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НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
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ANISOTROPY OF CHEESE "LORI" PRODUCED BY DOUBLE-SIDED PRESSING

Abstract. The article examines the influence, proposed for the first time by new methods: double-sided non-cloth without repressing; double-sided step non-cloth without repressing with fewer pneumatic cylinders.

The study was carried out by removing 2.5 cm thick layer from the upper and lower sheets and 1.5 cm of the middle layer at 4 side edges, which will allow you to test in deeper layers of the cheese head and reveal the true picture of anisotropy.

We have studied the moisture content in the central parts of the upper and lower sheets, at the edges along the length and width of experimental and control cheeses.

The study showed that the upper sheet sidewall N1 between the upper 0.3% and lower 0.5% edges the differences in moisture content in the experimental cheese is 0.3%, 0.5%, and respectively in the central part 0.3%, i.e. almost equalized.

In the central part, the moisture content of the experimental cheese is on average 42.9%, 43.2% correspond to the points in the middle layer of the control cheeses 43.4%, 43.4%. The difference is 0.3-0.5%. We can state that multiple repressing with double-sided pressing disappears. Distribution of moisture along the side length of sidewall N1, sidewall N2 increases from the edges to the central part. This also proves that with double-sided pressing, moisture is distributed more evenly in the cheese mass.

The above study confirms that for obtaining reliable data, it is necessary to remove the compacting layer.

By the second method we introduce the scheme of mold covers for double-sided pressing of cheeses.

Key words: anisotropy, moisture, variation, sheet, sidewall.

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ЕКІ ЖАҚТЫ ТЫҒЫЗДАУ АРҚЫЛЫ АЛЫНҒАН «ЛОРИ» ІРІМШІГІНІҢ АНИЗОТРОПИЯСЫ

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АНИЗОТРОПИЯ СРЕДНЕГО СЛОЯ СЫРА "ЛОРИ", ВЫРАБОТАННОГО ДВУХСТОРОННИМ ПРЕССОВАНИЕМ

Аннотация. В статье рассматривается влияние, предложенные впервые новыми способами: двухстороннее бессалфеточное без перепрессовок, двухстороннее ступенчатое бессалфеточное без перепрессовок с меньшим количеством пневмоцилиндров.

Исследование проводили отрезкой из верхних и нижних полотен толщиной 2,5 см и с 4-х боковых краев 1,5 см среднего слоя, что позволило тестировать в более глубоких слоях головки сыра и выявить истинную картину анизотропии.

Исследовали содержание влаги в центральных частях верхних и нижних полотнах, на краях по длине и в ширине, в углах опытного и контрольного сыра.

Исследование показало, что в верхнем полотне боковины N1 между верхними 0,3% и нижними 0,5% краями разница содержания влаги в опытном сыре составляет 0,3%, 0,5%, и соответственно в центральной части 0,3%, т. е. почти уравнивается.

В центральной части содержание влаги опытного сыра составляет в среднем 42,9%, 43,2% и соответствуют точкам среднего слоя контрольных сыров 43,4%, 43,4%. Разница составляет 0,3-0,5%. Можно заключить, что многократная перепрессовка при двухстороннем прессовании отпадает. Распределение влаги по длине боковины N1, боковины N2 от краев до центральной части увеличивается. Это тоже доказывает, что при двухстороннем прессовании влага распределятся более равномерно в сырной массе.

Вышеуказанное исследование подтверждает, что для получения достоверных данных необходимо удалить уплотняющий слой.

По второму способу представляем схему крышек прессформы для двухстороннего прессования сыров.

Ключевые слова: анизотропия, влажность, колебание, полотно, боковина.

