表 1 HA 基因在大肠杆菌中表达的稀有密码子(临界值为 1%)分析

Table 1 Analysis of rare codons translated in *E. coli* from HA gene (critical frequency: 1%)

基因 Gene	氨基酸序列大小 Size of amino acid sequence	密码子总数 Codon number	使用频率≤1%的稀有密码子数 Codon number with frequency≤1%	使用频率≤0.28%的稀有密码子数 Codon number with frequency≤0.28%	A	B	C
HA ORF HA ORF	567	567	156	23	0.175	0.377	−0.090
HA 抗原表位 HA antigencity	244	244	70	9	0.177	0.374	−0.098

注: 大肠杆菌密码子使用频率越低, 外源基因越难以表达; A: 密码子使用指数(CAI); B: 最佳密码子使用频率(FOP); C: 密码子偏好性指数(CBI); A,B: CAI 和 FOP 取值均在0~1之间; 值越大, 密码子偏好性越大; 等于 1 时, 密码子偏好性达最大; C: 密码子偏好性随 CBI 值升高而增大; 当 CBI 值等于 1 时, 密码子偏好性达最大; 当 CBI 值为负数时, 表示最优密码子的使用次数少于平均使用次数

Note: Codon frequency corresponds to the expression of exotic gene; Less frequency means that the exotic gene difficultly translated in *Escherichia coli*; A: Codon adaptation index (CAI); B: Frequency of optimal codons index (FOP); C: Codon bias index (CBI); A,B: The range for the index of CAI and FOP is between 0~1; The increasing of CAI and FOP means that the codons tend to *Escherichia coli* bias; The codons would be adapted to the bias of *Escherichia coli* when the index reaches 1; C: The codon bias increase followed by the index of CBI; The codon would be adapted to the bias of *Escherichia coli* when the index reaches 1; The minus CBI means that the frequency of optical codon is less than the average