Application of the alveograph device for the development of requirements for the quality of flour for the production of a wafer sheet

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Abstract. Due to the constantly growing demand for flour confectionery and culinary products, it became necessary to develop specialized requirements for the quality of wheat flour as a raw material. To date, there are no such requirements in our country, and for the production of these products, bakery flour obtained according to the traditional wheat grind scheme was used, the quality of which had to be leveled depending on the range of confectionery products. One way to solve this problem is to differentiate the properties of wheat flour according to its intended purpose and their rationing. The purpose of the study is to develop quality requirements for Russian wheat flour for the production of wafer sheets according to objectively and reliably determined indicators of the dough rheological properties using an alveograph device to create, in the future, a system for classifying wheat flour by its intended purpose. Flour quality assessment was carried out using domestic devices and laboratory equipment (MOK system, Falling-number value, etc.): the dough rheological properties were evaluated by an alveograph device (company Chopin, France), wafer sheets were baked and evaluated using methods previously developed by the authors. The analysis of the interdependence of standardized quality indicators, as well as newly developed ones, was conducted to identify indicators that differentiate the quality of wheat flour by its intended purpose, i.e. by finished products. For this, methods of mathematical statistics were applied.

1. Introduction

The lack of requirements for flour for the intended purpose leads to the lack of requirements for grain, which has already led to the lack of growing confectionery wheat - soft-grain, white-grain, etc. – leads to the production of «monoculture» wheat and its properties - hard-grain, red-grain I and IV types.

Wheat flour of various varieties, produced in different countries, is very different in rheological indicators. For example, in water absorption, the formation time during the test on the farinograph in Canadian varieties is higher - 60.7-65.9%, the stability of the test is from 5 to 25 minutes [1]. As you know, this depends on the quantity and quality of protein [2], an increase in protein content [3] increases the absorption of water. In Indo-Pakistani wheat varieties, water absorption ranges from 60-76% [4].

Abroad, the issue of the production of flour, which has the properties that are required by the consumer for the production of its products, is solved at flour mills. It is used for confectionery purposes...
in order to get thin crispy wafer sheets, an air cracker or a delicate biscuit, to choose soft-grained winter red-grain (Soft Red Winter) or white-grain wheat (Soft White Winter).

The production of flour in our country is carried out in accordance with the international standard GOST 9353-2017 «Baking wheat flour. Technical conditions». However, for confectionery from wheat flour, including wafers, it is necessary to identify new properties of flour, other than baking. This will not only provide various industries with flour having necessary quality parameters, but also use the grain resources of our country economically and rationally.

Today, technological recommendations for the quality of raw materials used for the production of wafers practically do not contain requirements for the quality of flour [5-6]. The main requirements for the quality of wheat flour for baking wafer sheets include the following. The flour should be finely ground and belong to the highest or first grade with a moisture content of not more than 14.5%. It must not have signs of rancidity, extraneous taste and smell. The recommended amount of weak gluten is not more than 32% [7-13]. However, in order to correctly assess the quality of wheat flour as a confectionery, especially for the production of wafers, it is necessary to develop not only requirements for the flour itself, but also for the properties of the dough [14-16].

Science has established a connection between the rheology of the test and the quality of the finished product [17]. Evaluation of the rheological properties of the test is fundamental for predicting the quality of a particular product [18]. The dough shows the characteristics associated with the physical and rheological properties when it is subjected to mechanical stress [19], and therefore, the rheological characteristics of the dough can be considered a measure to predict its behavior during processing and food quality control [20].

By developing specifications that reflect the main indicators specific to each particular type of product, it is possible to stabilize the quality of raw materials entering production [21].

In the world, to determine the rheological properties of the test, such devices as a pharyngograph, mixograph, extensograph, mixolab, and reoferometer are widely used [22].

