

1) Formulas for the dependence of criteria on the weight composition:

X0=The proportion of cream, X1=The proportion of milk, X2=The proportion of sugar, X3=The proportion of maple syrup, X4=The proportion of powder, X5=The proportion of cognac, X6= The proportion of chitosan.

The sum of the weights of all the product components

$$m(x) := x_0 + x_1 + x_2 + x_3 + x_4 + x_5 + x_6$$

Organoleptic criterion
---->max

$$Ko(x) := 1 - e^{-\left[4.35 \frac{x_0}{m(x)} + (-5.546) \frac{x_1}{m(x)} + (-7.637) \frac{x_2}{m(x)} + (-1.418) \frac{x_3}{m(x)} + (-271.229) \frac{x_4}{m(x)} + 70.069 \frac{x_5}{m(x)} + 57.862 \frac{x_6}{m(x)}\right]^2}$$

Microbiological criteria, x=X6=Chitosan, y=X0=Cream

---->min

After 96 hours, no more than 50000 CFU / g, with an initial contamination of 1256 CFU/g.

Hence, Km (x)<50000/1256=39.8 CFU/PO.

$$Km(x) := -30.5449 + 368.4584 \cdot x_6 + 116.98222 \cdot x_0 + 2068.0653 \cdot x_6 \cdot x_6 - 945.842 \cdot x_6 \cdot x_0 - 94.3032 \cdot x_0 \cdot x_0$$

Fat content
---->min

$$Ka(x) := 37.831 - 212.642 \cdot x_6 - 520.850 \cdot x_5 + 757.937 \cdot x_4 - 32.446 \cdot x_0 - 22.092 \cdot x_2$$

Density
---->max

$$Kn(x) := 887.17 + 80.46 \cdot x_1 + 5653.59 \cdot x_4 - 1353.13 \cdot x_6 - 146.54 \cdot x_0 - 1693.10 \cdot x_5$$

Viscosity

---->max

$$Kv(x) := 26.8239 + 21.432 \cdot x_1 + 1146.001 \cdot x_4 - 27.081 \cdot x_0 - 236.7259 \cdot x_6 - 205.859 \cdot x_5$$

2) Convolution of criteria to criteria K - - - ->max.

$$K(x) := \frac{Ko(x) \cdot Km(x) \cdot Ka(x)}{Km(x) \cdot Ka(x)}$$

3) Evaluation of the initial weight composition of products-recipes-in the diet:

$$x := \begin{pmatrix} 0.464 \\ 0.109 \\ 0.279 \\ 0.139 \\ 0.001 \\ 0.003 \\ 0.005 \end{pmatrix}$$

$$m(x) = 1$$

The value of the indicators of the original recipe

$$Ko(x) = 0.375 \quad Km(x) = 3.131 \quad Ka(x) = 14.745 \quad Kv(x) = 15.939$$

$$Kn(x) = 821.754$$

$$K(x) = 106.403$$

4) Optimization of the weight composition of products-recipes - in the diet.

Given

$$x \geq 0 \quad x < 1$$

-----> restrictions on the weight (g) of an individual product,

$$m(x) = 1$$

due to the initial approximation

$$Km(x) \leq 39.8$$

$$x_6 \geq 0.005$$

$$X := \text{Maximiz}(K, x)$$

$$X = \begin{pmatrix} 0.785 \\ 0.051 \\ 0.034 \\ 0.119 \\ 2.03 \times 10^{-4} \\ 1.984 \times 10^{-3} \\ 8.982 \times 10^{-3} \end{pmatrix}$$

vector of shares of each product:

x0=cream
x1=mlk
x2=sugar
x3=syrup
x4=powder
x5=cognac
x6=chitosa
n

$$M := \sum_{i=0}^6 X_i$$

$$M = 1$$

$$K(X) = 2.441 \times 10^8$$

$$K(x) = 106.403$$

-----> indicators

the quality of the buttercream recipe

Optimized recipe

$$Ko(X) = 1 \quad Km(X) = 1.542 \times 10^{-6} \quad Ka(X) = 8.825 \quad Kv(X) = 4.361 \quad Kn(X) = 761.915$$

Original recipe

$$Ko(x) = 0.375 \quad Km(x) = 3.131 \quad Ka(x) = 14.745 \quad Kv(x) = 15.939 \quad Kn(x) = 821.754$$