Features of static distributions of the mass of parts of rose hips

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Abstract. The article presents the need to use a systematic approach to assessing machine performance which is possible only on the basis of the widespread use of mathematical methods and electronic computing. Machines and experimental results on the distribution of masses of rose hips of the Rosa Conina variety and their parts (shell, seeds), as well as theoretical models in the form of analytical expressions that adequately describe the experimental data are described in the article.

1 Introduction

The comprehensive development of agriculture at the present stage is characterized by the expansion of interpectoral relations, the deepening of specialization and concentration of production, the development of integration, the technical re-equipment of farms, the transfer of a number of industries to industrial technology. In the conditions of the scientific and technological process, it is necessary to constantly improve the methodology, raise the scientific level of solving a number of problems. One of the important directions in this area is the development and consistent application of the methodology of a systematic approach to engineering calculations of the machines used in fruit processing. The essence of the system approach is to consider a complex object as an interacting complex of its parts and elements. In this case, all changes occurring in the system under the influence of a change in one of its parameters are traced. A systematic approach to assessing the performance of machines requires the improvement of the process of engineering calculation of equipment and technology for processing raw materials [1-5].

2 Materials and methods

With a systematic approach, the necessary coordination of long-term, medium-term and short-term forecasts for the development of the design and calculation of equipment is achieved. The use of a systematic approach to assessing the performance of machines is possible only on the basis of the widespread use of mathematical methods and computers. It is quite clear that no model, no matter how detailed it may be, can adequately reflect the

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whole variety of design technical and technological parameters of processed machines. This requires a set of models.

Thus, the development and practical application of analytical models is one of the forms of implementation of the system approach. To do this, we conducted a study of the components of the wild rose variety "Rosa Conina" according to the compiled program in order to study the features of the statistical distributions of the masses of whole fruits, shells and seeds, as well as to obtain theoretical models in the form of analytical expressions adequate to the results of experiments. The resulting equations can be used for engineering calculations of equipment and technology for processing this raw material [6-10].

The results of measurements of the weight of whole fruits, shells and seeds are shown in the table below. Since the splitting intervals for the fetus and its parts are very small, in order to ensure the best filling of the intervals, it was decided to carry out 100 measurements with samples of 5 randomly selected fruits.

An analysis of experimental distributions showed that for whole fruits, an analytical model can be applied

$$P_x = A \cdot e^{-\frac{(x-\bar{x})^2}{2\cdot\sigma^2}} \quad (1)$$

after determining the values of A, $\bar{x}$, σ, because substitution of experimental values $\overline{x} = 4{,}5940$, σ=0,5308 и $A = \frac{1}{\sigma\sqrt{2\pi}} = 0{,}7518$ into equation (1) does not give a satisfactory result. Therefore, to refine the parameters of equation (1), we transform it by changing the variables to a linear one with respect to the refined parameters:

$$z = a_0 + a_1 x + a_2 x^2 \quad (2)$$

where $z = ln\, P_x$; $a_0 = lnA - \frac{\bar{x}^2}{2\cdot\sigma^2}$; $a_1 = \frac{\bar{x}^2}{\sigma^2}$; $a_2 = \frac{1}{2\cdot\sigma^2}$.

Table 1. Results of measurements of the weight of fruits, shells and seeds.

Number of intervals	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Weight of 5 fruits, gr *							
Number of hits in interval n	5	20	25	20	20	10	Σni=100
Frequency $P_{xi} = \frac{n_i}{N}$	0.05	0.2	0.25	0.2	0.2	0.1	ΣPxi=1
Random value xi in the middle of intervals, gr	3.43	3.87	4.31	4.75	5.19	5.03	xmax=5.85 xmin=3.21
Sum of cumulative frequencies Fxi	0.05	0.25	0.5	0.7	0.9	1.0	
Shell weight of 5 fruits, gr							
Number of hits in interval n	5	15	20	23	27	10	Σni=100
Frequency $P_{yi} = \frac{n_i}{N}$	0.05	0.15	0.2	0.23	0.27	0.1	ΣPyi=1
Random value yi in the middle of intervals, gr	1.865	2.075	2.285	2.495	2.705	2.915	ymax=3.02 ymin=1.76
Sum of cumulative frequencies Fyi	0.05	0.2	0.4	0.63	0.9	1.0	
Seed weight 5 fruits, gr**							
Number of hits in interval n	10	20	25	20	15	10	Σni=100
Frequency $P_{zi} = \frac{n_i}{N}$	0.1	0.2	0.25	0.2	0.15	0.1	ΣPzi=1
Random value zi in the middle of intervals, gr	1.575	1.805	2.035	2.265	2.495	2.725	zmax=2.84 zmin=1.46
Sum of cumulative frequencies Fzi	0.1	0.3	0.55	0.75	0.9	1.0	

