DESIGNING OF NUTRITIONAL FOODS THROUGH ECONOMIC AND MATHEMATICAL MODEL

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Abstract

The study refers to designing vitamin C in order to find out its sortimental structure. The relevance of vitamin C is because it is found in most foods. The paper is based mainly on methodologically of analysis and synthesis using the linear programming method. The analysis take into account three direction: dynamics, correlation and causal. As a result, the assessments made in the analysis were presented and summarizes the trend, aiming, of course, not be overlooked key aspects of the production structure of the reference period. To meet market requirements, the companies must reorganize production structure. Starting from market studies regarding of the consumption needs of the population, is set up what will happen and how much of each sortiment of vitamin C. When choose sortiment have had on the availability of various kinds of companies (potentials) and the income it generates marketing of products. Through a selection process and combining all of these conditions, result maintenance of companies. The problem is to determine the structure (shares) of these conditions in the companies work. The optimal solution for combining these sortiments requires building a model of economic and mathematical linear programming. Linear programming is a quantitative method used in the decision process for selecting optimal management. The results shows that the sollution is when the profit is higher.

Key words: linear programming, nutritional foods, vitamin C, sortiment, efficiency

Introduction

One of the most significant current discussions in drug industry is getting vitamin C. It is becoming increasingly difficult to ignore such issues, because this vitamin acts as an antioxidant, being at the same time, and nutrient. Lacks of vitamin C represent one of the leading causes of the illness of scurvy. Equally, designing a plant for producing vitamin C, play a key role in processing drugs.

The vitamin C prevails in environment, being biosynthesized by plant and animal organisms, as well as by many microorganisms. In natural sources, it is found in the free state and in the form of complexes with proteins, polypeptides, amino acids, forming different types of ascorbigen complexes. Higher, vitamin C is found in lemons, oranges, mandarins, pomegranates, blackcurrants, sea buckthorns, unripe nuts, leaves, apples etc.

Ascorbic acid is the name recognized by IUPAC (Commission on Biochemical Nomenclature) for Vitamin C. Vitamin pure ($C_6H_8O_6$) has a molar mass of 176.13 g/mol; is soluble in water (solubility 0.33 g/L) and the optically active and seem as a white crystalline powder. Vitamin C (L-ascorbic acid) is the most common vitamin in nature, being biosynthesized by vegetable organisms and animal ones (with some exceptions), as well the numerous microorganisms. Vitamin C can be found in free form and in the form of complex (conjugate) proteins, polypeptides, amino acids, various kinds of complex forming ascorbigen. Vitamin C is involved in the metabolism of aromatic amino acids, carbohydrates, fatty acids, bile acids, iron, hemoglobin, proteins and other substances, protects tissues from the destructive action of the oxidative processes involved in many chronic diseases.

In the food industry, vitamin C prevents pigment discoloration, loss of flavor and extends shelf life (Chauchan et al., 1998).

The pharmaceutical industry uses vitamin C for medical applications and for the production of vitamin supplements (Marz, 2002). Vitamin C has many uses. As a percentage, 30% is used in the pharmaceutical industry, both medicinally and as vitamin supplements; 13% is used in the feed, 5% in the cosmetic industry and 2% in other industrial processes (Hancock, 2009). Also, approximately 50% of vitamin C production is used in the food industry, being added to technological processes.

The commercial value of vitamin C was recognized in the early century XX and industrial processes have been patented since 1930. The research that led to the discovery of vitamin C began in 1907 by Axel Holst and Theodor Fröhlich noticed that guinea pigs were suspected of scurvy. This has led to the development of an analysis for the biological determination of antiscorbutic activity of food products.

At European level, there are a number of regulations on the market for medicinal products for human use. In order to protect human health, the goal is to regulate the production, distribution and use of medicines. In this regard, the European Commission has concluded that the internal rules of the Member States of the European Union relating to the manufacture, control and inspection of medicinal products need to be harmonized in order to allow safe and good quality medicinal products to circulate throughout the Community. On 6 November 2001, Directive 2001/83/EC of the European Parliament and of the Council establishing a Community code relating to medicinal products for human use was adopted. The provisions of Directive 2001/83/EC apply to medicinal products for human use intended to be placed on the market in industrially manufactured European Union countries. In Romanian legislation, this directive has been transposed into Title XVII "Medicament" of Law no. 95/2006 on health reform.

