Abstract. We study the Mahler measures of certain families of Laurent polynomials in two and three variables. Each of the known Mahler measure formulas for these families involves $L$-values of at most one newform and/or at most one quadratic character. In this paper, we show, either rigorously or numerically, that the Mahler measures of some polynomials are related to $L$-values of multiple newforms and quadratic characters simultaneously. The results suggest that the number of modular $L$-values appearing in the formulas significantly depends on the shape of the algebraic value of the parameter chosen for each polynomial. As a consequence, we also obtain new formulas relating special values of hypergeometric series evaluated at algebraic numbers to special values of $L$-functions.