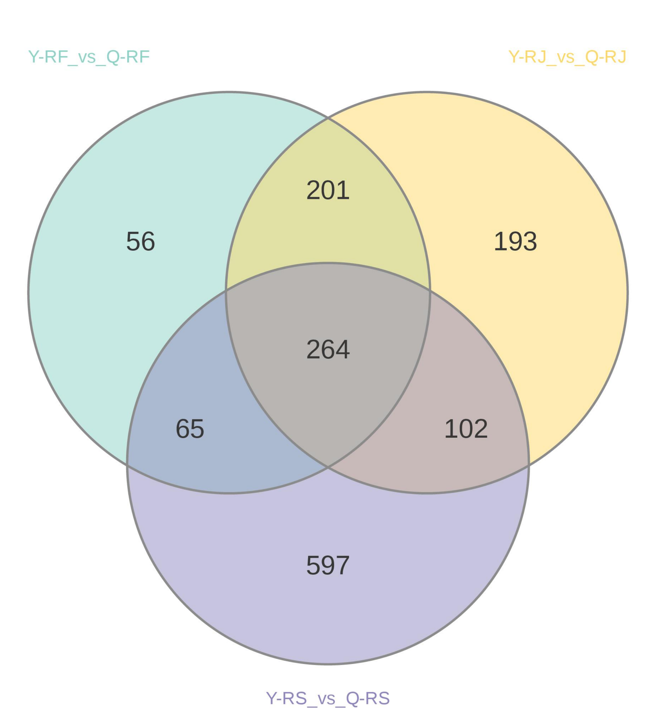


Fig. 2 Venn diagram of the differential metabolites of Y-RF vs. Q-RF, Y-RJ vs. Q-RJ, and Y-RJ vs. Q-RJ. Numbers represent the identified differential metabolites of the pairwise comparisons.

Results

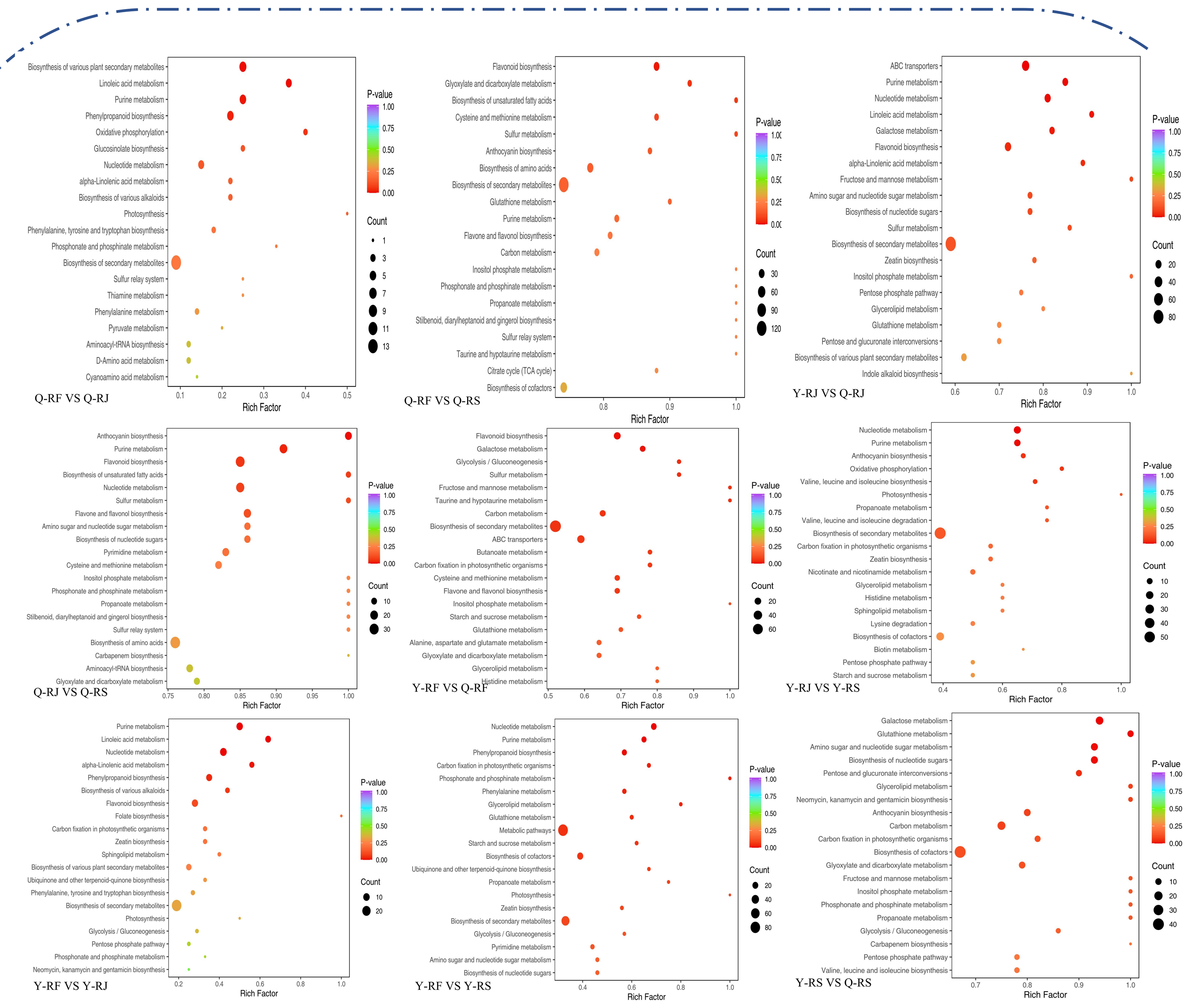


Fig. 3 Significant changed metabolites KEGG enrichment.

