Modeling and Optimizing Culture Conditions of Milk Kefir Grains Using Response Surface Methodology

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Abstract

This study provides the application of response surface methodology in modeling and optimizing culture conditions of milk kefir grains for nutrition and health. The operational conditions considered during the growth of the kefir grains were number of rotations, fat content and time. This led to an increase in biomass of kefir grains with high level of probiotics. In order to obtain the optimum growth of kefir grains; culture conditions, culture liquid and presence of random effects were considered. Thus, an experiment was carried out in order to obtain the data which was used to establish the necessary conditions on the growth of kefir grains. Box-Behnken design was used to model the data and hence identify optimal levels of conditions for growing kefir grains. Further the random effects were identified. The evaluation of the presence of random effects on growth of kefir grains was established. The Design expert was used to extract data through controlled experiment. Formulation of first order factorial experiment based on a Box –Behnken design was performed in order to determine the effects of culture conditions on the growth of kefir grains. The data was fitted to the first order model and its adequacy was tested using statistical analysis. It was found out that the first order model could not fit data and hence second order model was used. The second order model was used to determine the optimum settings of time, number of rotations and fat content. Testing the prediction of the second order and its adequacy was verified using the I-optimality and G –optimality criteria. The statistical analysis was done using a two-way analysis of variance for fitting the data. The predicted response based on the growth of the kefir grains was assessed using ridge analysis and Lagrange multiplier method. Evaluation of random effects to the growth of kefir grains was tested by blocking. The variance, covariance and standard errors were also computed to assess the presence of random effects in each block .It was noted that fat content and number of rotations had a positive effect while time had a negative effect on growth of kefir grains. The quadratic and interaction effects of all factors were found to be insignificant at $\alpha=0.05$. The tests for random effects were insensitive and remainder sum of squares was not uniform across the blocks hence presence of random effects. Using scaled predictive variance of stationery and non-stationary points, the second order model had a good prediction of region of interest for any two points. The study indicated the presence of random effects which should be controlled during growth. From the study it was recommended that all the culture conditions should be at stationery point so that the residuals are minimized during modelling and optimizing growth of kefir grains using milk.