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STUDY OF GELATIN INFLUENCE IN PRODUCT RESIPE THAT STRUCTURED ON THE ACTIVATION ENERGY

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Influence of gelatin on the loss of mass and speed of transformations which take place in a product structured at permanent speed of his heating is investigated by the thermogravimetric method. The energy dependence of processes activation that take place during melting of structured product is set.
Keywords: activation energy, endothermic transformations, thermogravimetry, endoeffects, thermoanalysis

Термогравіметричним методом досліджено вплив желатину на втрату маси та швидкість перетворень, що відбуваються в продукті структурованому за постійної швидкості його нагрівання. Встановлено залежність енергії активації процесів, які відбуваються під час плавлення продукту структурованого.
Ключові слова: енергія активації, ендотермічні перетворення, термогравіметрія, ендоеффекти, термічний аналіз

1. Introduction

Most of the physical and chemical processes are accompanied by heat consumption (endothermic transformation) or release (exothermic transformation). Moreover, some of them may go in forward or reverse direction: melting-crystallization, boiling-condensation, polymorphic transformations. All these processes may be investigated while fixing mass and temperature changes [1, 2].

The determination of kinetic parameters of endothermic processes, which take place along with changes of mass under non-isothermal conditions was fulfilled with the help of differential thermogravimetry (DTG) and differential thermal analysis (DTA) using a derivatograph. Basic to these methods is the assumption that at constant rate of heating the values corresponding to the degree of mass change or heat consumption in the area of fixed beginning and maximal development of the process are proportional to the constant of transformation rate for each temperature value [2, 3].

The analysis of literary sources of domestic and foreign scientists rotined that application of curd unfat, concentrate of kernel of seed of sunflower and gelatin in composition food products is actual from point of providing of technology of production valuable albuminous raw material. Also scientific and in area of technologies of the combined food stuffs carried out specialists research on development of scientific direction, related to creation of technologies of feed from raw material of vegetable and animal origin.

Thermogravimetry researches of influence of gelatin on thermal firmness of product structured and energy of activating of water together with other scientific researches allow to specify compounding composition and temperature the range of thermal treatment [4].

2. Tasks of experiment

– research of processes which take place in a product structured with different maintenance of gelatin because of the intensive heating during his melting [4, 5];

– research of influence of gelatin on the size of losses of mass and thermal firmness of product of structured;

– determination of the power state of product of the gelatin structured depending on maintenance.

3. Conditions of the experiment

Thermogravimetry devices, in particular derivatograf Q-1000 (fig. 1), are one of the most rational thermo-analytical devices, by which with large exactness it is possible to define all quantitative changes in the samples which are accompanied diminishing or gain in weight in food products because of redistribution of moisture during thermal treatment [6].

An universal fourchannel registration device which tails to derivatograf allows to produce the record of processes which take place depending on time, or from a temperature.

Experimental researches of the samples of product structured, geared-up to melting with different maintenance of gelatin did produce at speed heatings 5±1 ^{0}C/60 s in the air environment of stove of derivatograf at unisothermal terms on titanic crucible on which placed a hinge-plate 200±2 mg.

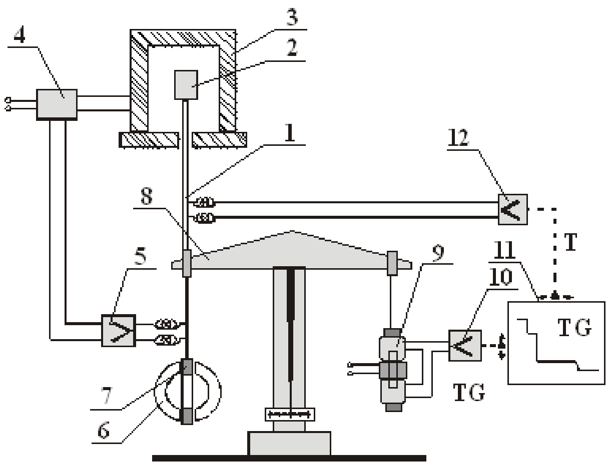

Fig. 1. The Functional diagram of derivatograph Q-1000: 1 – ceramic pipe; 2 – holder (crucible); 3 – stove; 4 – switch regulator of heating; 5 – strengthener; 6 – magnet; 7 – puttee; 8 – scales; 9 – differential transformer for the signal of TG shaping; 10 – strengthener; 11 – device registration; 12 – strengthener

