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Dzyuba Nadiia Anatoliyivna,
associate professor,
Odessa National Academy of Food Technologies PhD,
E-mail: dzyubanadya282@gmail.com

Oliynik Mariia Igorivna,
student Odessa National Academy of Food Technologies,
E-mail: moleynik4@gmail.com

Bezzodina Anastasia Ruslanivna,
student Odessa National Academy of Food Technologies,
E-mail: bezzodinaa@gmail.com

ASLT-Test – Methods for determining shelf-life of high-protein desserts

Nowadays there is much concern about nutrition and especially about sustainable nutrition. The process of eating has a main role in the absorption, excretion, pattern distribution and accumulation of nutrients[1]. The modern diet contains a large number of high-carbohydrate foods (bread, pasta, potatoes, etc.) and almost doesn't have food source of complete protein (meat, fish and dairy products), fiber, micronutrients (fruits, vegetables, nuts, vegetable oil, etc.).

In recent decades disease prevention among the population, which is in evidence by optimizing nutrition, is observed in a number of developed countries in Europe, the US and Canada. The immediacy of the problem points by acceptance of governments of several European countries (the Netherlands, Norway, Denmark, Spain, Finland, Malta) food concept[2].

One of the main sweet dishes acts desserts. In the life of modern man sweets hold pride of place. Demand for desserts, which is noted by suppliers of products and restaurateurs, is steadily increasing. Be on about the rapid increase in production volumes and varieties of desserts products is necessary to develop

[1] Матасар І.Т. Харчування як один з найважливіших чинників, що впливає на стан здоров'я населення України в сучасних екологічних умовах Z І.Т. Матасар ZZ Проблемы питания и здоровье. – 1997. – № 1. – С. 22–29.

[2] Тележенко Л.М. Моделювання раціонального харчування / Л.М. Тележенко, Н.А. Кушнір, М.М. Тодорова // Обладнання та технології харчових виробництв: темат. зб. наук. пр. / Голов. Ред. О.О. Шубін; Донец.нац.ун-т економіки і торгівлі ім.М. Туган-Барановського. – 2013. – Вип. 30. – С. 306–311.

approaches for their safety. The modern food industry requires theoretical and practical research in production engineering of desserts. However, the main thing is also a simulation of conditions and shelf-life of the finished product[1]. According to the definition, which was adopted by the British Institute of Food Research in Technology, shelf-life of food is a period during which the food product is safe; it retains own characteristic organoleptic, physical, chemical, microbiological and functional characteristics; it meets the label data on the nutritional value of the product during storage in the proposed regulations[2].

During control the quality of these general management functions are filled out by own content and composition of quality, so management functions can be represented as follows: quality policy; quality planning; training and employee engagement; activity management of quality; quality control; information about product quality, market demand and progress in science and technology; developing the relevant activities; decisions by management; measures implementation; interaction with the environment (solution of a quality problem with suppliers, customers, public authorities).

For the accumulation of experimental data and quality control of shelf-life of food products these approaches are widely used[3]: evaluation of the shelf-life of products, which is based on published data in accordance with the regulations; exploitation of the data on lifetime of these products; review and analysis of consumer complaints to identify existing problems with quality.

Accelerated shelf-life testing (ASLT). The model of accelerated testing to determine shelf-life ASLT has the following solution algorithm: obtain reliable data about the process of damage in a short in short order, choice model, forecasting method of actual shelf-life. The simplest method conceptually against accelerated shelf-life testing method is the initial velocity. It allows you to track the deterioration process by using analytical methods of research. The purpose and objectives of the article. The purpose of this work is to develop a model of accelerated testing ASLT to determine the shelf-life of milk – vegetable dessert.

The paper have solved the following tasks: to develop a program of accelerated testing ASLT; to determine the effect of storage conditions on the quality of samples of milk – vegetable dessert; to calculate predicted shelf-life for milk-vegetable dessert. Presentation of basic material of the research. Testing

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[1] Дідух Г.В. Технологія питних молочних напоїв геродієтичного призначення Z Г.В. Дідух, Н.А. Дідух ZZ Молочное дело. – 2006. – № 9. – С. 44–46; – № 10. – С. 44–45.

[2] Изучение возможности применения метода ускоренного старения дляпрогнозирования сроков хранения безалкогольных бальзамов [Электронный ресурс]. – Режим доступа: URL: <http://elib.altstu.ru/elib/books/Files/pv2007_03/pdf/1 84%20schk.pdf>; Инструкция по микробиологическому контролю производства на предприятиях молочной промышленности. – М.: Госагропром, – 1988. – 122 с.

