1)Formulas for the dependence of the criteria on the weight composition: X0 = Mass fraction o fat, X1 = Ripening time, X2 = Whipping temperature.

Organoleptic criterion
----->max

$$Ko(x) := 1 - \left[e^{-\left[0.546365 \cdot x_0 + 0.032711 \cdot x_1 + \left(-0.015012 \cdot x_2\right)\right]} \right]^2$$

Foaming ability, where a0, a1, a2,a3,b1,b2,b3,c1
----->max

$$K\pi(x) := 38.5123 + 104.2814 \cdot x_0 + 54.2218 \cdot x_1 - 3.1325 \cdot x_2 - 12.7951 \cdot x_0 \cdot x_1 - 0.6257 \cdot x_0 \cdot x_2 + 0.0296 \cdot x_1 \cdot x_2 + 0.0137 \cdot x_0 \cdot x_1 \cdot x_2$$

foam stability
---->max

$$Ky(x) := 9.99080 + 3.29867 \cdot x_0 + 1.86931 \cdot x_1 - 1.59846 \cdot x_2 + 0.00463 \cdot x_0 \cdot x_1 + 0.01379 \cdot x_0 \cdot x_2 + 0.00767 \cdot x_1 \cdot x_2 - 0.02691 \cdot x_0 \cdot x_1 \cdot x_2$$

Average size of the dispersed phase
---->max

$$Kc(x) := 131.0455 - 25.8962 \cdot x_0 + 4.3488 \cdot x_1 + 38.9845 \cdot x_2 - 1.6066 \cdot x_0 \cdot x_1 - 5.2486 \cdot x_0 \cdot x_2 - 4.5342 \cdot x_1 \cdot x_2 + 1.0929 \cdot x_0 \cdot x_1 \cdot x_2$$

2) convolution of criteria in criterion K ---->max.

$$K(x) := Ko(x) \cdot K\pi(x) \cdot Ky(x)$$

3) initial values of mass fraction of fat in milk, ripening time, whipping temperature:

$$x := \begin{pmatrix} 3.5 \\ 4 \\ 6 \end{pmatrix}$$

Changing initial values to find the best recipe and technology

value of indicators of the original recipe

$Ko(x) = 0.98$ $K\pi(x) = 411.18$ $Ky(x) = 17.701$ $Kc(x) = 141.981$

$K(x) = 7.132 \times 10^3$

4) Optimization of fat content in milk, ripening time, whipping temperature:

Given **changing restrictions to find the best recipe and technology.**

$x \geq 0$ $x_1 \leq 5$

$30 \leq Kc(x) \leq 135$ <---- restrictions on the average size of the dispersed phase

$X := Maximize(K, x)$

vector of each product sharea:

$$X = \begin{pmatrix} 5.932 \\ 5 \\ 4.461 \end{pmatrix}$$

x0=mass fraction of fat in milk,%
x1=ripening time, h
x2=whipping temperature

$K(X) = 1.502 \times 10^4$

$K(x) = 7.132 \times 10^3$ **<---milkshake quality indicators, optimal and initial**

Monitor the value of K (X) - the optimal recipe and technology has the largest value

optimized formulation

$Ko(X) = 0.999$ $K\pi(X) = 520.665$ $Ky(X) = 28.888$ $Kc(X) = 30$

original recipe

$Ko(x) = 0.98$ $K\pi(x) = 411.18$ $Ky(x) = 17.701$ $Kc(x) = 141.981$