TABLE 6.2 Constants of the Generalized Differential Specific Growth Rate Equation 6.34 for Different Models

	a	b	K
Monod	0	2	$1/K_s$
Tessier	0	1	$1/K$
Moser	$1-1/n$	$1+1/n$	$n/K_s^{1/n}$
Contois	0	2	$1/K_{sx}$

where $\upsilon = \mu_g/\mu_m$, S is the rate-limiting substrate concentration, and K, a, and b are constants. The values of these constants are different for each equation and are listed in Table 6.2.

The correct rate form to use in the case where more than one substrate is potentially growth-rate limiting is an unresolved question. However, under most circumstances the noninteractive approach works best:

$$\mu_g = \mu_g(S_1) \quad \text{or} \quad \mu_g(S_2) \quad \text{or} \quad \ldots \quad \mu_g(S_n) \tag{6.38}$$

where the lowest value of $\mu_g(S_i)$ is used.

6.3.2.2. Models with growth inhibitors. At high concentrations of substrate or product and in the presence of inhibitory substances in the medium, growth becomes inhibited, and growth rate depends on inhibitor concentration. The inhibition pattern of microbial growth is analogous to enzyme inhibition. If a single-substrate enzyme-catalyzed reaction is the rate-limiting step in microbial growth, then kinetic constants in the rate expression are biologically meaningful. Often, the underlying mechanism is complicated, and kinetic constants do not have biological meanings and are obtained from experimental data by curve fitting.

1. *Substrate inhibition:* At high substrate concentrations, microbial growth rate is inhibited by the substrate. As in enzyme kinetics, substrate inhibition of growth may be competitive or noncompetitive. If a single-substrate enzyme-catalyzed reaction is the rate-limiting step in microbial growth, then inhibition of enzyme activity results in inhibition of microbial growth by the same pattern.

The major substrate-inhibition patterns and expressions are as follows:

Noncompetitive substrate inhibition: $$\mu_g = \frac{\mu_m}{\left(1+\dfrac{K_s}{S}\right)\left(1+\dfrac{S}{K_I}\right)} \tag{6.39}$$

Or if $K_I \gg K_s$, then: $$\mu_g = \frac{\mu_m S}{K_s + S + S^2/K_I} \tag{6.40}$$