

С.Сейфуллин атындағы Қазақ агротехникалық университетінің **Ғылым жаршысы (пәнаралық) = Вестник науки** Казахского агротехнического университета им. С.Сейфуллина (**междисциплинарный**). - 2022. - №2 (113). – Ч.1. - Р.179-186

THE IMPACT OF THE SHAPE AND SIZE OF MELONS ON THE PROCESS OF MECHANIZED PROCESSING

Kizatova Marzhan Yerzhanovna

PhD, Head of the Laboratory of Primary processing of Plant raw materials of the Astana branch of Kazakh Research Institute of Processing and Food

Industry LLP,

Nur-Sultan, Kazakhstan

E-mail: marzhany87@mail.ru

Baykenov Alibek Omirserikovich

Head of the Laboratory of Deep processing of vegetable raw materials of the Astana branch of Kazakh Research Institute of Processing and Food Industry

LLP, Nur-Sultan, Kazakhstan

E-mail: alibek_89_89@mail.ru

Baigenzhinov Kadyrbek Aslanbekovich

Master of Technical Sciences

Senior Researcher at the Laboratory of Deep processing of vegetable raw materials of the Astana branch of Kazakh Research Institute of Processing and

Food

Industry LLP, Nur-Sultan, Kazakhstan

E-mail: baigenzhinov@inbox.ru

Akzhanov Nurtore

Junior Researcher at the Laboratory of Primary processing of Plant Raw Materials of the Astana branch of Kazakh Research Institute of Processing and

Food Industry LLP, Nur-Sultan, Kazakhstan

E-mail: nurtore0308@gmail.com

Saduakas Aigerim Sadibekkyzy

Researcher at the Laboratory of Primary processing of Plant raw materials of the Astana branch of Kazakh Research Institute of Processing and Food

Industry LLP, Nur-Sultan, Kazakhstan

E-mail: aykon96@mail.ru

Abstract

To develop equipment for cutting the crust and crushing the pulp of the melon, you need to know the linear dimensions of it. The article presents the geometric characteristics of melons of the variety "Mirzachelchkaya" and melons

of the variety "Kolkhoznitsa". The knowledge about the linear dimensions of melon fruits is important for the development of equipment for cutting the peel, cutting, and grinding (wiping) the pulp. The justification of rational modes of mechanized processing is carried out considering the classification of melon fruits. The parameters of cutting tools are investigated. The optimization has been carried out to obtain optimal parameters at which the machine will clean melons efficiently, without damaging or reducing the pulp layer.

Key words: melon; processing; shape; size; variety; mass; pulp.

Introduction

The bulk of melons produced in the republic are consumed in a fresh way, but the consumption period of such product is very short. Also, the sensory qualities of freshly cut melon, including density, flesh color, etc., can deteriorate rapidly due to an increase in respiratory rate and ethylene release [1]. At the same time, industrial melon processing allows a production of a wide range of natural consumer products, such as juices, jams, dehydrated pulp and salads or snacks [2].

It has been established that with waste-free processing from 1 ton of melon, it is possible to obtain: melon jam - 155-165 kg, or bekmes - 65-70 kg, dried melon - 70-75 kg, vegetable

oil - 2.5-3 kg, protein flour from the peel - 20-23 kg [3].

Cleaning, as a preliminary and main stage of post-harvest processing, is currently done by mechanical, chemical and thermal methods [4]. Although each method has its advantages and limitations, mechanical methods are preferable because they preserve the edible parts of fresh and undamaged products [5].

The analysis of existing technologies of primary melon processing, especially the transition to multi-tonnage production, requires the search and development of such technical means that would provide a complete replacement or replacement of most of the manual labor used with minimal loss of resources.

Materials and methods

Melons of the "Myrzachulskaya" and "Kolkhoznitsa" varieties of the 2021 harvest were taken as the object of research. Melons were grown in Maktaaral district of Turkestan region.

The linear dimensions of melon fruits: length, diameter were determined using a caliper with an

accuracy of 1 mm, with a 5 trials of experiments for fruits of different sizes. After measurements, the index of form i was calculated, which is the ratio of the length of the fruit to its diameter.

The weight of the fruits was determined by weighing them on the scales of VNC-10. The measurement results were recorded after statistical calibration.