* humidity of fruits 14-17%;

** The average weight of 1000 seeds is 16.38 gr.

The calculation of the coefficients of equation (2) was carried out on a PC in the MatLAB system using the file

Polyfin (x, z, 2), as a result of the implementation of which we got a_0; a_1; a_2 and then $\overline{x}_m = 4.642$; σ_m=0.6915; A=0.2622.

$$P_{xm} = 0.2622 \cdot e^{-\frac{(x-4,648)^2}{2\cdot 0,6915^2}} \quad (3)$$

Testing the H_0 hypothesis by χ^2 he criterion at the significance level α=0.05 and the degree of freedom k=m-c-1=3 (here c is the number of parameters - $\overline{x}$ and σ) gives the calculated value:

$$\chi_p^2 = \sum_{i=1}^{m} \frac{(M_i - nP_i)^2}{nP_i} = 2.4739,$$

where m=6 is the number of intervals; n=100 - number of experiments; $M = nP_{xi}$ - the number of hits in the i interval of a random variable x (according to the experiment); nP_{xm} - theoretical number of hits of a random variable in the i-interval.

From Table. 1. χ^2 distribution we have $\chi_{tabl}^2 = 7.8$. Since $\chi_p^2 < \chi_{tabl}^2$ then we can assume that the theoretical model (3) is in good agreement with the experimental data.

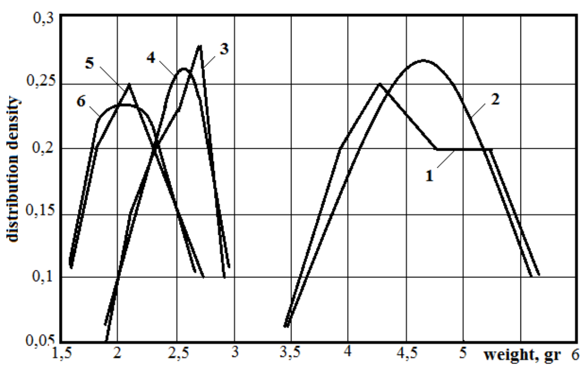

Fig. 1. Experimental and theoretical mass distribution densities: 1-experimental distribution density for fruits; 2-theoretical distribution density for fruits; 3-experimental distribution density for shells; 4-theoretical distribution density for shells; 5-experimental distribution density for seeds; 6 - theoretical distribution density for seeds [11-15].

3 Results and discussion

As a result of the analysis of the features of the experimental distribution densities P_{yi} and P_{zi}, theoretical models were obtained:

$$P_{ym}=6.1291-9.2289\cdot Y+4.5269\cdot Y^2-0.7099\cdot Y^3 \quad (4)$$

$$P_{zm}=-5.1291-7.3369\cdot Z+3.0879\cdot Z^2-0.4186\cdot Z^3 \quad (5)$$

Calculated values χ^2- criteria for experimental and theoretical distribution densities: $\chi_p^2 = 1.3201$ - for shell mass distributions; $\chi_p^2 = 0.3365$- for seed weight distributions. This is significantly less χ_{tabl}^2, therefore, Eqs. (4) and (5) can be considered adequate to the experimental results. In Figure 1 theoretical and experimental distribution densities are shown, from which some asymmetry can be seen. The absence of asymmetry is ensured if the central moments of the third (and more than the third, but odd order) order are equal to zero, i.e. $(x - \overline{x})^3 = 0$. The amount of asymmetry is determined by the coefficient of asymmetry

$$C = \frac{\sum(x - \overline{x})^3}{\sigma^3}$$

As a result of calculations using this formula for the distributions of the mass of whole fruits, C_x=-3.4472 (experimental distribution density) was obtained; C_{xm}=2.9945 (theoretical distribution density), which indicates right-sided asymmetry, with C_{1m} being 14% less than C_1. That is, the theoretical curve is more asymmetric.

Also for distributions:

P_y and P_{ym} received C_y =-6.3552; C_{xm}=-5.8895;
P_z and P_{zm} received C_z =1,6784; C_{zm}=1.3505.