Introduction. In cheese making, among the technological processes the molding and cheese pressing play an important role. The grains in the finished cheese mass are usually of different sizes, and they need to be combined into large monolithic pieces. Monoliths are given various shapes: spherical, cylindrical, rectangular, square, etc. Cheeses are also molded to separate the whey remaining between the grains. Besides, the shape of the cheese in some way affects the process of ripening and drying during storage. Thus, ripening of soft cheeses goes from the surface to the inside, so they are mainly produced in small sizes (2-3 kg), but with a large specific surface. Hard cheeses ripen from the centre to the periphery, their size is larger, and the specific surface in relation to the cheese mass is smaller. With a change in shape, the surface area also changes. With the same mass, the smallest surface will have a round cheese, then cylindrical, square and rectangular. [1, 2, 3, 12]

With a change in the shape and surface area, the moisture distribution of the cheese mass (anisotropy), the development and distribution of microorganisms that occur during ripening also change, which ultimately affects the quality of the product.

Sources of flavoring and aromatic substances of cheese are all macronutrients: fats, proteins, carbohydrates. The hydrolysis of these macronutrients is carried out by microorganisms, i.e., it is impossible to develop cheese without microorganisms. [1, 2, 3, 4, 12]

Thus, it is essential to create conditions (moisture, temperature and pH) to produce cheeses of the required quality. It is more important to distribute moisture in the cheese mass, which depends on the cloth wrapping, repressing, non-cloth and without repressing, the optimal modes (pressure and duration) and pressing method, as well as the incompatibility of technological processes (assembly and disassembly of moulds, filling of cheese grains, molding, pressing and extracting cheese from the mould) that lead to an increase of anisotropy of the cheese mass. In this sphere, a technological analysis of the review literature was carried out to determine the influence of each of these technological processes, anisotropy change (uneven distribution of moisture) in the cheese mass. **Technological analysis** has shown how three methods - cloth repressing, one-sided cloth pressing with repressing and one-sided non-cloth pressing without repressing the cheese mass - are still used in cheese making abroad and in the CIS. When self-pressing, there is pressure from the upper layers of the cheese mass on the lower ones. In the method of the second and third one-sided pressing in the direction of the side to be pressed from top to bottom, the pressure, of course, decreases. What happens in the third method? In the method, the following occurs: the initial acting pressure force of 0.1 kg/cm^2 is very weak and does not reach the lower layers of the cheese mass. In this case, the upper layers are compacted. At the same time, the lower layers of the cheese mass are compacted due to the pressure of the upper layers on the lower ones (self-pressing). A gradual increase in pressure up to 0.5 kg/cm^2 reaches the lower layers, but not completely, and it is greater than the effective pressure of the upper layers on the lower ones (self-pressing). As a result, the upper layers are compacted more than the lower ones. This method is effective for low-height cheeses. In both methods, repressing of the cheese mass is required for the equation of moisture distribution and density of the upper and lower layers of the cheese mass. If the pressure in the technological mode is higher than the norm over the cheese mass, then the drainage of the napkin is more pressed out that leads to rapid drying and closure due to the capillary openings and, ultimately, to settling of the whey in the capillaries. Besides, large pressings can be cut off when extracting pressed cheese from the mold. Unwanted microorganisms can enter these places, which further deteriorate the quality of the cheese. If the pressure is less, then the cheese is not fully pressed, i.e. again leads to the settling of whey in the capillaries. These operations increase the cost price of cheese, reduce the labor productivity, hinder the implementation of production flow, hamper the complex mechanization and automation of cheese production. [4]

Anisotropy formation theory. When cheese grains are displaced under the pressure of the pressing force, capillaries are formed in the inter-granular space, through which a leakage of the whey occurs in different directions to the surface of the cheese mass. Thus, the repressing and the napkin lead to the coincidence of the holes of mesh tape with the pressing, as a result of which the size of the pressing increases and the holes get quickly dried and closed, leading to the settling of whey in the capillaries. The whey can exit through other capillaries if the pressure is higher than in adjacent capillaries, but this extends the duration of pressing. And if the whey remains in the capillaries, then the moisture will be higher than in those capillaries, the holes of which did not close. As a result of this, the anisotropy increases, which is so unwanted in anisotropy. Besides, during one-sided pressing, the pressure from the pressing side towards the lower layers decreases, as a result of which, the density in the upper and lower clothes is different, for which they recourse to repressing. [5]

The above factors adversely affect the intensity of flow of the biochemical and microbiological processes. In this regard, the most important issue of cheese making is the development and widespread industrial introduction of new advanced technologies and technical means, such as the non-cloth pressing of cheeses.

