3-Hydroxypropionic acid (3-HP) can be produced via two enzymatic reactions: dehydration of glycerol to 3-hydroxypropanal (3-HPA) and oxidation to 3-HP. Commercial production of 3-HP has been beset with several problems. Some of these problems are associated with the toxicity of 3-HPA and the efficiency of NAD\(^+\) regeneration. We engineered \(\alpha\)-ketoglutaric semialdehyde dehydrogenase (KGSADH) for the second reaction to address these issues. The residues in the putative binding sites for the substrates, 3-HPA and NAD\(^+\), were randomized, and the libraries were screened for higher activity. Isolated KGSADH variants had lower Km values for both substrates. The enzymes showed higher substrate specificities for aldehyde and NAD\(^+\), less inhibition by NADH, and greater resistance to inactivation by 3-HPA than the wild-type enzyme. A recombinant \textit{Pseudomonas denitrificans} strain with one of the engineered KGSADH variants exhibited less accumulation of 3-HPA, decreased levels of inactivation of the enzymes involved in the production of 3-HP. These attributes facilitated sustained production of 3-HP in the late stages of culture and enhanced the final titer of 3-HP by approximately 40%.