One of the most common instruments for assessing the rheological properties of a test is an alveograph – an instrument of the company Chopin (France). As a result, the use of this particular device in our study to develop requirements that are interconnected with Russian standardized indicators of flour quality is of great practical interest for the prospective development of a domestic system of classifications of flour for its intended purpose.

2. Materials and methods

In this study, 30 wheat flour samples obtained as a result of milling soft wheat (table 1) at an MLU-202 mill from Bühler company (Switzerland) with a flour yield of 70% were used as the research material. Evaluation of the dough rheological properties was carried out using an alveograph device from Chopin (France) according to GOST R 51415-99 (ISO 5530-4-91). From each flour sample, 10 pieces of wafers were baked using a test laboratory baking method [23]. The quality of wafer sheets was evaluated according to the developed methods for assessing the quality of wafers in laboratory test baking [24].

The methodology of work is the following. The selection of the material (wheat flour) of the widest possible range of quality is carried out to cover all the diversity that exists in our country. Further, finished products, in this study - wafer sheets, are made from flour. To identify quality indicators that would allow us to evaluate the suitability of flour for the production of wafers, we compare the qualitative characteristics of raw materials, in this study, of the dough rheological properties according to the alveograph, and finished products (wafer sheets) based on correlation analysis. According to the highest values of the correlation coefficients, the most significant indicators of the flour quality are sampled, ensuring its greatest differentiation by suitability for the production of wafers. Since the dependence of qualitative characteristics often has a normal distribution, a regression analysis is also performed with a graphical one.

In the course of the work, it was taken into account that, in addition to the various properties of different flour samples, many factors can influence the result of measurements performed by the same method, such as, for example, the operator, the equipment used and its calibration, environmental
parameters and time between measurements. In this regard, the experiment was carried out with careful observance of reproducibility conditions in accordance with GOST R ISO 5725-1-2002, authentic international standard ISO 5725-1: 1994. The tests were carried out on the same equipment, under the same environmental conditions, by one operator using the same measuring instruments in a short period of time. In order to comply with the repeatability conditions in accordance with GOST R ISO 5725-1-2002, the same testing was carried out by another researcher.

When conducting research, criteria allowing one to obtain an objective assessment of the quality of flour as soon as possible and at minimal cost were taken into account. This is the use of standard laboratory equipment, the simplicity and accessibility of the method being developed, the use of a minimum of components. At the same time, taking into account the criteria for the indicators and norms validity that reflect the necessary set of properties of raw materials and its differentiation allows one to objectively and reliably assess the quality of flour and its suitability for the manufacture of wafers.

Mathematical processing of experimental data was carried out using descriptive statistics, correlation, regression, and analysis of variance using the Microsoft Excel analysis package.

3. Results

Thanks to the selection of wheat grains with a wide range of qualitative characteristics (table 1), flour of different quality was obtained as well (table 2).

Table 1. Characteristics of the quality of wheat grain (number of samples n = 30)

| Sample code | Indicator value |
|-------------|----------------|
|             | smallest       | largest      | arithmetic mean |
| Mass of 1000 grains, g, d.v. | 23.3           | 33.7         | 29.7           |
| Liter weight, g/l | 679            | 804          | 769            |
| Ash content, % | 1.74           | 2.04         | 1.82           |
| Wet gluten content, % | 19.8          | 31.0         | 23.4           |
| Gluten quality, units IDK | 21            | 76           | 49             |
| Falling-number value, с | 61            | 459          | 282            |

Table 2. Characteristics of the wheat flour quality (number of samples n = 30)

| Sample code | Indicator value |
|-------------|----------------|
|             | smallest       | largest      | arithmetic mean |
| Humidity, % | 11.3           | 14.8         | 12.8           |
| Ash content, % | 0.49          | 1.12         | 0.60           |
| Sieve residue 36/40PA | 0.2           | 1.3          | 0.4            |
| Throughs scalp 45/50PA | 81.0         | 99.3         | 90.6           |
| Wet gluten content, % | 14.0          | 33.4         | 25.7           |
| Dry gluten content, % | 5.2           | 13.0         | 9.9            |
| Gluten quality, units IDK | 27            | 71           | 48             |
| Falling-number value, с | 62            | 591          | 319            |