Thus, the above mentioned technological processes increase the anisotropy of the cheese mass, reducing the quality of cheese.

Technical analysis. In the last decade, many natural cheese production processes have been mechanized and automated. A few semi-industrial and industrial methods for the continuous production of cheese mass, its molding and pressing, various designs of apparatus of periodic and continuous actions are used. To obtain high-quality cheese mass, molding and dosing devices, presses (lever, screw and pneumatic, horizontal, tunnel) were used. Until now, methods, designs of forms and devices have been used in cheese making mainly for the implementation of one-sided pressing of cheeses. Among them, a special place is occupied by tunnel presses, in which two types of devices are used as power elements developing the pressing force: [5, 6, 7, 8, 9]

1.Pneumatic cylinders: a separate pneumatic cylinder presses on each cheese bar. Thus, the difference in height of each of the cheese bars does not matter much, the presses with pneumatic cylinders have a large working space height, which facilitates the loading. Moreover, their design provides parallelism of the upper and lower planes at any load and any molding method. This positive feature makes such presses attractive to many cheese producers. Such a pressing design is quite high-priced and material-intensive, but it is considered the best and is used in cheese production with a large mass.

2. Flexible inflatable power elements: the disadvantage of such elements lies in the small size of the working stroke (with large differences in the height of the cheese heads, the quality of the pressing may deteriorate), the advantage is in high specific pressure provided by the specificity of press designs with the use of flexible power elements. Thus, the main way to create the pressing pressure is to use the energy of compressed air and most often a separate pneumatic cylinder presses on each cheese bar in them. At the same time, the compaction of the cheese mass in the direction from the pressed side downwards falls anyway, and to obtain the same density of the upper and lower sides, the cheeses are repressed. This is a very time-consuming process, leading to an uneven distribution of moisture and hardness in the cheese mass, therefore, to an uneven distribution and development of microflora and to non-intensive flow of biochemical processes in the cheese mass, in the result of which the quality of cheesee decreases. Therefore, the current method of one-sided pressing of cheeses with repressing, without repressing and using napkins leads to cheese anisotropy. [5, 6, 7, 8]

Of the existing tunnel presses, presses of high automation manufactured by “Press Pallet” company are distinguished. Press pallets are combined into blocks that have a common compressed air supply system, as well as a system of lifting and transporting devices for loading and unloading the presses (press-room equipped with Chalon Megard press pallets [8]).

The analysis of the existing pressing systems allows concluding that they are constantly being improved, but the main way to create pressing pressure is to use the energy of compressed air.

Improvements concern the automation of loading and unloading systems, and not the design of forms, molds and installations. [5, 6]

To obtain high-quality cheese, it is necessary to obtain a more homogeneous cheese mass when pressing, i.e. with a more uniform distribution of moisture and hardness, which provides the new method of pressing proposed by us - double-sided pressing of the cheese mass, which contributes to the compaction of the cheese mass by one temporarily from both sides. In this case, the upper and lower layers of the cheese mass, moving towards each other and displacing the whey from the intergranular space, create the same compaction almost throughout the cheese mass [5], which cannot but have a positive effect on the quality of the cheese.

The new method was tested on round ("Dutch") and cylindrical ("Swiss") cheeses. Based on the positive results, we tested it on mature rectangular cheeses "Lori", knowing that the shape of the cheese somehow influences the ripening of the cheese. The study of changes in the anisotropy of the middle layers on mature cheeses continues, so we set the task of obtaining high quality cheese, with a decrease in anisotropy, reduction in the duration of pressing and with the exception of repressing: [1, 2, 3, 4, 5]

Thus, we have studied the following:

1. Determine the distribution of moisture in the central parts of upper and lower sheets of sidewalls N1 and N2 of mature "Lori" cheeses after removing the compacting layers.