4. The method of investigation

Speeds of decomposition of the samples with sufficient exactness can be described the known kinetic equalization [7]:

$$\frac{d\alpha}{d\tau} = A_0 e^{-E/RT}(1-\alpha)^n, \quad (1)$$

where α – degree transformations of initial the sample; n – degree of reaction; R – universal gas permanent; E – energy of activating which characterizes the power state of the system, kDzh; T – temperature, ^{0}K; τ – duration of process, s; A – multiplier which does not depend on a temperature in a small temperature interval.

Is it possible to write down in our case α as relative losses of mass of the sample:

$$\alpha = \frac{\Delta m}{m_0} = \frac{m_0 - m}{m_0} \qquad (0 \le \alpha < 1). \quad (2)$$

If a temperature changes in time on some law T=T(τ), it is possible to get equalization for determination of dependence α(τ) or α(T). In our case of T=T+bτ, at what α(T)=α(τ)=0. Then dt=b·dτ (b=const).

We will get equalization:

$$\frac{d\alpha}{(1-\alpha)^n} = \frac{A_0}{b} e^{-E/RT} dT \quad (3)$$

or

$$\int_0^\alpha \frac{d\alpha}{(1-\alpha)^n} = \int_{T_0}^T \frac{A_0}{b} e^{-E/RT} dT.$$

Integrating at n=1 and at E/RT>>1, we will get:

$$\ln\frac{1}{(1-\alpha)} = \frac{A_0}{b}\cdot\frac{RT^2}{E}\cdot e^{-E/RT}. \quad (4)$$

In addition, if α<<1, that $\ln\frac{1}{(1-\alpha)} \approx \ln(1-\alpha) \approx \alpha$, then

$$\alpha \approx \frac{A_0}{b}\cdot\frac{RT^2}{E}\cdot e^{-E/RT} \quad (5)$$

$$\ln\alpha = \ln\left(\frac{A_0 R}{bE}\right) + \ln\left(T^2\right) - \cdot\frac{E}{RT} = A + 2\ln T - \cdot\frac{E}{RT}$$

or

$$\ln\alpha - 2\ln T = A - \cdot\frac{E}{RT}. \quad (6)$$

As α≈Δm, lnα=ln(Δm)+const, that

$$\ln(\Delta m) - 2\ln T = A - \cdot\frac{E}{RT}. \quad (7)$$

Thus, on the basis of equalization (7), defining the losses of mass for a derivatogramme size Δm the sample (curve of TG) at the proper temperature, expected the size of energy of activating of process of melting of product of structured E:

$$E = -R\cdot\frac{\Delta(\ln m - 2\ln T)}{\Delta(T^{-1})}. \quad (8)$$

5. Results and discussions

Exposition of basic material of research. It is set (Fig. 2) that the process of decomposition of all the samples takes place endothermic in two stages. On curves DTA is fixed to on two endoeffects, position of which for every the sample is different [8].

Every stage characterizes the proper process which takes place in a product structured under the action of temperature influence. The first stage characterizes is completion of process of melting, second is a process of destruction of structure through the considerable losses of water because of its intensive evaporation.

Maximal values of temperatures which characterize the stages of thermal decomposition of the samples resulted in Table 1.

The comparative analysis of thermo-analytical curves (TG, DTG, DTA, T) the samples rotined with different maintenance of gelatin, that speed of process of decomposition of product of the gelatin structured with maintenance 1 % substantially higher both on the first stage (began the end of process of melting) and on the second stage (process of destruction of structure) in relation to the samples with maintenance of gelatin 3 % and 5 % [6–8].