To identify the influence of one or another indicator of the dough rheological properties on the quality of the wafer sheet, flour samples with different indicators by alveograph were combined into 3 groups according to the shape of the curve. The first group of 4 samples had a P / L curve shape less than 1 (P/L <1). The second group had the shape of a curve of 1 or more, but less than 2 (1≤ P/L <2); the third group - 2 or more (P/L ≥ 2).

The value of the indicator P/L<1 characterizes the dough, in which the extensibility predominates over the elasticity. However, the remaining indicators can have different values. With a gluten content
of 23-24%, the strain energy had a range from 120 to 150 x 10^-4 J, which characterizes the flour as “weak”. With a gluten content of 28%, the value of the strain energy corresponded to a “strong” flour. In accordance with the rheological properties, samples No. 2-16 and 1-16 (gluten content 23.0%) had the largest average diameter D_{av}, equal to 104 and 106 mm, respectively, and flour sample No. 4-16, having the highest gluten content (28.0%) in this sample group (P/L<1) had the smallest wafer diameter equal to 99 mm.

When considering the change in the developed wafer sheet quality indicator as a result of changes in the gluten content and quality, the strain energy of the dough, an alveograph clearly shows a direct dependence on the gluten content and the strain energy. Also, with an increase of gluten content in flour and the strain energy of the dough, the diameter of the wafers decreased.

In group 1 < P/L ≤ 2 selected flour samples had a ratio of elasticity to extensibility of the dough from 1.0 to 1.7. When ranking flour samples in terms of strain energy from lower to higher, it can be seen that along with an increase of strain energy, the gluten content also increases from 20.3 to 30.8%.

However, of more interest was the analysis of the quality of finished products from the position of identifying the most significant indicators of flour quality and rheological properties of the dough in this range. First of all, it should be noted that in contrast to the range in which the ratio of elasticity to extensibility is less than 1 in this range. This reflects the balance of the elastic properties of the dough from the studied flour samples, the average diameter of the wafers from flour samples of different quality did not differ significantly and for 7 out of 12 samples amounted to 98-99 mm. In contrast to the average diameter of wafers, the hardness of wafer sheets had a greater difference for different quality flour samples. Its range was from 0.193 to 0.277 kgf with an average value of less than 220.

An evident direct relation between the dough rheological properties and the quality of wafer sheets was not observed, but a tendency of hardness and wafer sheets average diameter change was found: as the wafer sheets hardness indicator is higher, the smaller becomes its average diameter.

Herewith, the revealed deviations from this tendency make it possible to sort out and reject flour, since these deviations are clearly related to existing flour defects. So, flour sample No (11+12)-16 despite the gluten content of 25% has gluten quality of 60 units. IDC and the falling-number value of 371 s were distinguished by a large average diameter size and low strength property of wafers, which is associated with its extremely low strain energy of 85 x 10-4 J. Sample No (13+14)-16 had the same good gluten content and quality – 25% and 51 IDK.

IDC, respectively, however, had a very low hardness indicator, which, apparently, can be associated with an excessively high falling-number value of 402 s. Table 6 shows that the hardness indicator of sample No. 57-15 is distinguished from a number of data, which is explained by a very low gluten content of 20% in terms of its highest gluten quality out of all other samples – 36 units. Idk. The same applies to flour sample No. 5-16 (21% and 41 units of IDK). Sample No. 273m also showed a low wafer hardness result, which is a consequence of its low falling-number value of 186 s. Thus, all wheat flour samples that had a hardness indicator less than 0.200 kgf had some defects or required quality adjustments. Based on the conducted analysis, it is possible to preliminarily determine the optimal level of hardness of the wafer sheet for wheat flour of 0.200 kgf.