Antioxidant capacity

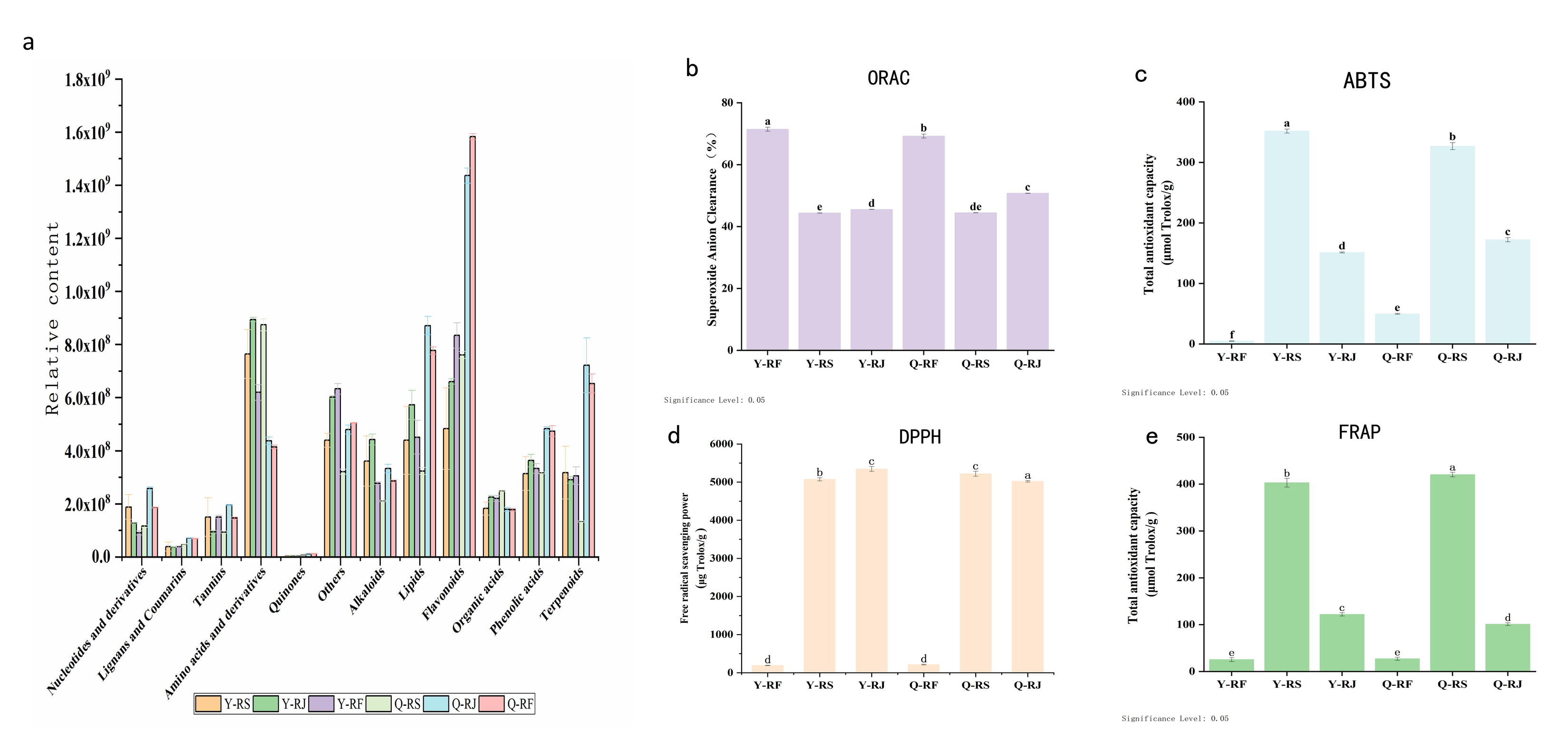


Fig. 4 The relative content of each class of metabolites and antioxidant activities of the different highland raspberries and berry parts. Comparison of the relative content of each category of metabolites in Y-RS, Y-RJ, Y-RF, Q-RS, Q-RJ, and Q-RF (a); antioxidant activities the different highland raspberries and berry parts using ORAC assay (b), ABTS assay (c), DPPH assay (d), and FRAP assay (e). Different letters above bars indicate statistically significant differences at $p < 0.05$.

Conclusion

The composition of metabolic compounds varied significantly with the whole berry, parts, and regions. The most significant differential metabolites between the different highland raspberries mainly included flavonoids, and terpenoids. Biosynthesis of secondary metabolites and flavonoid biosynthesis were the mainly differently regulated pathways. The DPPH, FRAP, ABTS, and ORAC assays showed that the antioxidant activity of Qinghai raspberry was stronger than Yunnan. In addition, the antioxidant capacity of seed was the maximum (5072.01 μg TE/ dw, 402.86 μM TE/dw, 351.72 μM TE/g dw, and 44.36%, respectively). The order of the antioxidant capacity was seed > puree > berry. The biological proprieties of seeds may correlate primarily with their contents of flavonoids, amino acids and derivatives.

Reference

[1] Lopez-Corona A V, Valencia-Espinosa I, González-Sánchez F A, et al. Antioxidant, Anti-Inflammatory and Cytotoxic Activity of Phenolic Compound Family Extracted from Raspberries (Rubus idaeus): A General Review[J]. Antioxidants, 2022, 11(6): 1192.
[2] Piña-Contreras N, Martínez-Moreno A G, Ramírez-Anaya J D P, et al. Raspberry (Rubus idaeus L.), a Promising Alternative in the Treatment of Hyperglycemia and Dyslipidemias[J]. Journal of Medicinal Food, 2022, 25(2): 121-129.