The index of the form was determined throughout mathematical calculation. It allows you to compare the shapes of melons with each other and is calculated according to the formula of A.L. Romanov:

$$IF = 100 \times d/D \quad (1)$$

where: d is the transverse (small) diameter, mm;

D is the longitudinal (large) diameter, mm.

An experiment to study the parameters of the cutting tool was carried out on a sample of melon of the "Myrzachulskaya" variety. The main technique of the experiment is to clean melons in one batch with a change in the main parameters affecting the quality of cleaning. The staging part of the experiment consists

Results

The appearance of melons of the "Kolkhoznitsa" and "Mirzachulskaya" varieties are determined according to GOST 7178-2015 "Fresh melons. Technical conditions". Studies have established that the variety "Kolkhoznitsa" in appearance is a round fruit, weighing up to 1.5 kg.

The variety "Mirzachulskaya" in appearance has an oblong shape, a rich yellow color of the peel, with thin white veins forming a meshy pattern. The smell resembles the aroma of vanilla, honey and pear, the taste is very sweet with a vanilla flavor. The flesh is milky in color, the consistency is gently oily, juicy.

The fruits of the melon variety "Kolkhoznitsa" are rounded up to 1.5 kg, dense, bright yellow with an orange tint, and sometimes yellow-green, depending on ripeness. There is a mesh pattern, but not dense, rare. The rind is thin and the flesh is very soft, juicy and sweet with a light color. If the melon is not overripe, then when biting, you can hear a characteristic crunch.

The geometric characteristics of melon fruits and the mass of the constituent parts of the fruit are shown in Table 1.

of constructing a matrix of conducting experiments on cleaning melons. The following factors were taken as the main parameters affecting the quality of cleaning: the product rotation speed (N , rpm), the gap distance between the roller and the knife (D , mm) and the forces applied to cutting (H , N/m).

The percentage of melon peel loss was calculated using the weight of the product before and after cleaning, as indicated below. The efficiency of melon cleaning was calculated by the formula 2:

$$y_1 = \frac{W_1 - W_2}{W_1 * t} * 100$$

where: W_2 must be zero or W_1 .

All the samples obtained were weighed before (W_1) and immediately after (W_2) peeling on a scale with an accuracy of ± 1 g.

The blades were sharpened from the side outside to ensure the discharge of the separated melon peel to the side.

Table 1 - Yield of components when cutting melon fruits

Variety	Mass of fruit, g	Flesh		Peel		Placenta		Seeds	
		g	%	g	%	г	%	г	%
"Mirzachulskaya"	5 575	4 000	71,75	1 370	24,57	133	2,39	72	1,29
"Kolkhoznitsa"	1 500	800	63,35	500	31,62	65	3,23	30	1,8

From Table 1 it can be observed that the yield of pulp in the melon variety "Myrzachulskaya" is 71.75% and in the melon variety "Kolkhoznitsa" - 63.35%. The thickest crust was found in the melon variety "Kolkhoznitsa" 31.62% against the variety "Myrzachulskaya" - 24.57%.

The seed content varies from 1.29 to 1.8%. The dependence of the seed content on which class the melons belong to in terms of maturation has not been observed. This indicator depends only on the characteristics of the variety.

The indices of the melon shape obtained by calculation are presented in Table 2.

Table 2 - Characteristic parameters of melon

The melon variety	Index of form
"Mirzachulskaya"	1,80-1,90, average 1,85
"Kolkhoznitsa"	1,20-1,25, average 1,23

The index of form is very important when choosing devices for removing the peel from melon fruits. The higher the shape index, the easier it is to mechanize the process of cutting it. The amount of mechanical force needed for cutting the peel of

pulp for further recycling were determined. For example, Figures 1 and 2 show graphs of the "displacement - cutting force" relationship for the peel and pulp of melon.

