RESEARCH OF SELECTIVE FUNCTIONS OF GRINDING OF CHOCOLATE MASS IN THE ELECTROMAGNETIC MECHANOACTIVATION

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Crushing machine needs to carry out given the selectivity of the grinding process at minimum cost of energy. This type of apparatus can be considered universal and combines the functions of mechanoactivation-shredder, classifier, and separator. This is especially true in the area of the most energy intensive fine grinding of chocolate masses. The combination of the stages of dispersion in a single unit is a priority direction of development of grinding equipment in the confectionery industry. Implementation of the method of mechanical activation, providing high levels of selectivity requires a detailed study energodynamics regularities of the processes. Proved the applicability of the lognormal distribution law for the analysis of granulometric properties crushed in the electromagnetic mechanoactivation chocolate, allowing three known points to objectively assess its quality.

Keywords: mechanoactivation electromagnetic, chocolate.

Introduction

Given the scheduled increase in future production volumes of confectionery products and improve their quality and range, aimed at meeting the needs of the demand, the more urgent becomes the problem of more efficient use of expensive imported raw materials - cocoa beans - the main prescription component of chocolate products, by reducing production losses at the stage of its processing.

The implementation of the goals can be achieved by using specialized enterprises advanced technological schemes, equipped with advanced equipment with automated process control.

The objective of the work:

The aim of the study is to establish regularities of the distribution of granulometric composition of the solid phase of the chocolate mass, sedicenni in the electromagnetic mechanoactivation.

The material and methods of the investigation:

Used experimental and statistical methods of research and analysis.

The results of the investigation and discussion about them:

The leading place in the processing of cocoa beans into finished products is a mechanical grinding processes, from the successful carrying out of which depends largely on production efficiency, quality and cost of finished chocolate.

The degree of grinding of chocolate semi-finished products regulated by the standard that controls the maximum number of solid phase particles larger than 30 μm, the content of which

degrades the organoleptic indicators of finished chocolate products and reduce their quality. Particles of fine fraction does not affect the quality of chocolate and their number is not regulated by the standard. Meanwhile, they have a significant impact on the cost of finished products. The most reasonable is the choice of the lower limit of the particle size of the solid phase chocolate semi-finished products with a size of 10 microns. Particles smaller than 10 microns are undesirable as it contributed to a dramatic increase in the specific surface of the product and redistributing it adsorbiruyuschee dispersion medium is cocoa butter, which leads to a viscosity increase of the chocolate semi-finished products and violates the course of further technological operations - chocolate forming and glazing of buildings candy. Decrease the viscosity by adding cocoa butter affects the taste of cocoa beans and increases the cost of the finished products. The redistribution of the fractional composition of semi-finished products in the area of dispersion of from 10 to 30 microns allows to reduce in the chocolate fat (cocoa butter) without lowering the regulated value of viscosity and high palatability.

Currently in roizvodstvo chocolate products used multistage technological scheme of grinding include the separate processes of pre-dispersing the compounding components and the subsequent fine grinding of the prescription mixtures of chocolate masses. Processes pre-and fine grinding are seen as steps in the overall process the purpose of reducing the quantities of particles of separate solid components in the composition of chocolate products. A multistage grinding operation caused by the lack of easily manageable high-performance crushing equipment that enables the processing of the product, consisting of heterogeneous in their rheological properties of the components (sugar and cocoa).

Currently known in the food industry and in the confectionery industry the grinders are devices of purely mechanical principle and are based on traditional methods create chopping effort by using SSH one of the two surfaces (between the rollers or balls). Structurally they are complex, have high energy and metal consumption, small capacity and low efficiency. Practically do not give possibility to automate control of and subordinate to the operation of the devices to the requirements of technology of dispersion of the product. As a result, the conduct of the grinding process, quality and cost of products chocolate roizvodstvo far from optimal performance.

Therefore, in the field of devices for grinding of semi-finished chocolate is quite urgent search for more effective, manageable devices to intensify the technological scheme of grinding in the manufacture of chocolate by reducing the stages of dispersion and to obtain a high quality product with maximum uniformity of its fractional composition.

Modern progress in technology of crushing is associated with the development of high-intensity ways to create chopping effort and devices implementing them, based on a fundamentally

new, not traditional methods use various types of energy, including electromagnetic energy. In recent years, made a number of important and original works, expanding insight into the possibilities of using alternating magnetic fields in the processes of grinding for various purposes [1,2,3].

