Application of optimization techniques in development of probiotic dairy products

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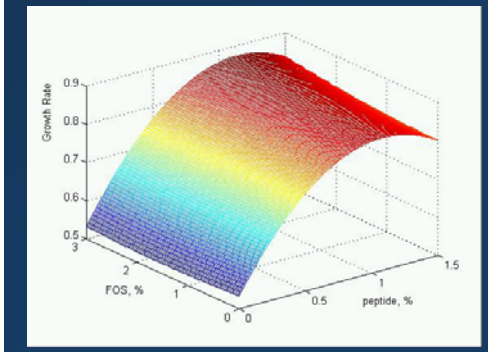
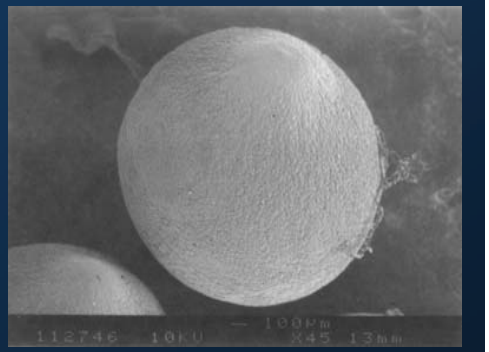
Outline

- Introduction
- Research scheme
- Applications





Probiotics, Prebiotics and Synbiotics

Probiotics

Live
Beneficial
Bacteria

Prebiotics

Foods for
Beneficial
Bacteria

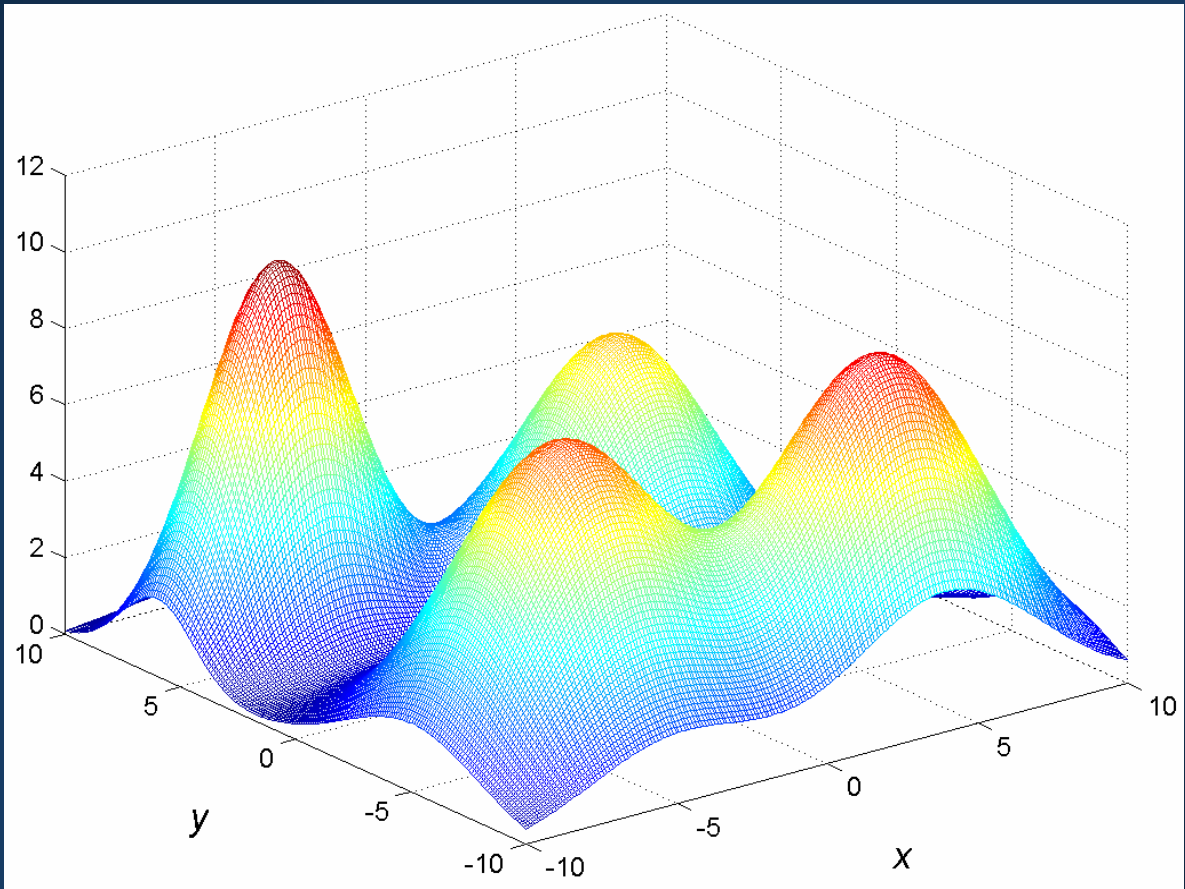
Synbiotics

Combination of probiotics with prebiotics

Improves survivability and implanting of probiotics