Experimental and theoretical mass distribution densities: 1-experimental distribution density for fruits P_{xi} with parameters $\overline{x} = 4.5940; D = 0.4722$; σ=0.5308; 2-theoretical distribution density for fetuses $P_{xm} = 0.2622 \cdot exp\left(-\frac{(x-\overline{x}_m)^2}{2\cdot\sigma^2}\right)$with parameters $\overline{x} = 4.648$; D_m=0.4782; σ_m=0.5908; 3-experimental distribution density for P_{yi} shells with parameters $\overline{y} = 2.4572$; D=0,0832; σ=0.2885; 4-theoretical distribution density for shells P_{ym}=6.1281-9.2289·Y+4.5269·Y^2-0.7099·Y^3 with parameters $\overline{y}_m = 2.4502$ D_m=0.083; σ_m=0.288; 5-experimental distribution density for seeds P_{zi} with parameters $\bar{z} = 2.127$; D=0.1132; σ=0.3365; 6-theoretical distribution density for seeds P_{zm}=-5.4339-7.3369·Z+3.0879·Z^2-0.4186·Z^3 with parameters $\overline{z}_m = 2.1314$ D_m=0.1136; σ_m=0.337.

The distribution of the shell mass has the highest density σ=0.337, and the most successful approximation by the theoretical model is the seed mass distribution $\chi^2 = 0{,}3365$at C_z=1.6784 and C_{zm}=1.3505. The distribution of a random variable F allows you to determine the probability of a random variable falling into any interval based on experimental results. When using theoretical models, the probability of a random variable falling into a given interval (for example, for a random variable x when falling into the interval x_1= 3.87, = 4.75).

$$F_m(x_1 \leq x \leq x_2) = \int_{x_1}^{x_2} P_{xm} \cdot dx = \int_{3.87}^{4.75} 0.2622 \cdot exp\left(-\frac{(x - 4.648)^2}{2 \cdot 0.6915^2}\right) dx = 0.478;$$

also $F_m(3.21 \leq x \leq 5.85) = \int_{3.21}^{5.85} P_{xm} \cdot dx = 1.021$.

The integration was performed on the PC in the MatLAB system using the file F=`func`; quad (F, x_1, x_2). Similar calculations were carried out for the P_{ym} and P_{zm} models and showed good agreement between the results obtained and the experimental distributions.

4 Conclusion

This approach allows the implementation of engineering calculations of equipment and technology for processing raw materials, monitors the implementation of measures aimed at improving the performance of machines for processing raw materials.

The theoretical model is in good agreement with the obtained experimental data on the value of the distribution density criterion.

The mass of the shell has the highest density of distribution of parts of rose hips.

References

1. B. Shaymardanov, A. Borotov, Y. Jumatov, IOP Conference Series: Earth and Environmental Science **868**, 012035 (2021)
2. D. Alijanov, B. Shaymardanov, Y. Jumatov, IOP Conference Series: Earth and Environmental Science **1112**, 012047 (2022)
3. A. Li et al., IOP Conf. Ser.: Earth Environ. Sci. **868**, 012008 (2021)

4. D. Alijanov, Y. Jumatov, Journal of Physics: Conference Series **2176**, 012063 (2022)
5. O.V. Nanka, Agrotechnics and energy supply **1(1)**, 204-209 (2014)
6. E. Yalpachyk, S. Budenko, Praci Tavria State Agrotechnological University **13(1)**, 218-226 (2013)
7. D. Alijanov et al., IOP Conf. Series: Materials Science and Engineering **883**, 012155 (2020)
8. D. Alijanov et al., IOP Conf. Series: Earth and Environmental Science **614**, 012110 (2020)
9. N. Umirov, Sh. Abdurokhmonov, IOP Conference Series: Earth and Environmental Science **868**, 012002 (2021)
10. D. Alijanov et al., IOP Conf. Series: Materials Science and Engineering **883**, 012117 (2020)
11. N.T. Umirov, Sh.X. Abdurokhmonov, AIP Conference Proceedings **2762**, 020006 (2022)
12. S.X. Abdurokhmonov, N.T. Umirov, IOP Conference Series: Earth and Environmental Science **1076**, 012030 (2022)
13. N.T. Umirov , Sh.X. Abdurokhmonov, AIP Conference Proceedings **2762**, 020006 (2022)
14. S.V. Melnikov, *Technological equipment for livestock farms and complexes* (L., Agropromizdat, 1984)
15. A.A. Vertiy, *Improving the efficiency of the process of grinding coarse stalked karmas* (Voronezh, *2019*)