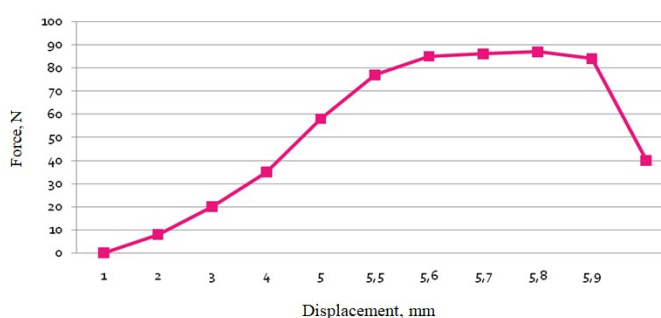


Figure 1 - Graph of the relationships of the cutting force against the movement of the knife when cutting the pulp of melon variety "Kolkhoznitsa"

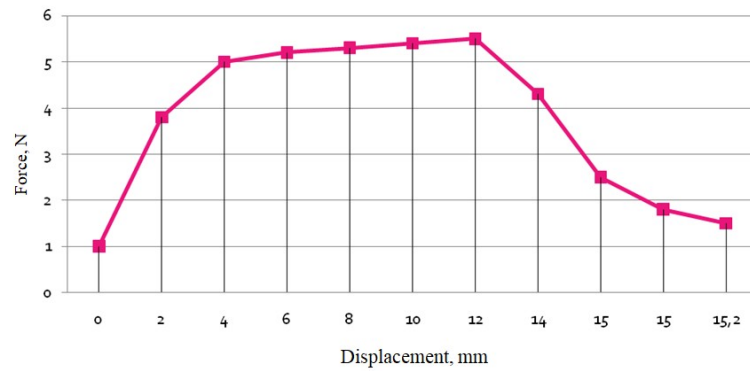


Figure 2 - Graph of the relationships of the cutting force against the movement of the knife when cutting the pulp of melon variety "Myrzachulskaya"

Analyzing the given data of characteristic both melons, it can be concluded that during the initial period of contact of the knife with the crust, elastic-plastic deformation of the crust occurs. At the same time, the cutting force changes only slightly, whilst at the maximum value of deformation, an abrupt increase in force occurs, afterwards leading to the destruction of the material. When cutting the pulp, the cutting force remains almost constant during the movement of the blades.

was not sufficiently peeled or the peel was removed along with part of the pulp.

To obtain optimal parameters at which the machine will clean melons qualitatively without removing the pulp, it is necessary to optimize the specifications of the technology.

Based on the planning matrix, 20 melon cleaning experiments with various parameters were carried out. The experimental data obtained are presented in Table 3.

From the data obtained, it can be seen that the yield of the peel varies from 19 to 29%. This tells us that with some parameters, the melon

Table 3 - Matrix of experiments on melon cleaning

№	Encoded values			Natural values			Optimization criteria
	x ₁	x ₂	x ₃	N, rotations/min	D,mm	H,N/m	B, %
1	-	-	-	35	6	2 369,5	20
2	-	-	+	35	6	2 380,5	25

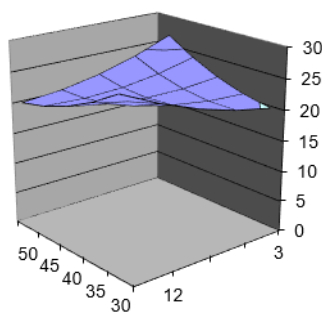
3	-	+	-	35	12	2 369,5	23
4	-	+	+	35	12	2 380,5	26
5	+	-	-	45	6	2 369,5	19
6	+	-	+	45	6	2 380,5	18
7	+	+	-	45	12	2 369,5	17
8	+	+	+	45	12	2 380,5	20
9	-1,68	0	0	30	9	2 375	17
10	+1,68	0	0	50	9	2 375	26
11	0	-1,68	0	40	3	2 375	25
12	0	+1,68	0	40	15	2 375	22
13	0	0	-1,68	40	9	2 364	29
14	0	0	+1,68	40	9	2 386	19
15	0	0	0	40	9	2 375	22
16	0	0	0	40	9	2 375	21
17	0	0	0	40	9	2 375	21
18	0	0	0	40	9	2 375	20
19	0	0	0	40	9	2 375	21
20	0	0	0	40	9	2 375	20

Based on the data of the conducted experiments, a mathematical model is constructed (Figure 3). Also, a regression equation was obtained that helps to calculate the optimal parameters of the indicators when their values change:

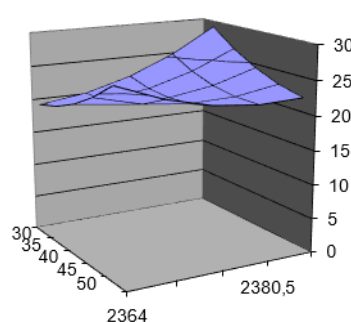
$$y_1 = 21,40118752 - 0,43627x_1 - 0,4187x_2 - 0,17275x_3 - 0,125x_1x_2 - 0,625x_3 - 0,125x_2x_3 - 0,60624x_1^2 + 0,62856x_2^2 + 98136x_3^2$$

The three-dimensional model shows that each variable is equally important for performing the technological process of melon cleaning.