More effective than probiotics alone

Optimization



The 3D graph of $f_2(x, y)$ with 4 local maxima.

Optimization

- Optimization Methods
  - Steepest Ascent
  - Sequential Quadratic Programming (SQP)
  - Genetic Algorithms (GAs)

Sequential Quadratic Programming

- Quadratic objective function
- Linear constrains
- Single point search
- $\Pr[F=F^*] \geqq q(n, r)=1-[(n+1)!(2n-r)!]/[(2n+1)!(n-r)!]$

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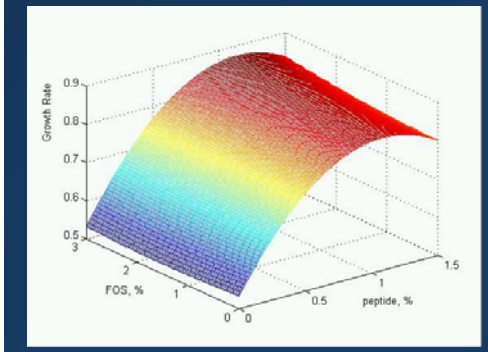
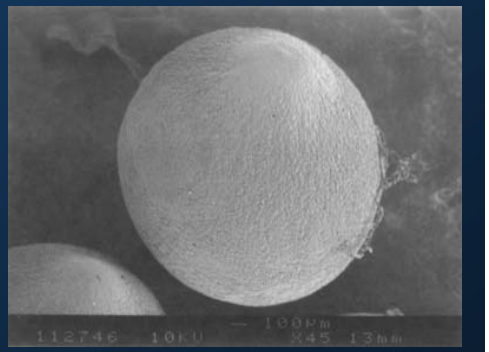
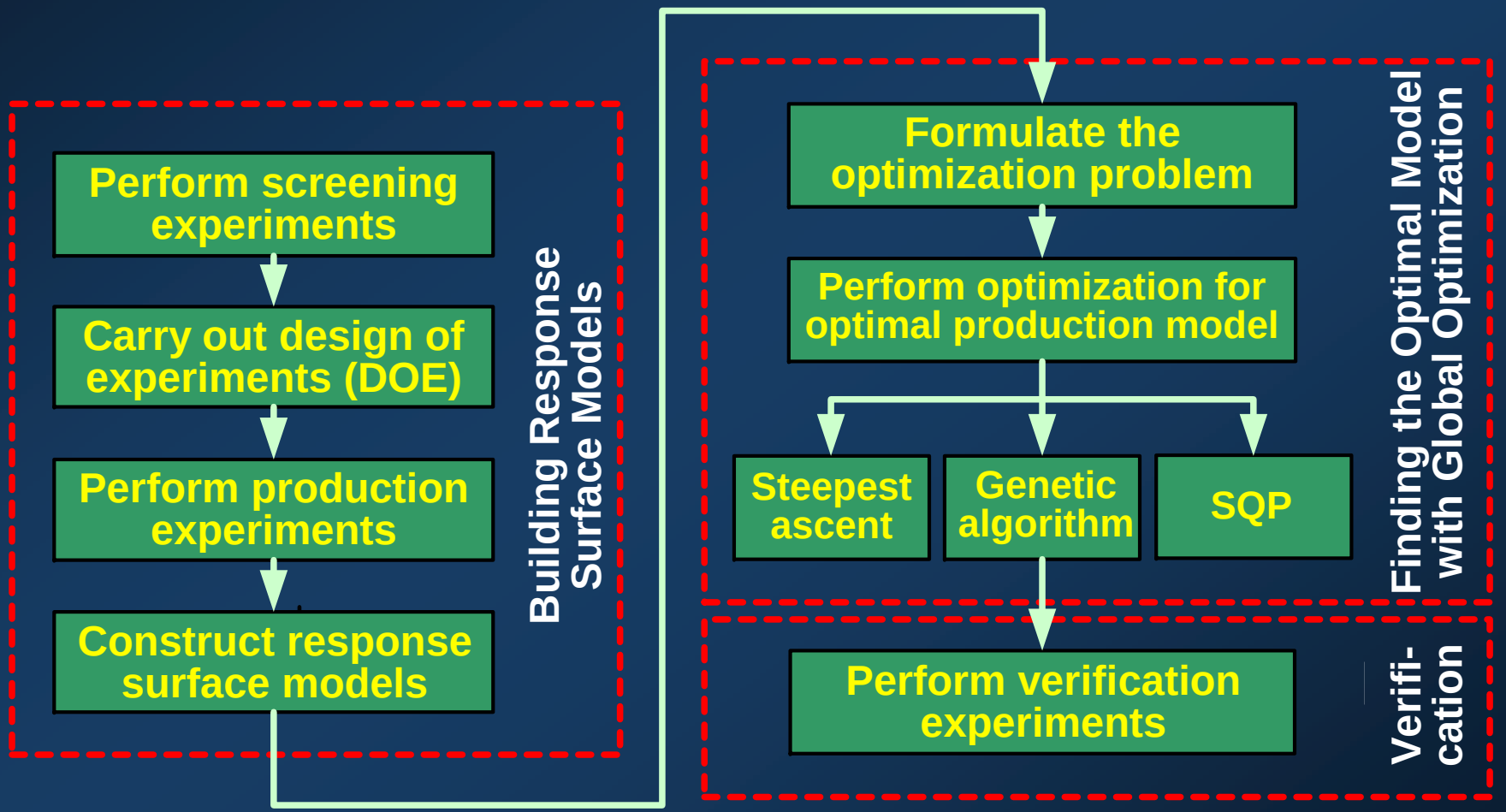