[3] Изучение возможности применения метода ускоренного старения для прогнозирования сроков хранения безалкогольных бальзамов [Электронный ресурс]. - Режим доступа: URL:<http: //elib.altstu.ru/elib/books/Files/pv2007_03/pdf/1 84%20schk.pdf>

ASLT may be applied to various processes of losing quality or food spoilage, for which adequate kinetic model is known. The processes of food spoilage are pronounced by figure of merit such as organoleptic, physical, chemical, microbiological and biological. The program of studies is shown in Fig.1.

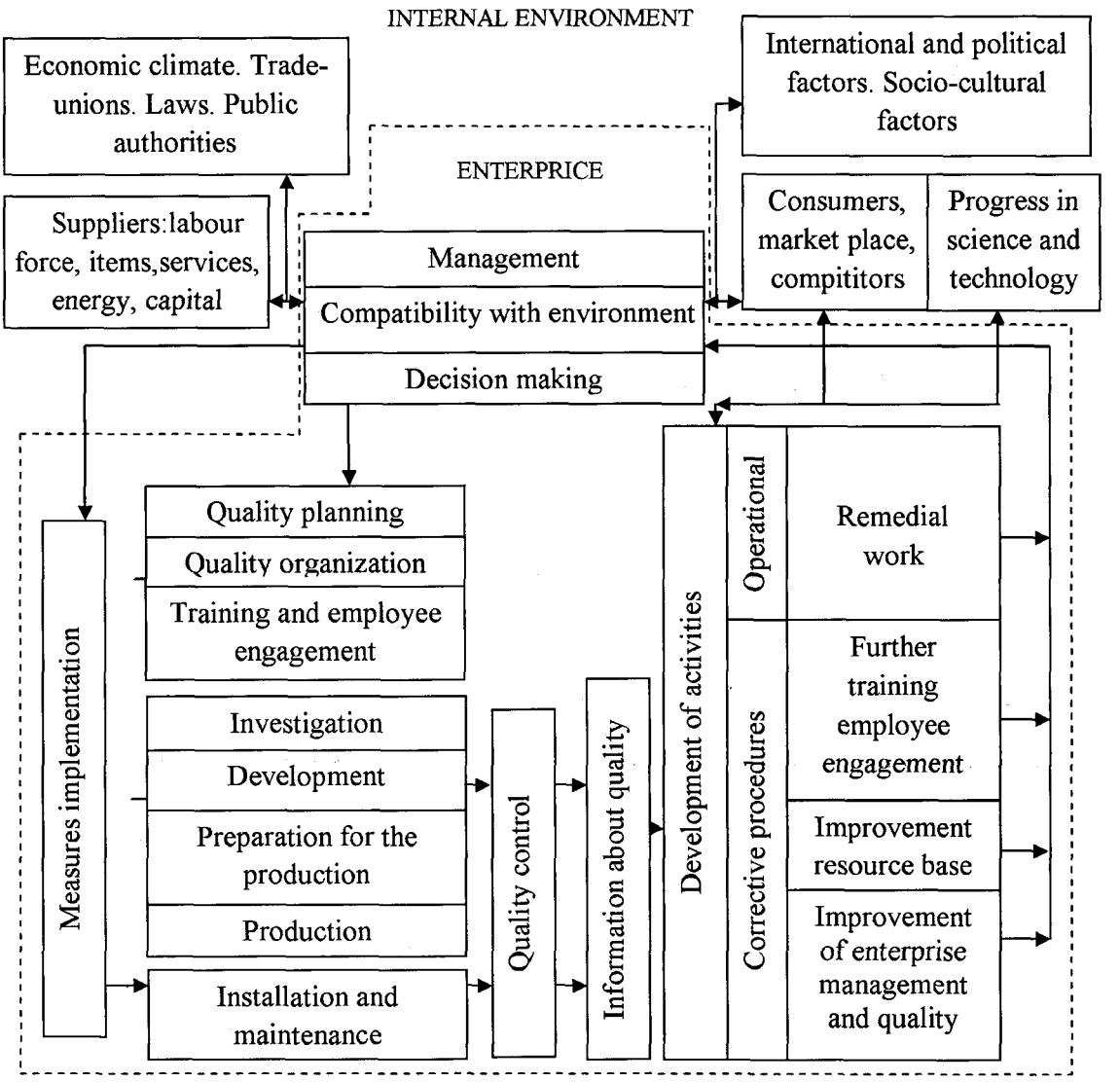

Figure 1. Functional scheme of product quality control ("quality loop")

All functions are inextricably linked and their consistent implementation is a quality management process. This process should cover all stages of production and can be served as a "quality loop", which is shown in Fig. 1[1]. To optimize recipe of dessert "Martyshka" with judicious mix between macronutrients, Excel Solver tab of MS Excel was used by the method[2] (Fig. 2). To predict the actual

[1] Капінос Г.І Операційний менеджмент [текст]: навч. Посіб. / Г.І. Капінос, І.В. Бабій – К.: «Центручбовоїлітератури», – 2013. – 352 с.