Material and method

Vitamin C is the first vitamin produced by industrial scale synthesis. Major suppliers of vitamin C are Hoffmann – La Roche, as well as many Chinese companies. Production also occurs in Eastern Europe and India. This process has become very profitable. In commercial production the value of one kilogram exceeded 1000 €. Thus, the price subsequently showed a steady decrease with the improvement of productive efficiency.

Since the market entry of the state-subsidized Chinese producers, the price has fallen to a historical level of approx. 3 €/kg in the early 2000s, since then has increased and since 2007, stagnating at 11 €/kg.

In order to overcome the threat posed by Chinese competition, significant research and development investments have been developed in the US, Europe and Asia, the result of which has been the revival of patents in AAs (ascorbic acid) activity over the last few years. Despite the fact that China now supplies more than 81% of vitamin C worldwide, very little information is available on the latest research and findings in the US and Europe (Figure 1). The price varies between 6 şi 8 €/kg which can ensure an annual profit over 500 milion €.

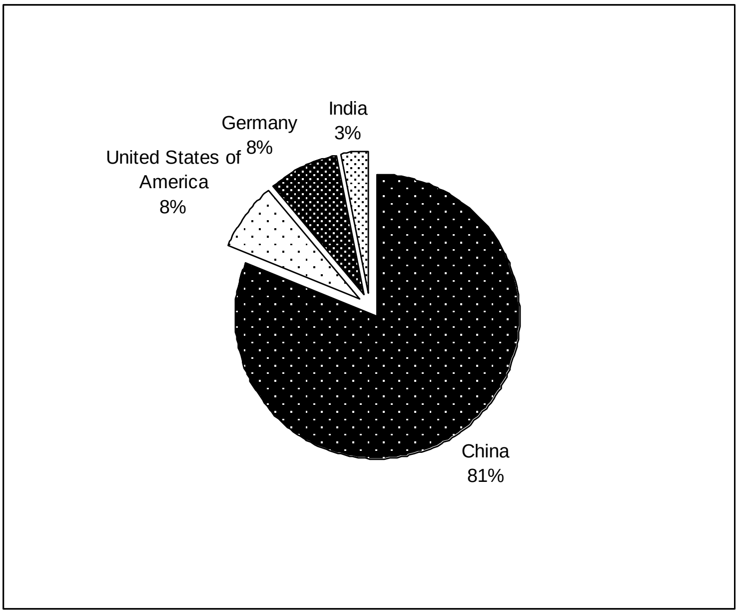

Figure 1. The main producers of raw material to vitamin C

Source: PublishedLiteratureDOWCOM

Vitamin C has multiple uses. It is used in the pharmaceutical industry, food industry, animal feed and cosmetics industry (Figure 2).