2. Compare the average hardness data on the central part from the edges in width and in length of the central part of the upper and lower sheets of sidewalls N1 and N2.

3. Study the moisture content at the edges in length in the upper and lower sheets of the middle layer.

Research methodology of the first method. Experimental research was carried out by standard and generally accepted methods according to GOST. Determination of the content of nitrogenous substances in cheese "Lori" by the Kjeldahl method GOST 23327 in 1978 at Ashotsk cheese factory of Ghukasyan region of the Republic of Armenia. We determined the moisture content in the cheese by express method (GOST 3625-75g.), and the hardness of the cheese – by a specially designed and manufactured device.

Research results. In order to identify the effect of double-sided pressing on the quality of cheeses, we also compared the moisture content between the upper and lower edges of the upper and lower sheets of the middle layer of the same (1 cheese head of each) mature experimental and control cheeses (without the upper, lower and side compacting layers).

1. The moisture content in the cheese mass of the upper and lower sheets of the middle layer of mature "Lori" cheeses is given in table 1, which indicates that with double-sided pressing, the moisture content averages 43% and 42.7%, and in the control ones - 42.63% and 42.57% respectively, i.e. almost equalizes after removing the compacting layer formed during self-pressing, which once again confirms the uselessness of re-pressings and napkins during double-sided pressing.

Based on the study results, it was found that the difference in distribution of moisture at the edges in width of the head of the middle layer of the experimental cheese mass (without compacting layers), the upper sheet of the sidewall N1 of the upper edge on average is 43.2%, of the lower edge - 42.9% (43, 2 - 42.9 = 0.3%), the sidewall N2 of the upper edge is 42.7%, 42.3% (42.7 - 42.3 = 0.4%). Accordingly, the sidewall N1 of the upper sheet of the central part is on average 42.9%, of the lower sheet - 43.2%, i.e. in the upper sheet the difference is 43.2 - 42.3 = 0.9%, the sidewall N2 is 43.2 - 42.9 = 0.3% respectively. Thus, the difference in moisture between the edges is almost the same (0.3%, 0.4%), which compared to the central part of 0.3% is also insignificant.

In the control cheese, respectively, the upper edge averages 42.4%, the lower edge 41.8%, compared with the central parts of the sidewall N1 - 43.4%, sidewall N2 - 43.4%.

43,4 – 42,4=1,0%, 43,4-41,8=1,6%, 1,6 -1%=0,6%.

2. The study showed that the distribution of moisture on the edges of the upper sidewall N1, the lower sidewall N2 in the control cheese compared with the central part (0.6%) at the corresponding points, the difference and variations are insignificant.

We also researched the moisture content in the central part of the middle layer of the experimental cheese head in width of the sidewall N1 (upper sheet) at points 10; 11; 12 and sidewall N2 (lower sheet) 12; 11; 10, which respectively amounted to 42.9%; 43.2%; 42.8% (on average 42.9%) and 42.9%; 43.7%; 43.1% (on average 43.2%), and at the corresponding points of the middle layer of the control cheese was on the sidewall N1 - 43.6%; 43.2%; 43.4% (on average 43.4%) and sidewalls N2 - 43.7%; 43.5%; 43.1% (on average 43.4%). (Table 1)

It can also be seen that the distribution of moisture along the length from the edges of the experimental cheese (left, right) to the central part increases, but slightly above the central part: the sidewall N1 left - 42.9%, central - 43.3%, right - 43.1%, sidewall N2 left - 42.6%, central - 43.0%, right - 42.5%, and for the control cheese, respectively, sidewall N1 left - 42.5%, central - 42.7%, right - 42.5%, sidewall N2 left - 42.6%, central - 43.0%, right - 42.4%. This proves the uselessness of napkin repressing.