A study of the quality of wafers baked from wheat flour with a predominance of elastic properties over plastic ones in the dough (P/L ≥ 2) indicates that wafer sheets made from such flour have a very high hardness indicator.

By the example of wheat flour samples with an indicator P/L ≥ 2, it is clearly seen that the curve shape indicator is an important limitation in the selection of flour for making wafers. Regardless of the gluten content and quality and other indicators that had a wide range of values in the sampling, at P/L ≥ 2 in 100% of cases wafers had a low quality of top condition.

To confirm the direct dependences of the quality of finished products such as wafer sheets on the quality of wheat flour in the range P/L < 1, a correlation analysis was performed. As it is seen in table 3, wafer (sheets) quality indicators that we developed, namely its average diameter and hardness indicator, as well as the shape of the wafers, had strong dependence on the flour gluten content. At the
same time, an interdependence of the gluten content in the flour and the color of the finished wafers has been also established.

It’s noted that out of the dough rheological properties indicators by an alveograph in the studied range the indicators of maximum positive pressure, characterizing the elasticity of dough, and of strain energy, characterizing the strength of flour, have a direct influence on the wafer sheets hardness. Besides, we found out that the indicator of maximum positive pressure and the elasticity index related to it have an inverse relation with the wafer sheets top condition and color and a direct relation with its taste (Table 4).

Table 3. Correlation of the wheat flour quality with wafer quality indicators in the range P/L<1

| Indicators                      | Wet gluten content, % | Dry gluten content, % | Gluten quality, units IDK | Falling-number value, s |
|---------------------------------|-----------------------|-----------------------|---------------------------|-------------------------|
| Average diameter, D_{av}, mm    | -0.960                | -0.974                | -0.475                    | -0.362                  |
| Mass of 1 sample, g             | -0.015                | -0.063                | 0.510                     | 0.614                   |
| Humidity, %                     | -0.785                | -0.750                | -0.100                    | -0.077                  |
| Hardness, kgf                   | 0.941                 | 0.921                 | 0.495                     | 0.444                   |
| Form, grade                     | 0.977                 | 0.969                 | 0.247                     | 0.160                   |
| Top condition, grade            | -0.400                | -0.361                | -0.741                    | -0.792                  |
| Broken view, grade              | -0.450                | -0.502                | -0.302                    | -0.174                  |
| Color, grade                    | -0.843                | -0.815                | -0.605                    | -0.583                  |
| Taste, grade                    | 0.484                 | 0.432                 | 0.358                     | 0.407                   |
| Texture, grade                  | 0.040                 | -0.018                | -0.186                    | -0.098                  |
| Aggregate organoleptic assessment, grade | -0.198 | -0.243 | -0.672 | -0.600 |

Note - A significant correlation coefficient of 0.811 at a significance level of $\alpha = 0.05$

Table 4. Correlation of the dough rheological properties by an alveograph in the range of P/L<1 with the wafer sheets quality indicators

| Indicators                      | Maximum positive pressure, P, mm | Average abscissa at rupture, L, mm | Inflation index, G | Curve shape indicator, P/L | Strain energy W, $10^4$ J | Elasticity index, % |
|---------------------------------|----------------------------------|------------------------------------|-------------------|---------------------------|---------------------------|---------------------|
| Average diameter, D_{av}, mm    | -0.539                           | -0.280                             | -0.281            | -0.071                    | -0.712                    | -0.431              |
| Mass of 1 sample, g             | 0.645                            | -0.904                             | -0.843            | 0.955                     | 0.185                     | 0.703               |
| Humidity, %                     | -0.879                           | -0.087                             | -0.191            | -0.366                    | -0.985                    | -0.874              |
| Hardness, kgf                   | 0.918                            | -0.058                             | 0.007             | 0.492                     | 0.934                     | 0.865               |
| Form, grade                     | 0.732                            | 0.310                              | 0.365             | 0.140                     | 0.943                     | 0.666               |
| Top condition, grade            | -0.861                           | 0.786                              | 0.730             | -0.980                    | -0.471                    | -0.867              |
| Broken view, grade              | 0.218                            | -0.453                             | -0.365            | 0.420                     | 0.000                     | 0.343               |
| Color, grade                    | -0.976                           | 0.292                              | 0.224             | -0.686                    | -0.866                    | -0.939              |
| Taste, grade                    | 0.946                            | -0.485                             | -0.381            | 0.804                     | 0.739                     | 0.980               |
| Texture, grade                  | 0.611                            | -0.311                             | -0.191            | 0.512                     | 0.492                     | 0.706               |
| Aggregate organoleptic assessment, grade | 0.189 | 0.117 | 0.224 | 0.000 | 0.289 | 0.296 |