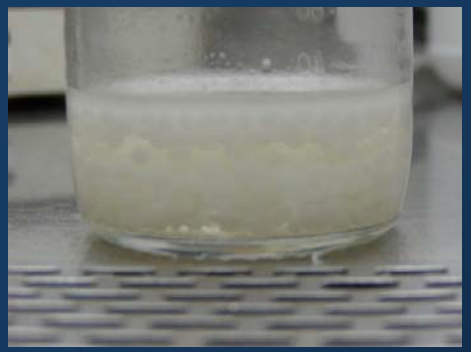


Research Scheme



Perform screening test

- Concentration of sodium alginate
  - Emulsion method

(a)  (b)  (c) 

  - Extrusion method

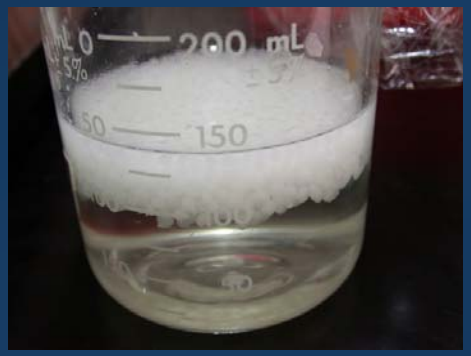
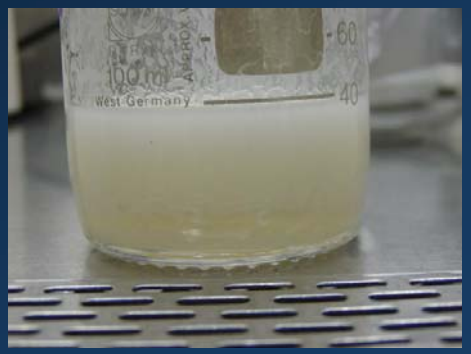
(d)  (e)  (f) 

Fig. The sodium alginate microcapsules were prepared by emulsion or extrusion method, and were composed of (a) 2%, (b) 3%, (c) 4%, (d) 2%, (e) 2.5% and (f) 3% sodium alginate forming in 0.1M calcium chloride solution.