[2] Тележенко Л.М. Основи наукових досліджень: навч. Посіб.: [для вищ. Навч. зал.] / Л.М. Тележенко, Н.А. Дзюба, М.А. Кашкано, Л.О. Валевська. – Херсон: Грінь Д.С., – 2016. – 192 с.

shelf-life storage of dessert we used the dependence of process of change commodity indices and indices of safety dessert of time and storage term. Critical quality attributes were organoleptic and microbial attributes. Made dessert was divided into samples by mass 50 grams, which are subjected to the temperature of 5 °C to 15 °C during storage, at a pitch of 5 °C and shelf-life of 12 to 72 hours at a pitch of 12 hours. Production and storage of dessert was performed under the same conditions by changing storage attributes according to the established plan and in conditions, which are similar to modern facilities of restaurant food.

On completing of projected storage terms in specified criteria, we defined and analyzed changes of quality attributes in samples of dessert. Dynamics of changes in biomass of dessert during storage is tabulated 1 and organoleptic attributes are tabulated in Fig. 3.

Dynamics of changes organoleptic characteristics of designed dessert "Martyshka" (Fig. 4) during storage, is showed that by every analysed attributes during 72 hours of storage, product retains relatively high organoleptic properties.

It is established that the overall organoleptic quality attribute of dessert didn't change during storage for 24 hours at different temperatures. And during the next 12 hours all parameters were decreased except color. Quality attributes remained relatively high during 72 hours. Consistency index showed sustainable high attributes, which is related to the introduction of gluten product. Thanks to it the moisture isn't released.

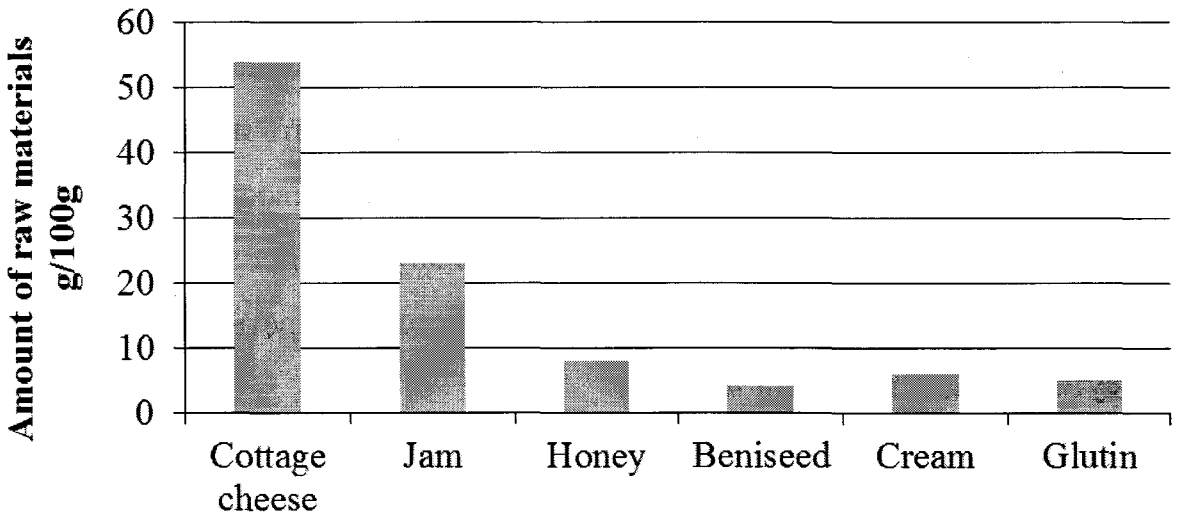

Figure 2. Recipe of dessert "Martyshka"

Attained results allow argue that dessert can be stored during 5 days at temperature (5 ± 1)°C. To monitor changes of quality attributes of dessert (D) it was built kinetic equation, which is written as follows:

$$\frac{dD}{d\tau} = k \cdot D^n \qquad (1)$$

where k – kinetic constant; τ – storage time, hrs.