Influence if double-sided pressing on moisture content in the cheese mass of the middle layer of mature cheeses "Lori" after removal of compacting layers. In order to identify the effect of double-sided pressing on the quality of cheeses, we also compared the moisture content between the upper and lower edges of the upper and lower sheets of the middle layer of the same (1 cheese head of each) mature experimental and control cheeses (without the upper, lower and side compacting layers).

The moisture content in the cheese mass of the upper and lower sheets of the middle layer of mature cheeses "Lori" is given in table 1, which shows that the use of double-sided pressing provided for the moisture content of average 43% and 42.7%, and in control ones - 42.63% and 42.57% respectively, i.e. almost equalizes after removing the compacting layer formed during self-pressing, which once again confirms the uselessness of repressing and napkins during double-sided pressing.

The moisture content of the upper and lower sheets (sidewall N1) on the edges in width of the middle layer of the experimental and control cheeses is given in Table 1.

Table 1. Moisture content in the upper and lower sheets of the middle layer of the experimental and control mature cheeses "Lori" without compacting layers, %

Point N	Experimental cheese		Control cheese	
	upper sheet sidewall 1	lower sheet sidewall 2	upper sheet sidewall 1	lower sheet sidewall 2
1	2	3	4	5
1.	43,5	42,7	42,4	42,1
2.	43,3	43,1	43,7	40,3
3.	42,8	42,4	41,2	41,6
4.	42,8	42,4	42,8	42,6
5.	43,1	42,9	42,9	43,8
6.	43,1	42,8	43,1	42,2
7.	43,0	42,6	42,7	42,8
8.	43,4	43,2	43,1	43,6
9.	42,9	42,4	42,8	42,6
10.	42,9	43,1	43,2	43,1
11.	43,2	43,7	43,6	43,7
12.	42,8	42,9	43,4	43,5
13.	42,8	42,5	43,2	42,7
14.	43,4	43,5	42,5	43,9
15.	42,6	42,7	42,7	42,3
16.	42,7	42,3	42,3	42,4
17.	43,5	42,9	42,1	43,8
18.	42,5	42,5	42,3	42,8
19.	42,9	42,6	42,1	42,3
20.	43,5	41,9	41,3	40,1
21.	42,4	42,3	41,9	41,8
Average	43,0±	42,7±	42,63±	42,57±
Variations	42,4-43,5 difference 1,1 %	41,9-43,7 difference 1,8 %	41,2-43,7 difference 2,5 %	40,1-43,9 difference 3,8 %

We also researched the moisture content in the central part of the middle layer of the experimental cheese head in width of the sidewall N1 (upper sheet) at points 10; 11; 12 and sidewall N2 (lower sheet) 12; 11; 10, which respectively amounted to 42.9%; 43.2%; 42.8% (on average 42.9%) and 42.9%; 43.7%; 43.1% (on average 43.2%), and at the corresponding points of the middle layer of the control cheese was on the sidewall N1 - 43.6%; 43.2%; 43.4% (on average 43.4%) and sidewalls N2 - 43.7%; 43.5%; 43.1% (on average 43.4%) (Table 1). From the above data it can be seen that the distribution of moisture in the central parts of the middle layer of the experimental cheese without compacting layers compared to the central part of the middle layer of the control cheese (without compacting layers) differs little, i.e. the moisture is distributed in the central parts in the same way (the difference is 0.3-0.5%). It can be noted that multiple repressing leads to conditions of double-sided pressing.

Based on the study results, it was found that the difference in distribution of moisture at the edges in width of the head of the middle layer of the experimental cheese mass (without compacting layers), the upper sheet of the sidewall N1 of the upper edge on average is 43.2%, of the lower edge - 42.9% (43, 2 - 42.9 = 0.3%), the sidewall N2 of the upper edge is 42.7%, 42.3% (42.7 - 42.3 = 0.4%). Accordingly, the sidewall N1 of the upper sheet of the central part is on average 42.9%, of the lower sheet - 43.2%, i.e. in the upper sheet the difference is 43.2 - 42.3 = 0.9%, the sidewall N2 is 43.2 - 42.9 = 0.3% respectively. Thus, the difference in moisture between the edges is almost the same (0.3%, 0.4%), which compared to the central part of 0.3% is also insignificant.