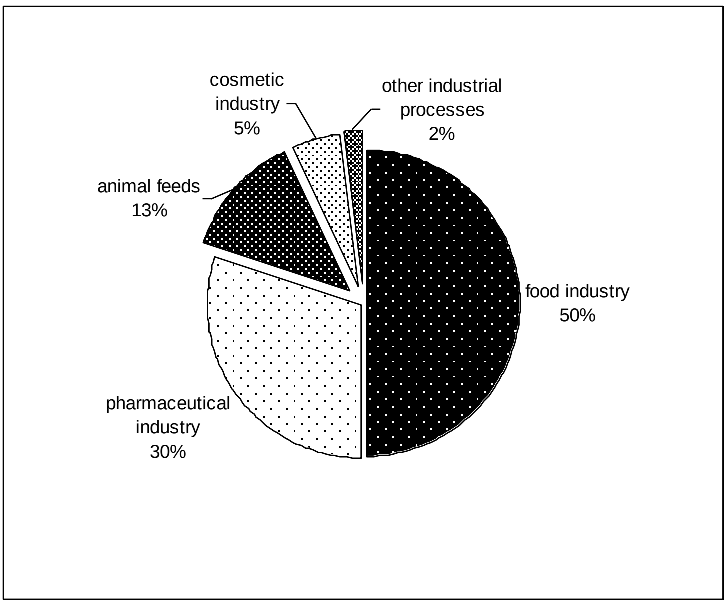

Figure 2. The use field of vitamin C

Source: Hancock, 2009

An important problem for producers is the determination of the vitamin C assortment (solid or liquid) to meet consumer requirements, as well as the possibilities of obtaining technology at the company level, as well as to obtain a profitable advantage for the producers. In this respect, based on statistically retrieved data, models of optimization of the assortment structure is used.
Linear programming is an optimization method that provides results that can be applied in practice (Gheorghiţă, ASE online).
The components of the linear programming model are: the variables, the restrictions and the optimization criterion, in which the variables are the varieties of vitamin C, according to the physical state of the products.
The restrictions refer to relations between variables and quantitative and financial availability, rendered in mathematical expression.
The optimization criterion is a mathematical function of maximizing the total profit of the economic activity as a result of the new assortment structure and the connection between the types of products and the profit for each of them.
Model was solved with Quantitative Management software package, module A - linear programming using the Simplex-Primal method.
Elements needed for optimization refer to:
- Production capacity of the company, in tons;
- Production of assortment n, n = 1-3, expressed in grams;
- Production costs for each assortment, expressed in lei/g;
- Profit for each assortment, expressed in lei/g.

The coefficients of the variables have predicted values, based on existing resources and specific consumption.
Constraints (equality and inequality) are algebriac expressions of degree I and refer to:
- Full use of production capacity (C1);
- Ranking in the availability of financial resources (C2);
- Higher and lower limit of active substance concentrations of vitamin C (C3);
- Limitations of non-negativity, all variables have positive values greater than 0 (C4).

Data sources were an official statistic. They were subjected to procedures for calculating relative size and dynamic structure in order to capture changes of the production structure.
The optimal determination of vitamin C assortments starts from the active substance concentration at product level.
Differentiation is based on the physical state of the product (solid or liquid), implicit after the technology of obtaining.

Results and discussions
Optimizing assortments
Introductory data

Table 1. Assortment and Expenditures

Indicators	x_1 1g	x_2 0.75g	x_3 0.2g	Resources/ Availability
Assortment (grams)	-	-	-	10000
Expenditures (€[x]/gram)	0.06	0.66	0.24	7709.25
Profit (€[x]/gram)	0.02	0.03	0.027	maximum

[x] Euro 4.5411, 30.12.2016, http://www.cursbnr.ro/arhiva-curs-bnr-2016-12-30

Where x means concentration of active substance.

Linear programming model

A) Objective function

Max $f(x) = 0.02\ x_1 + 0.03\ x_2 + 0{,}027x_3$

B) Constraints (first variant)

C1 Full use of production capacity

$x_1 + x_2 + x_3 = 10000$

C2 Availability of financial resources

$0.06x_1 + 0.66x_2 + 0.24x_3 \leq 7709.25$

C3 Non-negativity constraints, all variables have positive values higher than 0.

1) $x_1 \geq 0$

2) $x_2 \geq 0$

3) $x_3 \geq 0$

The first solution of model shows that $x_1 = 0$, $x_2 \geq 10000$, $x_3 = 0$ and Z (Profit) = 308.37 €, given that x_1 and x_3 are 0. This means that the optimum value of profit is obtained only when we have a single product. According to C_1, the solution can not be optimal because it is not satisfactory for the market. As a result, the process which determine the optimal structure of vitamin C products is much more complex, making it necessary to resort to the addition of superfluous or lower and upper limitations of product quantities. In this respect, the linear programming model involves the elaboration of 8 variants.

According to data the constraints are shown below.

V_1. $x_2 \leq 4000$;

V_2. $x_2 \leq 5000$;

V_3. $x_2 \leq 1000$;

V_4. $x_1 \geq 2000$;

V_5. $x_2 \geq 5000$;

V_6. $x_1 \leq 2000$;

V_7. $x_2 \leq 5000$;

V_8. $x_3 \geq 5000$.

In these conditions the results were between from 308.37 € to 272.02 € (Table 2). The fesable sollutions are presented in table 2.