Note - A significant correlation coefficient of 0.811 at a significance level of $\alpha = 0.05$

For the range of $1 \leq P/L < 2$ the correlation analysis confirmed an interdependence of the flour gluten content and wafer sheets hardness, texture and taste, flour gluten quality and form, humidity indicator, taste and texture of wafer sheets and finally of the flour falling-number value and the wafer sheets color (Table 5).
At the same time correlation analysis didn’t allow one to detect any significant direct connection between the dough rheological properties by an alveograph and the wafer sheets quality indicators. That is explained by a small range of values of a number of dough rheology indicators on alveograph and let us suggest that there is a curvilinear relation.

**Table 5.** Correlation of wheat flour quality with the wafer sheets quality indicators in the range of \(1 \leq \frac{P}{L} < 2\)

| Indicators                        | Wet gluten content, % | Dry gluten content, % | Gluten quality, units. IDK | Falling-number value, c |
|----------------------------------|-----------------------|-----------------------|-----------------------------|------------------------|
| Average diameter, \(D_{av, mm}\) | -0.231                | -0.268                | -0.047                      | -0.352                 |
| Mass of 1 sample, g              | -0.288                | -0.243                | 0.123                       | 0.405                  |
| Humidity, %                      | 0.378                 | 0.308                 | 0.586                       | 0.164                  |
| Hardness, kgf                    | 0.648                 | 0.661                 | 0.445                       | 0.380                  |
| Form, grade                      | -0.532                | -0.474                | -0.803                      | -0.479                 |
| Top condition, grade             | -0.251                | -0.272                | -0.145                      | 0.206                  |
| Broken view, grade               | 0.258                 | 0.206                 | 0.227                       | 0.172                  |
| Color, grade                     | 0.168                 | 0.101                 | 0.341                       | 0.575                  |
| Smell, grade                     | 0.382                 | 0.392                 | 0.229                       | 0.303                  |
| Taste, grade                     | -0.579                | -0.499                | -0.582                      | -0.420                 |
| Texture, grade                   | -0.640                | -0.592                | -0.804                      | -0.442                 |
| Aggregate organoleptic assessment, grade | -0.480                | -0.460                | -0.575                      | -0.036                 |

Note - A significant correlation coefficient of 0.553 at a significance level of \(\alpha = 0.05\)

Thus, the maximum positive pressure indicator had a wide range – from 55 to 94 mm that allowed one to detect a significant influence of the dough elasticity on the texture of the wafers (Table 6).

