The sweet-clover vetch (*Vicia pulchella*) is generally a forb or herbaceous species native to the United States, used in farming as a forage plant. In this study, we examined the seeds of the two subspecies of *Vicia pulchella, V. pulchella* subsp. *pulchella* Kunth and *V. pulchella* subs. *mexicana* **(**Hemsl.) C.R.Gunn using gas chromatography-mass spectrometry coupled with multivariate data analyses to discriminate between the two subspecies via their chemical profiles. The metabolic differences of seeds derived from seven accessions belonging to the two subspecies were assessed. Eighty-two metabolites and derivatives, including 21 amino acids and other 13 nitrogen containing compounds, 8 sugars, 2 sugar alcohols, 17 organic and inorganic acids, 6 fatty acids, 4 glycosides and other compounds, were identified. All the replicates of all accessions examined for each subspecies were clustered together via principal component analysis and hierarchical clustering analysis. In general, *V. pulchella* subsp. *pulchella* presented more amino acid and fatty acid contents, while higher levels of sugars and organic acids were identified in *V. pulchella* subs. *mexicana.* Although our results confirmed that the species could provide a good set of nutritive compounds for livestock, a significant number of bioactive compounds, such as free amino acids and hydroxy fatty acids, which could have a toxic effect on the livestock and limit the potential role of the plants in the farming system, were also detected.