Table 1

Description of the stages of decomposition of product of structured

Content of gelatin, %	Position of maximums of DTG, ºC	
	1 stage	2 stage
1	87	112
3	90	116
5	92	120

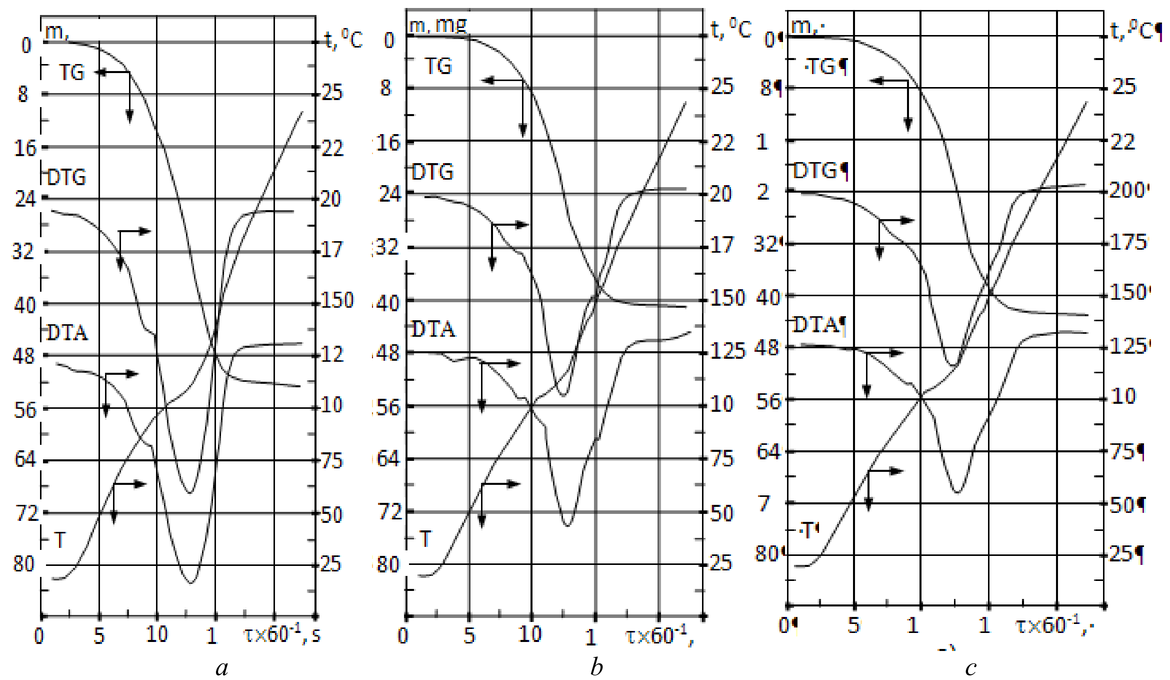

Fig. 2. Derivatogrammy of product of the gelatin structured with maintenance: *a* – 1 %; *b* – 3 %; *c* – 5 %. T – curve of heating; TG – curve of change of mass; DTG – curve of speed of change of mass; DTA – differential curve of thermoanalysis

At all stages of decomposition of experimental the samples there is a loss of mass because of evaporation of water. The severest losses of mass are observed for a the sample with maintenance of gelatin 1 % and on the first stage arrive at to 5,1 % (10,2 mg), on the second – 17,1 % (34,1 mg).

Losses of mass for the samples with maintenance of gelatin 3 % and 5 % considerably less and accordingly make on the first stage 2,8 % (5,6 mg) and 2,4 % (4,8 mg) and on the second stage 11,0 % (22,0 mg) and 10,2 % (20,4 mg). That they are more thermally stable.

For the calculations of energy of activating, processing of experimental data from the thermo-analytical curves (TG, DTG, DTA, T) the samples with different maintenance of gelatin in semilogarithmic co-ordinates build the chart of dependence of losses of mass from the temperature of lnm–2lnt=f(1000t) (Fig. 3)

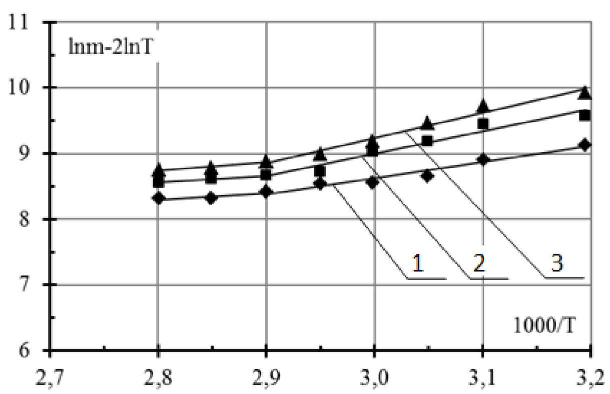

Fig. 3. Logarithmic dependence of losses of mass on the temperature of product of the gelatin structured with different maintenance: 1–1 %; 2–3 %; 3–5 %

From graphic dependence of lnm-2lnt on 1000/T, which in obedience to equalization (8) has the expressly expressed rectilineal character, the tangents of angle of slope of lines found, whereupon expected energy of activating.