Attribute of spoilage index (P) is showed as:

$$dP = \frac{dD}{D^n} = k \cdot d\tau \quad (2)$$

Table 1.– Microbiological quality attributes of high-protein dessert "Martyshka"

Attribute	Storage, hrs					
	12	24	36	48	60	72
Coliform bacteria, CFU in 0,01 g of product	Not observed					
Pathogenic microorganisms, Salmonella, in 25 g of product	Not observed					
Amount of mold fungi, CFU in 1 g of product	1	2	3	5	7	7
Amount of Ascomycetes, CFU in 1 g of product	25	45	45	47	48	50
Staphylococcus aureus, in 0,01 g of product	Not observed					

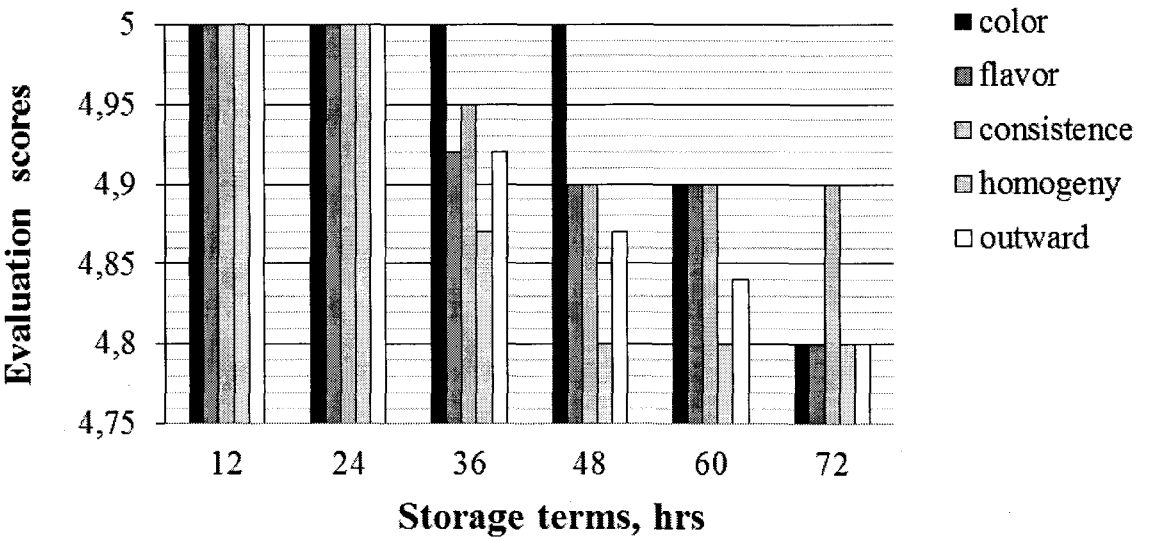

Figure 3. Dynamics of changes organoleptic attributes in the process of storage

So, the attribute of spoilage index (P) changes, which is depended on changing of quality attributes, it has a linear dependance:

$$P - p_0 = k \cdot d\tau \quad (3)$$

where p_0 — initial level of quality attributes.

Shelf-life of high-protein dessert (t_s) is determined by the following equation:

$$t_s = \frac{P - p_0}{k} \quad (4)$$

Kinetic equations for estimation of shelf-life are specific to each species studied food of specific environmental conditions. In the kinetic model temperature is included, which greatly affects the speed of reactions, which are occurred after technological treatment.

Among the mathematical models, which were proposed to describe the dependence on rate of change in quality of temperature, often the Arrhenius equation is used, which was derived on basic of thermodynamics and principles of statistical mechanics[1].

$$k = k_a \cdot exp\left\{\frac{-E_a}{R \cdot T}\right\} \quad (5)$$

where k_a – constant Arrhenius equation; E_a – additional energy barrier, which might be overcome by option *D*, which is for beginning of deterioration of the product (*J* or cal/mol); *R* – universal gas constant (1.9872 kcal/mol * *K* or 8.3144 J/mol*K).

To calculate the kinetic parameters it was selected the type of function of quality, which were occurred during storage – of the first order. According to Table 1 graphical semilogarithmic dependence lnk on the temperature (1/T) was built. The activation energy was calculated by the slope of the resulting line $\frac{-E_a}{R}$. Since the process of deterioration dessert is described by the first order, it makes use of linear regression in assessing the reaction rate of constant *k*.

According to the Arrhenius equation it was calculated the shelf-life for high-protein dessert:

$$\tau_x = \alpha \cdot \tau_j \cdot \exp\left[\frac{E}{R} \cdot \left(\frac{1}{T_x} - \frac{1}{T_j}\right)\right] \quad (6)$$

where τ_x, τ_j, T_x, T_j – time and temperature of natural storage and artificial study consequently; α – temporary factor, which is considered term of experimental storage.

Conclusions. On the basis of undertaking study it was found a shelf life of high-protein dessert, which is:

- at a temperature of storage at 5 °C for 60 ...72 hours;
- at a temperature of storage at 10 °C for 36 ...48 hours;
- at a temperature of storage at 15 °C to 24 hours.

As a result, we have developed an algorithm by the method of testing the quality ASLT, can be recommended for predicting shelf-life of high-protein dessert.

[1] Arrenius S. About the reaction rate of the inversion of non-refined sugar at souring / S. Arrenius // Zeitschrift fur Physikalische Chemie. – 1889. – No. 4. – P. 226–248.

Contents