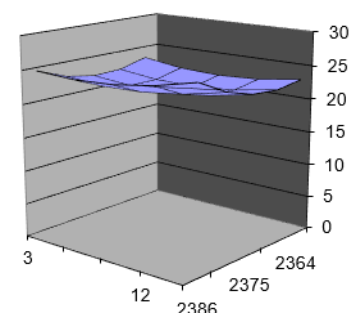
In the course of optimizing the parameters that affect the effective peeling of melons, the product rotation speed is of particular interest as a characteristic that determines one of the main parameters. Figure 3a shows that the faster the product rotates and the larger (wider) the gap between the roller and the knife, the greater the loss of the product itself, that is, the pulp. Figure 3a shows the percentage of crust in the melon of the "Myrzachulskaya" variety, it is 22.38%. This means that the entire optimization process is focused on achieving this indicator of crust separation.



a



b



c

a – the rotation speed of the product (N, rpm) and the gap between the roller and the knife (D, mm); b - the rotation speed of the product (N, rpm) and the force applied to cut (H, N/m); c - the effect of the gap between the roller and the knife (D, mm) and the force applied to cut (H, N/m)

Figure 3 - A three-dimensional model in space characterizing the dependence of

$$x_n=f(N,D,H) \text{ on } y_n=f(B)$$

The main peak of losses occurred at rotation rates up to 30 rpm and the applied maximum force of 2,386 N/m - 30% was removed (Figure 3b). At the same time, in the extraction of the crust of 22.38%, the loss of the necessary raw materials amounted to 7.62%.

Figure 3c shows the effect of the force and clearance of the roller and knife on the separation of the peel. The graph shows that with the maximum effort applied, regardless of

Discussion

Currently, the technology of removing the outer cover from the fruits of melons to obtain purified pulp is based on the use of manual labor, and the existing design and technological solutions of machines for cleaning fruits from the bark do not provide effective and high-quality work when processing melons - full completeness of cleaning and small losses of edible pulp. In addition, in all known bark removal machines, the

Conclusion

Thus, the geometric parameters of melons of 2 varieties sold in Kazakhstan in the period from the end of June to the end of October have been determined. They differ in terms of maturation, size and shape, the shape index varies for varieties from 0.92 (spherical) to 2.4 (cylindrical). This requires the development of a

the gap of the roller and its resistance, the knife rushes deep into the pulp, cutting off its valuable part. While at minimum values, the cutting of the peel is less effective.

Thus, it follows from the model shown in Figure 3 that the optimal parameters for peeling melons fall on the peel separation rate of 22.5%. The optimal rotation speed of the product will be 40 rpm with a roller clearance width of 6 mm, as well as with an average applied force of 1375 N/m.

quality of the technological process depends on the fruit shape index. The lack of clarity in the classification and choice of the type of these machines creates certain difficulties for their theoretical and computational justification when processing melons. Therefore, the problem of mechanization of primary melon processing operations is an urgent task nowadays.

universal technology for separating the crust.

Thus, the optimal parameters for cleaning melons from the peel fall on the peel separation rate of 22.5%. The optimal rotation speed of the product will be 40 rpm with a roller clearance width of 6 mm, as well as with an average applied force of 1,375

N/m. When determining the optimal parameters for cleaning melons from the peel, the sharpening angle of the knife was not taken into account, since the geometry of the cutting element is not the main indicator of cleaning efficiency.

The work was carried out within the framework of the "Grant".

Information about financing

The article is based on the results obtained within the framework of the grant project "Improving the technology of separating the pulp of melon fruits for the production of dried fruits and healthy breakfasts", funded by the Ministry of Science and Education of the Republic of Kazakhstan № AR08052539.

The authors of the article thank their colleagues who jointly carry out research work on this project.