6. Conclusions

1. The thermografhic findings confirm that content gelatin in the structured product increases power connection of molecules of water with an albumen, diminishing energy of activating of water. The sample of the structured product with maintenance of gelatin 1 % has large energy of activating among the probed the samples, which specifies on his less thermostablity.

2. Experimentally rotined possibility of estimation of values of seeming energy of activating by curves of differential thermogravimetric (DTG) and temperature (T) in the conditions of survey: hinge-plate of product of structured 200±2 mg, speed of heating of the samples 5±1 ^{0}/60s in the air environment of stove at unisothermal terms, the shut of thermocouple is placed in a the sample.

3. It is set that process of decomposition of product structured takes place endothermally in two stages with the loss of mass because of evaporation of water. Most thermostability were the samples with maintenance of gelatin 3 and 5 %.

4. The values of sizes of seeming energy of activating of process of melting are expected, which characterizes the size of binding by of moisture the albumen of product of the gelatin structured with different maintenance: 1 %, 3 %, 5 %, that for the unisothermal terms of research makes accordingly: 1,7; 1,5; 1,2 kDzh/mol.

5. The got results are comparable with the sizes of thermal effects for the temperature interval of leadthrough of process and comport with researches of

structural-mechanical descriptions of product, and organoleptic indexes.

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ВПЛИВ ПАРАМЕТРІВ І РЕЖИМІВ РОБОТИ ФРЕЗЕРНОГО РОБОЧОГО ОРГАНУ НА ЯКІСТЬ МІЖРЯДНОЇ ОБРОБКИ ЯГІДНИХ КУЛЬТУР

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Запропоновано вдосконалений фрезерний робочий орган для обробці міжрядь ягідних культур. Обґрунтовано оптимальні параметри і режими роботи фрезерного робочого органу. Досліджено їх вплив на якість процесу міжрядного обробітку. Встановлено, що забезпечується якісне рихлення ґрунту, знищення бур'янів і винесення їх на поверхню поля.
Ключові слова: догляд за ягідними культурами, міжрядна обробка, фрезерний робочий орган, знищення бур'янів.

The improved design of milling working body for berry crops inter-row cultivation has been developed. The optimal parameters and modes of the milling working body operation have been substantiated. The influence of the working body parameters on the quality of inter-row cultivation has been investigated. Qualitative soil tillage, weed destruction and its removal on the field surface has been provided.
Keywords: berry crops care, inter-row cultivation, milling working body, weed destruction.

1. Вступ

Для створення сприятливих умов розвитку кореневої системи ягідних культур слід створити дрібногрудкувату структуру ґрунту вільною від бур'янів.

Нині в сільських господарствах використовуються для міжрядної обробки ягідних культур дискові борони, які зміщують ґрунт із центру міжряддя до кущів, утворюючи повздовжні борони висотою 0,2…0,3 м. Це ускладнює збирання врожаю ягіднозбиральним машинам та спричиняє розвиток водної та вітрової ерозії влітку та підмерзання коренів взимку. Культиватори з пасивними робочими органами недостатньо ефективні в боротьбі з високими бур'янами і мають значний тяговий опір.

Фрези з горизонтальною віссю обертання при високій енергоємності не забезпечують належної обробки ґрунту, так як спричиняють утворення ерозійно-небезпечних фракцій ґрунту та намотування стебел бур'янів на вал барабана, при цьому не обробляється ділянка ґрунту, що знаходиться під редуктором.

Тому, для міжрядної обробки ягідних культур доцільно використовувати вертикально-ротаційні робочі органи, які задовольняють основним агротехнічним вимогам.

2. Постановка проблеми

Для створення оптимальних умов розвитку ягідних культур до робочих органів вертикально-фрезерних культиваторів ставиться ряд агротехнічних вимог:

– упередження пошкодження кореневої системи ягідних культур;