In the control cheese, respectively, the upper edge averages 42.4%, the lower edge 41.8%, compared with the central parts of the sidewall N1 - 43.4%, sidewall N2 - 43.4%.

43,4 – 42,4=1,0%, 43,4-41,8=1,6%, 1,6 -1%=0,6%.

The study showed that in the distribution of moisture at the edges of the upper sheet sidewall N1, the lower sheet sidewall N2 in the control cheese is compared with the central part (0.6%) at the corresponding points, the difference and fluctuations are insignificant.

It can also be seen that the distribution of moisture along the length from the edges of the experimental cheese (left, right) to the central part increases, but slightly above the central part: the sidewall N1 left - 42.9%, central - 43.3%, right - 43.1%, sidewall N2 left - 42.6%, central - 43.0%, right - 42.5%, and for the control cheese, respectively, sidewall N1 left - 42.5%, central - 42.7%, right - 42.5%, sidewall N2 left - 42.6%, central - 43.0%, right - 42.4%. This proves the uselessness of napkin repressing.

Our proposed new method of double-sided pressing contributes to a more uniform distribution of moisture in the cheese mass (low anisotropy) in rectangular cheeses, since the layers of the cheese mass are compacted simultaneously on both sides without overpressing and using napkins.

After maturation of studied “Lori” cheeses, they were tasted. The tasting results showed that all the experimental and control cheeses were of the highest grade. Experimental cheeses of all variants were evaluated with a high score - 93 and 92 points, respectively, due to their good taste and smell, while the control cheeses were rated only 90 and 91 points.

Discussions. For the first time double-sided non-cloth pressing was proposed without repressings, with a decrease in the anisotropy of cheese “Lori” and a reduction in the pressing duration.

1. For the experiment a screw mold for cheese “Lori” and a dynamometer for measuring the pressing force over the cheese mass were designed and manufactured. Later the screw press was reconstructed to a pneumatic one, providing a more accurate perpendicularity of the pneumatic cylinder rod in relation to the surface layer of the cheese head.
2. The optimal mode of double-sided pressing of cheese “Lori” was set.
3. The optimality of the technological modes of the results of rheological and biochemical analyzes has been substantiated.
4. We have studied the distribution of moisture in the central part of the middle layer of the upper and lower sheets of sidewalls N1, N2 of the experimental and control cheeses (without compacting layers) by cutting of 2.5 cm, 1.5 cm from 4 side edges.
5. We have compared the distribution of moisture in the central part of the experimental and control cheeses of the upper and lower sheets of the sidewall N1, N2 of the middle layer.
6. We have compared the distribution of moisture at the edges in width and in length in the central parts of the upper and lower sheets of the sidewall N1, N2 of the middle layer.
7. For the implementation of double-sided presses we have developed schemes of molds for double-sided pressing of cheese “Lori”, which are fully subject to automation, combining the assembly, disassembly of molds, shaping, pressing and extracting of pressed cheese.

Conclusion.

1. Thus, we can conclude that the distribution of hardness in the middle layer of the cheese mass of the experimental cheeses (without re-pressing and napkins, reducing the duration of pressing) is more constant and stable in comparison with the control ones. Therefore, double-sided pressing to some extent reduces the hardness in the cheese mass.
2. It should also be noted that the distribution of moisture and hardness in the cheese mass is irregular, and in order to obtain reliable data when studying the distribution of moisture and hardness in the layers of the cheese head, it is necessary to remove the compacting layers thereto.
3. From the above we can conclude that the reason for the high anisotropy is the more durable compacting layers of the control cheese, which are formed when using napkins and under the influence of re-pressing during self-pressing.

Inference.

1. The study has shown that the distribution of moisture in the upper and lower sheets of the central parts of the middle layer is equalized, i.e. almost the same.
2. Compared with the distribution of moisture at the edges in width with the central parts of the upper and

lower sheets of the sidewall N1, N2 of the middle layer (without the compacting layer) of the experimental and control cheeses, the difference in moisture is insignificant (0,3-0,5%).