Table 2. Result of the data

Constraints/Variants	Value (grams)	Profit (€)	Expenditures (€)
V_0 $x_1 \geq 0$ $x_2 \geq 0$ $x_3 \geq 0$	x_1=0 x_2=10000 x_3=0	308.37	7709.25
V_1 $x_2 \leq 4000$	x_1=0 x_2=2000 x_3=8000	281.93	3259.91
V_5 $x_1 \geq 3000$	x_1=3000 x_2=4000 x_3=3000	272.02	3370.04
V_6 $x_1 \geq 2000$	x_1=2000 x_2=4000 x_3=4000	277.53	3744.49

Source: own proccesing

The optimal solution for which the analysis has been made is ensuring when profit is equal to 272.02 €. It is obvious that this variant is the best in terms of the restrictions mentioned (Figure 3).

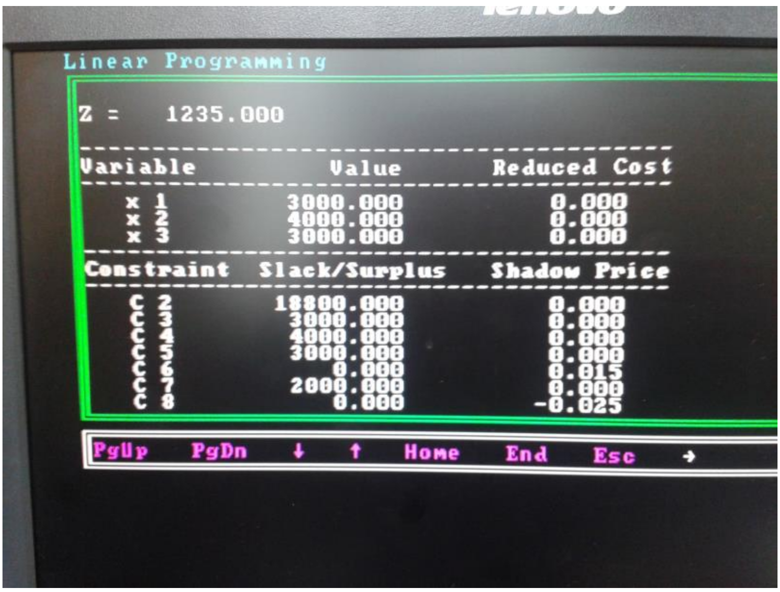

Figure 3. Linear programming-optimal variant

Source: own calculation

Conclusions

The study reffered to designing vitamin C in order to find out its sortimental structure, because its relevance for human health. Vitamin C has become indispensable in industrial food, as an additive and complement of nutritional value. Thus, market demand was constantly increasing.

Much of Vitamin C is obtained through chemical synthesis with industrial and medicinal applications in extension. The synthetic product, according to the bibliographic study, has been shown to have the same biological activity as the natural substance. The vitamin C prevails in environment, being biosynthesized by plant and animal organisms, as well as by many microorganisms. In natural sources, it was found that vitamin C is in the free state and in the form of complexes with proteins, polypeptides, amino acids, forming different types of ascorbigen complexes.

The optimal solution for combining the vitamin C assortments was obtained with the help of econometric-mathematical models, relying on linear programming whose objective function was to maximize profit. The importance of linear programming for the efficiency of the assortment structure is that it allows, in a relatively short time, that it is possible to choose the best variant in the given physical and economic conditions from a multitude of possible solutions and variants.

The linear programming model shown achieving an optimal combination of the influence factors of the vitamin C assortments. The application of this method have had the role of conducting economic activity not by appreciation and experience, but by precise and scientific methods and methods.

The first solution of model showed that $x_1 = 0$, $x_2 \geq 10000$, $x_3 = 0$ and Z (Profit) = 308.37 €. This means that the optimum value of profit was obtained only when we have a single product.

According to C_1 (constraint 1) the solution can not be optimal because it is not satisfactory for the market. As a result, the process which determine the optimal structure of vitamin C products was much more complex, making it necessary to resort to the addition of superfluous or lower and upper limitations of product quantities. In this respect, the linear programming model involves the elaboration of 8 variants. In these conditions the results were between 281.93 € and 272.02 €. The fesable sollutions was when $x_1 = 3000$, $x_2 = 4000$, $x_3 = 3000$ and profit is equal to 272.02 € and expenditures are 3370.04 €.

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