**Table 6.** Correlation of the dough rheological properties by an alveograph in the range of \(1 < \frac{P}{L} < 2\) with the wafer sheets quality indicators

| Indicators                        | Maximum positive pressure, \(P, mm\) | Inflation index, \(G\) | Strain energy \(W, x 10^4\) J | Elasticity index, % |
|----------------------------------|-------------------------------------|-----------------------|--------------------------------|---------------------|
| Average diameter, \(D_{av, mm}\) | -0.015                              | -0.134                | -0.141                         | -0.312              |
| Mass of 1 sample, g              | -0.593                              | -0.448                | -0.684                         | -0.614              |
| Humidity, %                      | 0.115                               | 0.303                 | 0.094                          | -0.248              |
| Hardness, kgf                    | 0.282                               | 0.459                 | 0.414                          | 0.360               |
| Form, grade                      | -0.243                              | -0.120                | -0.106                         | 0.083               |
| Top condition, grade             | 0.073                               | -0.253                | -0.077                         | 0.175               |
| Broken view, grade               | -0.227                              | 0.569                 | 0.094                          | -0.201              |
| Color, grade                     | 0.429                               | -0.236                | 0.184                          | 0.390               |
| Smell, grade                     | -0.073                              | 0.496                 | 0.204                          | 0.125               |
| Taste, grade                     | -0.533                              | -0.197                | -0.468                         | -0.448              |
| Texture, grade                   | -0.612                              | -0.009                | -0.351                         | -0.289              |
| Aggregate organoleptic assessment, grade | -0.266                              | -0.099                | -0.161                         | 0.062               |

Note - A significant correlation coefficient of 0.553 at a significance level of \(\alpha = 0.05\)

For the range of \(\frac{P}{L} \geq 2\) we determined that out of the dough rheological properties by an alveograph there is a significant correlation between strain energy and minimum/maximum wafer diameter, and also between the curve shape indicator and the broken view grade (Table 7).

When summarizing the data on the quality of wafer sheets (table 8), it is clearly seen that as the ratio of the dough elasticity to its extensibility increases, the diameter of the finished wafer sheet decreases...
(surface fluidity of dough worsens), the wafer sheet hardness indicator significantly increases, i.e. its important consumer property – fragility – worsens. With a ratio of elasticity to extensibility of more than 2, the quality of wafers briefly deteriorates: an assessment of the top condition is below 3 points.

**Table 7.** Correlation of the dough rheological properties by an alveograph and the wafer sheets quality indicators in the range of P/L ≥ 2

| Indicators                          | Maximum positive pressure, P, mm | Average abscissa at rupture, L, mm | Inflation index, G | Curve shape indicator, P / L | Strain energy W, x10⁴ J | Elasticity index,% |
|-------------------------------------|----------------------------------|-----------------------------------|-------------------|-----------------------------|-------------------------|-------------------|
| Minimum diameter, D_{min}, mm       | -0.708                           | -0.633                            | -0.624            | -0.133                      | -0.774                  | -0.650            |
| Maximum diameter, D_{max}, mm       | -0.703                           | -0.606                            | -0.608            | -0.210                      | -0.737                  | -0.607            |
| Average diameter, D_{av}, mm        | -0.655                           | -0.545                            | -0.526            | -0.282                      | -0.681                  | -0.518            |
| Mass of 1 sample, g                 | -0.184                           | -0.251                            | -0.296            | 0.264                       | -0.028                  | -0.126            |
| Humidity, %                         | -0.490                           | -0.646                            | -0.667            | 0.684                       | -0.425                  | -0.515            |
| Hardness, kgf                       | 0.188                            | 0.036                             | 0.030             | 0.559                       | 0.119                   | 0.014             |
| Form, grade                         | 0.239                            | 0.078                             | 0.091             | 0.575                       | 0.019                   | -0.183            |
| Top condition, grade                | 0.505                            | 0.345                             | 0.329             | 0.503                       | 0.443                   | 0.332             |
| Broken view, grade                  | -0.302                           | -0.479                            | -0.487            | 0.751                       | -0.473                  | -0.597            |
| Color, grade                        | -0.482                           | -0.478                            | -0.508            | 0.018                       | -0.329                  | -0.155            |
| Smell, grade                        | -0.591                           | -0.474                            | -0.490            | -0.237                      | -0.630                  | -0.603            |
| Taste, grade                        | -0.227                           | -0.331                            | -0.354            | 0.410                       | -0.302                  | -0.337            |
| Texture, grade                      | -0.113                           | -0.195                            | -0.214            | 0.271                       | -0.162                  | -0.235            |
| Aggregate organoleptic assessment, grade | -0.266             | -0.432                             | -0.458            | 0.692                       | -0.414                  | -0.507            |