References

- 1 C. Lucas-Torres. Microwave heating for the catalytic conversion of melon rind waste into biofuel precursors [Text]: Journal of Cleaner Production / C. Lucas-Torres. – 2016. – Vol. 138. P. 59-69.
- 2 M. Cavaiuolo., G. Cocetta., R. Bulgari. Identification of innovative potential quality markers in rocket and melon fresh-cut produce [Text]: journal. - Food Chemistry / M. Cavaiuolo. G. Cocetta., R. Bulgari. – 2015. –Vol. 188. – P. 225-233.
- 3 G. E. Lester., R. A. Saftner. Marketable quality and phytonutrient concentrations of a novel hybrid muskmelon intended for the fresh-cut industry and its parental lines: Whole-fruit comparisons at harvest and following long-term storage at 1 or 5 C // [Text]: journal. - Postharvest biology and technology / G. E. Lester., R. A. Saftner. – 2008. – Vol. 48. No. 2. P. 248-253.
- 4 B. ShiunLuh., J. G. Woodroof. Commercial vegetable processing [Text]: journal. B. ShiunLuh., J. G. Woodroof. – 1988. No. 36 (3). P. 215–221.
- 5 B. Emadi., V. Kosse., P. Yarlagadda. Abrasive peeling of pumpkin [Text]: Journal of Food Engineering / B. Emadi., V. Kosse., P. Yarlagadda. – 2007. - Vol. 79. №. 2. P. 647-656.
- 6 Fundo J. F. Physicochemical characteristics, bioactive compounds and antioxidant activity in juice, pulp, peel and seeds of Cantaloupe melon [Text]: Journal of Food Measurement and Characterization. J. F. Fundo. – 2018. – T. 12. – №. 1. – C. 292-300.7 Ezekaibeya A. C., Nnenna A. O., Kenechukwu O. C. Proximate, phytochemical and vitamin compositions of Cucumis metuliferus (Horned Melon) rind [Text]: J. Complement. Altern. Med. Res. A. C. Ezekaibeya., A. J. Nnenna., J. C. Kenechukwu. – 2020. – T. 9. – P. 40-50

financing of scientific research" of the Ministry of Education and Science of the Republic of Kazakhstan No. AP08052539 "Improving the technology of separating the pulp of melon fruits for the production of dried fruits and healthy breakfasts

8 Salehi R. Evaluation and measurement of bioethanol extraction from melon waste (Qassari cultivar) [Text]: Agricultural Engineering International: CIGR Journal. R. Salehi. – 2018. – Т. 20. – №. 3. – С. 127-131.

9 Kumar C. S., Mythily R., Chandraju S. Studies on sugars extracted from water melon (Citrullus lanatus)rind, a remedy for related waste and its management [Text]: Int. J. Chem. Anal. Sci. C. S. Kumar. K. Mythily., S. Chandraju. – 2012. – Т. 3. – №. 8. – С. 1527-1529.

10 Amekan Y.. Effect of Different Inoculum Combination on Biohydrogen Production from Melon Fruit Waste [Text]: International Journal of Renewable Energy Development. Y. Amekan. – 2018. – Т. 7. – №. 2.

ВЛИЯНИЕ ФОРМЫ И РАЗМЕРА ДЫНЬ НА ПРОЦЕСС МЕХАНИЗИРОВАННОЙ ОБРАБОТКИ

Кизатова Маржан Ержановна

*PhD, заведующий лабораторией первичной переработки растительного сырья Астанинского филиала ТОО "Казахский НИИ перерабатывающей и пищевой промышленности" ,
г. Нур-Султан, Казахстан
E-mail: marzhany87@mail.ru*

Байкенов Алибек Омурсерикович

*Заведующий лабораторией глубокой переработки растительного сырья Астанинского филиала ТОО "Казахский НИИ перерабатывающей и пищевой промышленности", г. Нур-Султан, Казахстан
E-mail: alibek_89_89@mail.ru*

Байгенжинов Кадырбек Асланбекович

магистр технических наук

*Старший научный сотрудник лаборатории глубокой переработки растительного сырья Астанинского филиала ТОО "Казахский НИИ перерабатывающей и пищевой промышленности", г. Нур-Султан, Казахстан
E-mail: baigenzhinov@inbox.ru*

Акжанов Нурторе

*Младший научный сотрудник лаборатории первичной переработки растительного сырья Астанинского филиала ТОО "Казахский НИИ перерабатывающей и пищевой промышленности", г. Нур-Султан, Казахстан
E-mail: nurtore0308@gmail.com*