The use of alternating magnetic fields to create chopping effort in the mills is significantly intensificare grinding process, and also allows you to turn raw materials into finished products, bypassing the stage of intermediate processing. Meanwhile, currently used electromagnetic devices (AMY and VEA) have a number of drawbacks, principal among which are their high metal content and the practical impossibility of regulating power loads for the processed product, making it difficult to automatically control the grinding process.

The development of fundamentally new, manageable ways to create chopping effort using electromagnetic fields, is promising in improving the techniques of shredding.

Crushing machine needs to carry out given the selectivity of the grinding process at minimum cost of energy. Then this type of apparatus can be considered universal and combines the functions of mechanoactivation-shredder, classifier, and separator. This is especially true in the most energy-intensive fine and ultrafine grinding. The combination of the stages of dispersion in a single unit is the priority direction of development of technology of grinding. Implementation of the method of mechanical activation, providing high levels of selectivity requires a detailed study energodynamics regularities of the processes.

It is known that the well-known theory of grinding them unsuitable for direct design of grinding equipment as it is based on is not consistent (not adequate) scale vnutripechenochnykh processes and extent of the fracture mechanism in machines for grinding. And although, as the formulas describing the phenomena in machines for chopping, there is an equation of the theory of energetic grinding, the problem query is the definition of election functions and distribution functions appearing in this equation.

Based on these experimental studies it was found that for the description of the distribution function of the dispersed phase of the chocolate mass treated in the EMMA, the most reasonable is the logarithmically normal distribution law [4, 5, 6].

A function of logarithmic normal law of distribution of the mass of material in the diameters of the particles is described by the expression:

$$D_{LNR} = \frac{100}{\sqrt{2\pi lg\delta}} \int_{-\infty}^{lg\delta} \exp\left[-\frac{(lg\delta - lg\delta_{50})^2}{2lg^2\delta}\right] dlg\delta, \quad (1)$$

where δ_{50}- median of the distribution; $lg\delta$ - standard deviation of the logarithms of diameters from

their average value.

Replacing in equation (1) the integrand on

$$u = lg\delta - lg\delta_{50}/lg\delta \ , \tag{2}$$

get the normalized normal distribution function

$$D(\delta) = F(u) = F\left(\frac{lg\delta - lg\delta_{50}}{lg\delta}\right) = \frac{100}{\sqrt{2\pi}}\int_{-\infty}^{u} exp\left(-\frac{u^2}{2}\right)du \tag{3}$$

which ranges from 0 to 100 %.

It is revealed that the increase in induction in the working volume EMMA helps to improve the homogeneity of the product. The distribution line grain structure with B = 0,4 Tl in the field of fine fractions has a lower location, which indicates a smaller proportion of particles are "harmful" factions, with a size of < 10 microns. The closer the location of the distribution line to the vertical of said lower variance and, accordingly, a smaller standard deviation of the distribution curve, and hence the narrower the distribution and higher homogeneity in size of the particles of the mixture. The standard deviation can be determined analytically, according to the formulas:

$$lg\delta = lg\frac{\delta_{84}}{\delta_{50}};\ \delta = \frac{\delta_{84}}{\delta_{50}}\ . \tag{4}$$

Obtained from the equation (2) as a result of lookup table values of the distribution function D(δ) = 84,1 %, which corresponds to a standardized normally distributed value U = + 1 (4). Quantities appearing in equation (4): the diameters of the particles (the passage of 84.1% and 50%) are from the traffic distribution function of particle size. The analytical formula (4) can be used to characterize the uniformity of the processed in EMMA chocolate masses.

The analysis of the experimental data revealed the following particle size distribution characteristics of products of grinding:

when B= 0,25 Tl ; D =90,5 %; δ_{50} =12 microns; δ_{84}= 25 microns; δ = 2,08;

when B = 0,4 Tl ; D = 96 %; δ_{50}=12 microns; δ_{84}= 19,9 microns; δ = I,66.

The optimal particle size distribution for the preparation of chocolate products has a mixture dispersed in the electromagnetic mode with EMMA B= 0,4 Tl. Obtaining a more homogeneous semifinished product with a high dispersion positive effect on the taste merits of chocolate products and their cost.

Established the applicability of the logarithmic normal distribution law allows us to calculate the grain-size characteristics in chopped EMMA the chocolate mass through the three known points and objectively assess its quality.

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