3. The reason for the high hardness is the compacting layer formed during self-pressing with re-pressing and the napkins, as well as the duration of self-pressing, is that the lower sheet is pressed 40 minutes more than the upper one according to the technological mode.

4. During double-sided pressing, the shape of the cheeses does not affect their ripening process, but only affects the anisotropy of the cheese mass, i.e. the distribution of moisture and hardness in rectangular cheeses is much more uneven than in round ones. This is due to the fact that when pressing in rectangular cheeses during shifting and displacement of cheese grains under pressure, sidewalls are formed and when they are displaced towards each other, the compaction of the cheese mass increases precisely in the corners and at the edges in width.

5. High hardness and less moisture are noted at the edges and in the corners of the cheese head, formed during shifting and displacement of the sidewalls towards each other under the pressing force.

The proposed method of double-sided pressing eliminates these disadvantages (napkins, re-pressing) as a result of the simultaneous compaction of the upper and lower layers of the cheese mass on both sides. Thinner compaction layers are obtained, which contribute to an intense release of whey and a shorter pressing time. In this case, moisture is retained both in the upper and lower layers, softening the consistency of the cheese mass, as a result of which the eatable parts of the cheese increase.

We also offer two molds for double-sided (stepwise) pressing of large round and rectangular cheeses (the second method) with the possibility of full automation with the combination of the processes of assembling forms, filling grain in a closed form, molding, pressing, disassembling forms, extracting cheese. We study the mechanism for double-sided stepped (step) non-cloth pressing with a smaller amount of pneumatic cylinder.

We herewith introduce a diagram of mold covers for double-sided cheese pressing.

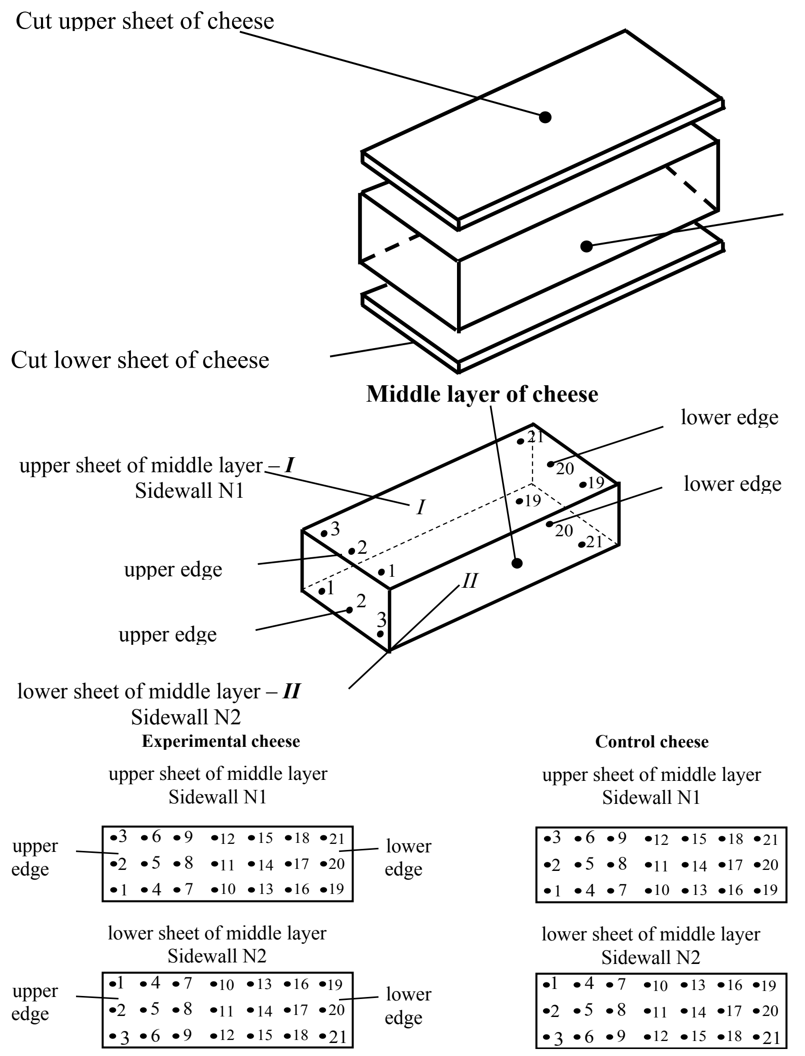
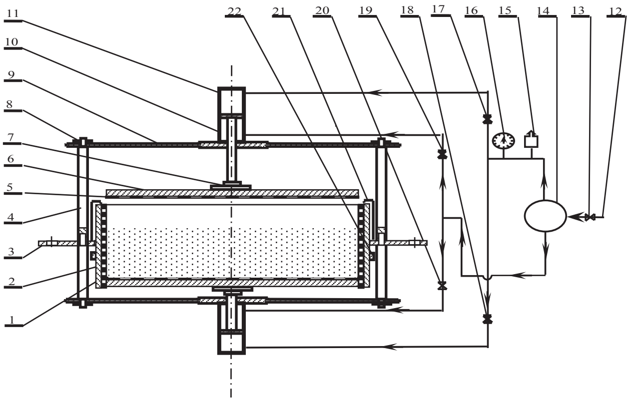
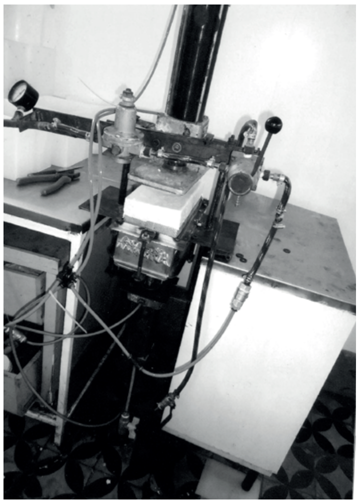