Perform screening test

- Concentration of calcium chloride
  - Emulsion method

(a)  (b)  (c) 

  - Extrusion method

(d)  (e)  (f) 

Fig. The sodium alginate microcapsules were prepared by emulsion or extrusion method, and were forming in (a) (d) 0.05M, (b) (e) 0.1M, (c) (f) 0.15M calcium chloride solution.

Response

- Survival of microencapsulated probiotics
  - Before and after simulated gastric conditions.
  - Lactobacillus and Bifidobacteria.

Research scheme

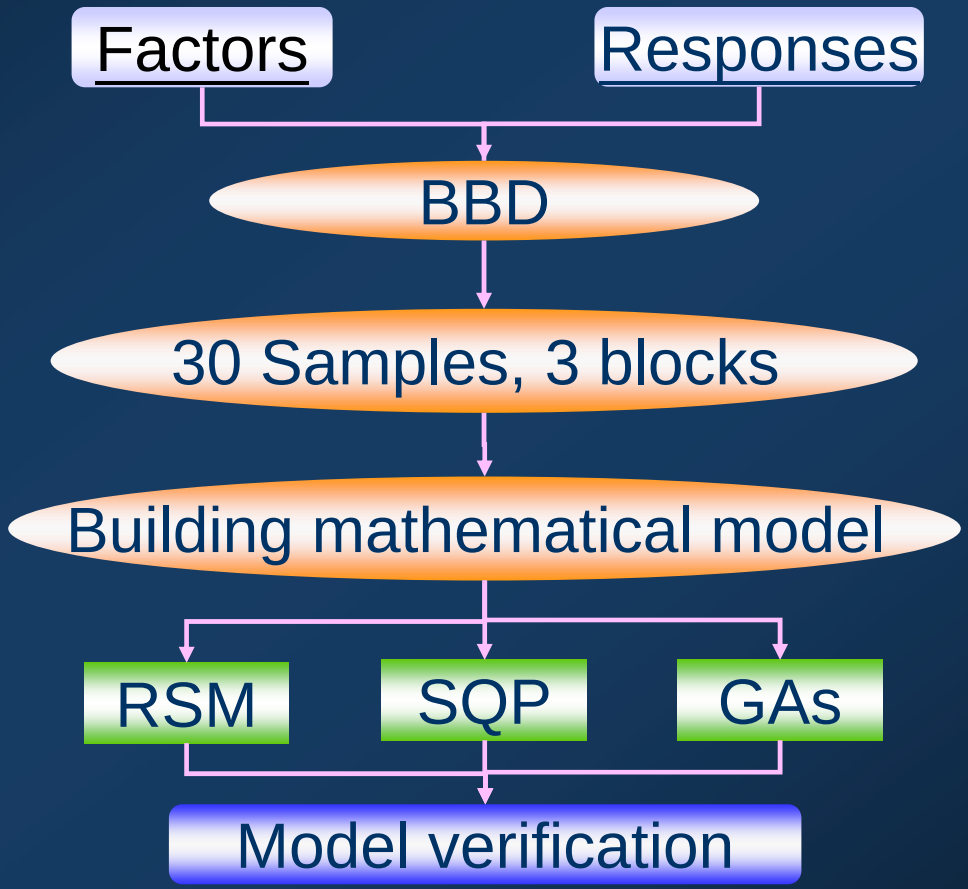


Fig. Experimental design.