Садуакас Айгерим Сәдибекқызы

Научный сотрудник лаборатории первичной переработки растительного сырья Астанинского филиала ТОО "Казахский НИИ перерабатывающей и пищевой промышленности", г. Нур-Султан, Казахстан

E-mail: aykon96@mail.ru

Аннотация: Чтобы разработать оборудование для срезания корки и дробления мякоти дыни, необходимо знать ее линейные размеры. В статье представлены геометрические характеристики дынь сорта "Мирзачульчкая" и дынь сорта "Колхозница". Знания о линейных размерах плодов дыни важны для разработки оборудования для срезания кожуры, резки и измельчения (протиранья) мякоти. Обоснование рациональных режимов механизированной обработки проводится с учетом классификации плодов дыни. Исследованы параметры режущего инструмента. Оптимизация была проведена для получения оптимальных параметров, при которых машина будет эффективно очищать дыни, не повреждая и не уменьшая слой мякоти.

Ключевые слова: дыня; переработка; форма; размер; сорт; масса; мякоть.

ҚАУЫННЫҢ ПІШІНІ МЕН МӨЛШЕРІНІҢ МЕХАНИКАЛАНДЫРЫЛҒАН ӨНДЕУ ПРОЦЕСІНЕ ӘСЕРІ

Кизатова Маржан Ержановна

*PhD, "Қазақ қайта өңдеу және тағам өнеркәсіптері ҒЗИ" ЖШС
Астана филиалының Өсімдік шикізатын бастапқы қайта өңдеу*

зертханасының меңгерушісі,

Нұр-Сұлтан қ, Қазақстан

E-mail: marzhany87@mail.ru

Байкенов Алибек Өмірсерікұлы

*"Қазақ қайта өңдеу және тағам өнеркәсіптері ҒЗИ" ЖШС Астана
филиалының Өсімдік шаруашылығы өнімдерін терең қайта өңдеу*

зертханасының меңгерушісі, Нұр-Сұлтан қ, Қазақстан

E-mail: alibek_89_89@mail.ru

Байгенжинов Кадырбек Асланбекович

техника ғылымдарының магистрі,

*"Қазақ қайта өңдеу және тағам өнеркәсіптері ҒЗИ" ЖШС Астана
филиалының Өсімдік шаруашылығы өнімдерін терең қайта өңдеу*

зертханасының аға ғылыми қызметкері, Нұр-Сұлтан қ., Қазақстан

E-mail: baigenzhinov@inbox.ru

Акжанов Нурторе

*"Қазақ қайта өңдеу және тағам өнеркәсіптері ҒЗИ" ЖШС Астана
филиалының Өсімдік шикізатын бастапқы қайта өңдеу зертханасының кіші*

ғылыми қызметкері, Нұр-Сұлтан қ, Қазақстан

E-mail: nurtore0308@gmail.com

Сәдуақас Әйгерім Сәндібекқызы
"Қазақ қайта өңдеу және тағам өнеркәсіптері ҒЗИ" ЖШС Астана
филиалының Өсімдік шикізатын бастапқы қайта өңдеу зертханасының
ғылыми қызметкері, Нұр-Сұлтан қ, Қазақстан
E-mail: aykon96@mail.ru

Түйін. Қауынның қабығын кесуге және мәйегін ұсақтауға арналған жабдықты жасау үшін оның сызықтық өлшемдерін білу қажет. Мақалада "Мирзачульчкая" сортының қауындары мен "Колхозница" сортының қауындарының геометриялық сипаттамалары келтірілген. Қауын жемістерінің сызықтық мөлшерін білу қабықты кесуге, мәйегін кесуге және майдалауға арналған жабдықты жасау үшін маңызды. Механикаландырылған өңдеудің ұтымды режимдерін негіздеу қауын жемістерінің жіктелуін ескере отырып жүзеге асырылады. Кескіш құралдың параметрлері зерттелді. Оңтайлы параметрлерді алу үшін оңтайландыру жүргізілді, онда машина қауындарды жұмсақ мәйекті қабатын бүлдірмей немесе азайтпай тиімді тазартады.

Кілт сөздер: қауын; өңдеу; пішін; мөлшер; сұрып; масса; мәйек.