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细菌凝乳酶干酪素生产工艺参数优化

Optimization of technology parameters for casein production with bacteria rennet

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中文摘要:

以新鲜牛乳为原料、细菌凝乳酶作凝固剂，先采用单因素试验研究了凝乳温度、pH值、CaCl2添加量和凝乳酶添加量4个因素对凝乳效果的影响，然后通过Box-Benhnken设计进一步优化了细菌凝乳酶干酪素生产工艺参数。根据试验结果，采用逐步回归的方法进行二次回归分析，得到相应的回归方程式，模型的R2值为0.98%，说明回归方程的拟合程度良好。采用Design-Expert软件预测得到干酪素得率的最大估计值为3.534%，此时因素X1、X2、X3的对应值分别为0.306、0.216、0.342，3个因素的对应水平为：温度36.53℃、pH值6.216、凝乳酶添加量为0.368 mL。采用上述优化条件进行验证试验时将温度设定为36.5℃、pH值设定为6.2、凝乳酶添加量设定为0.37 mL。验证试验结果表明，在此条件下凝乳酶干酪素的得率为3.527%±0.02%，与理论预测值相比，相对误差为0.19%。分别测定了细菌凝乳酶干酪素和小牛皱胃酶干酪素的水分、灰分和蛋白质等理化指标，结果表明细菌凝乳酶干酪素所含水分、灰分和蛋白质含量比小牛皱胃酶干酪素高，但差异不显著（P>0.05），而脂肪含量比小牛皱胃酶干酪素低，差异也不显著（P>0.05）。将2种凝乳酶干酪素进行红外光谱扫描，发现小牛皱胃酶干酪素和细菌凝乳酶干酪素的特征峰基本一致。以上结果表明，2种凝乳酶干酪素品质差异不显著，说明细菌凝乳酶可作为小牛皱胃酶的替代品用于凝乳酶干酪素的生产。研究结果可为细菌凝乳酶的应用提供技术依据。

英文摘要:

Abstract: In this paper, rennet casein was prepared from fresh milk using bacteria rennet as a coagulant and the technology was optimized by a single factor test and response surface methodology. First, temperature, pH value, and an addition volume of enzyme were shown to have significant effects on the yield of rennet casein using the single factor experiment. Subsequently, three significant independent variables were selected and further optimized using the box-behnken design to determine their optimal levels. Via multiple regression analysis on the experimental data using Design-Expert software, the following second-order polynomial equation was obtained. The regression coefficients and the analysis of the variance indicated the high significance of the model. The highest R2 value (0.98) was also in good agreement with the experimental results and theoretical values predicted by the model. From equations derived by differentiation, the optimal values of X1, X2, and X3 in the coded units were found to be 0.306, 0.216, and 0.342, respectively. Correspondingly, we obtained the maximum point of the model, which was 36.53℃ of temperature, 6.216 of pH value, and 0.368 mL of additional volume of enzyme, respectively. The maximum predicted yield of rennet casein was 3.534%. The optimal coagulation parameters in the validated experiment were set as follows: temperature 36.5℃, pH 6.2 and 4 mL 4% CaCl2, 0.37 mL bacteria rennet per 500 mL milk. Under the optimized conditions, the yield of rennet casein reached 3.527%±0.02% and the relative error was 0.19% compared with the predicated value, showing that the response surface method are effective to optimize culture conditions. The contents of water, ash, protein, and fat of rennet casein produced with bacterial rennet and calf rennet were measured. The results showed the contents of water, ash, and protein of rennet casein produced with bacterial rennet were higher than that of calf rennet, but not significantly different (P>0.05), the contents of fat of rennet casein produced with bacterial rennet were lower than that of calf rennet, but not significantly different (P>0.05). The FTIR technique was used to determine and compare the rennet casein produced with bacterial rennet and calf rennet. The spectra of rennet casein produced with bacterial rennet and calf rennet were similar. The results of physical and chemical tests and infrared spectrum scan showed that there was no obvious difference between the two products, suggesting that bacteria rennet from Bacillus amyloliquefaciens could be used as calf rennet alternatives in the production of rennet casein. The research can provide a reference for the full utilization of bacteria rennet.

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