Building mathematical model

- Linear model

$$y = \beta_0 + \sum_{i=1}^{n} \beta_i X_i$$

- Quadratic model

$$y = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \sum_{i=1}^{n} \beta_{ii} X_i^2 + \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \beta_{ij} X_i X_j$$

- Cubic model

$$y = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \sum_{i=1}^{n} \beta_{ii} X_i^2 + \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \beta_{ij} X_i X_j + \sum_{i=1}^{n} \beta_{iii} X_i^3$$

$$+ \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \beta_{iij} X_i^2 X_j + \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \beta_{ijj} X_i X_j^2 + \sum_{i=1}^{n-2} \sum_{j=i+1}^{n-1} \sum_{k=j+1}^{n} \beta_{ijk} X_i X_j X_k$$

- The composite function fitness (CFF)

$$(f_1 \times f_2 \times \ldots \times f_n)^{1/n}$$

Optimal production model

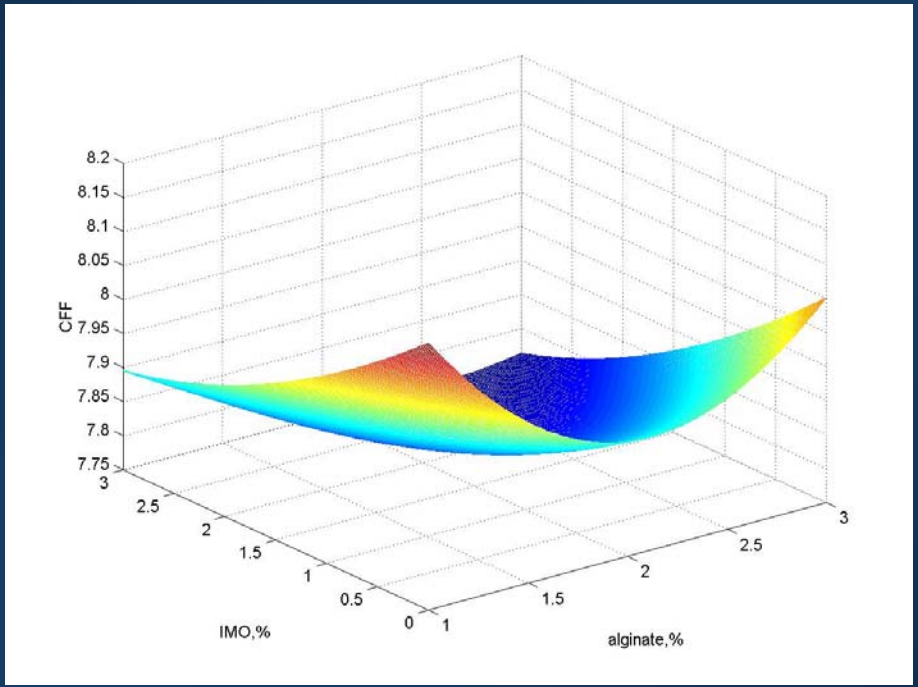


Fig. Model plot of the composite function fitness.

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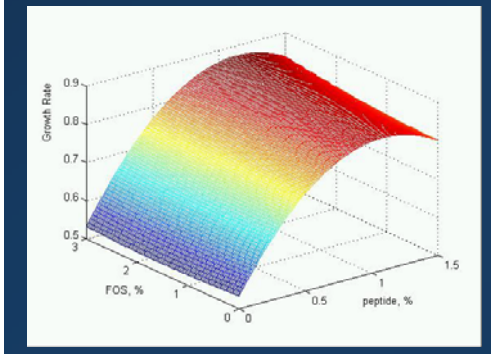

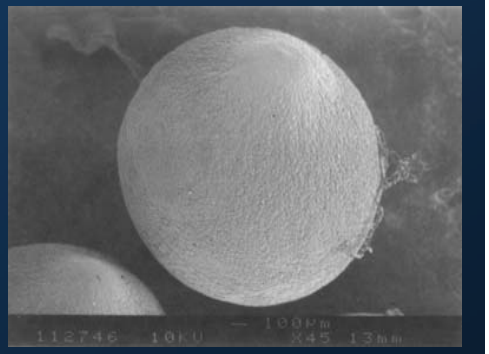

Applications

- Synbiotic dairy tofu
- Synbiotic fermented milk
- Probiotic microcapsules

Patent