Fig. 1 - Scheme of middle layer of experimental and control cheeses



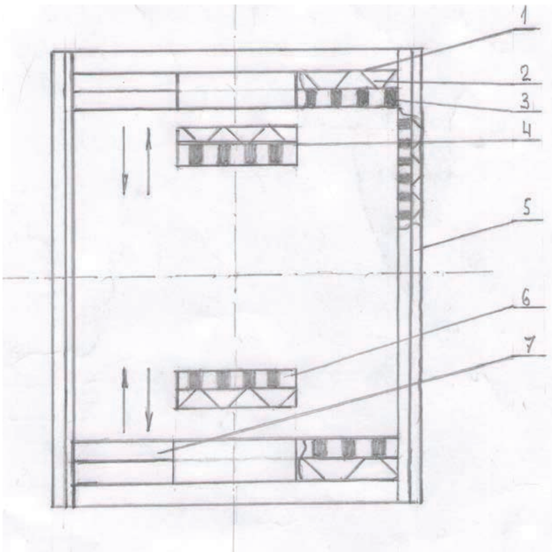
a)

1-body, 2-perforated ferrule, 3-platform, 4-bars, 5-perforated inserts, 6-pressing tiles, 7-upper and lower ball bearings, 8-locking caps, 9-balancing lever, 10-rod, 11-pneumocylinders, 12-main pipe, 13-valves, 14-tap, 15-gear, 16-manometer, 7, 18, 19, 20-valves, 21-lock, 22-rib stiffeners



b)

Fig. 2 (a, b) - Pneumatic mould for double-sided pressing of rectangular small-size cheeses



1-large part of upper cover of mould, 2-corrugated tile, 3-perforated insert, 4-small part of upper cover of mould (automatic valve for pouring the cheese grain into the mould), 5-mould sidewall, 6- small part of lower cover of mould, 7-large part of lower cover of mould.

Fig. 3 - Scheme of mold covers for double-sided cheese pressing.

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