Note - A significant correlation coefficient of 0.710 at a significance level of α = 0.05

**Table 8.** Quality indicators of wafer sheets depending on the range of the curve shape indicator

| Value | Diameter, mm | Mass of 1 sample, g | Humidity, % | Hardness, kgf | the form | top condition | broken view | color | smell | taste | texture | aggregate |
|-------|--------------|---------------------|-------------|---------------|---------|---------------|-------------|------|-------|-------|---------|-----------|
|       | min.  max.   | average             |             |               |         |               |             |      |       |       |         |           |
| Average | 102 104 103 | 4.10                | 4.5         | 0.170         | 3.3     | 3.5           | 4.3         | 4.3  | 5.0   | 4.5   | 3.8     | 28.5      |
| Min.    | 97 100 99   | 4.02                | 4.2         | 0.143         | 3       | 3             | 4           | 3    | 5     | 4     | 3       | 27        |
| Max.    | 105 108 107 | 4.16                | 4.6         | 0.208         | 4       | 5             | 5           | 5    | 5     | 5     | 5       | 30        |
| Average | 97 99 98    | 4.31                | 3.6         | 0.216         | 4.1     | 3.2           | 4.4         | 4.9  | 4.6   | 4.2   | 25.9    |           |
| Min.    | 93 94 94    | 4.15                | 2.2         | 0.193         | 3       | 2             | 4           | 3    | 4     | 3     | 3       | 24        |
| Max.    | 99 102 100  | 4.52                | 5.2         | 0.277         | 5       | 4             | 5           | 5    | 5     | 5     | 5       | 29        |
| Average | 95 97 96    | 4.25                | 4.4         | 0.262         | 3.8     | 2.8           | 4.1         | 3.9  | 4.1   | 3.7   | 22.1    |           |
| Min.    | 90 92 91    | 4.12                | 3.6         | 0.199         | 3       | 2             | 3           | 3    | 3     | 3     | 3       | 18        |
| Max.    | 98 100 99   | 4.34                | 5.6         | 0.381         | 5       | 5             | 5           | 5    | 5     | 5     | 5       | 25        |

4. Discussion

As is known, the method of test laboratory baking of finished products, in our case, wafer sheet, is a direct method for assessing the technological properties of flour by its intended purpose, and therefore - the most objective and complete. However, baking is a long-lasting process, consisting of many operations and requiring a set of laboratory equipment and devices, as well as additional raw materials
in addition to flour. At assessing the quality of production this is not always acceptable, that generates a need for the development of more fast and less time-, material- and labour-consuming methods.

From previously conducted studies [25] it is known that to the greatest degree the baking properties of grain and flour are characterized by the gluten content and quality, the falling-number value, as well as by the dough rheological properties by an alveograph such as the strain energy $W$, the curve shape indicator $P / L$, in addition - the maximum positive pressure $P$ and the average abscissa during rupture $L$. These quality indicators were developed as a result of many years of comprehensive studies conducted in different countries by different scientists. In Russia, they are standardized, that allows them to be used for the development of new target classifications for wheat flour.

Since by assessment objectivity the assessment of the dough rheological properties is the closest to the direct method of baking, after the development of the method of test laboratory baking of wafers (sheet), there were studies carried out to identify the most significant for the finished product quality dough properties by an alveograph device. As is known, the indicators estimated by this device are included in the list of indicators by which the "strength" of bread flour is evaluated worldwide.

One of the main characteristics of wafer sheets in comparison with other types of flour confectionery products is the high plasticity of the dough and its fluidity. The most important indicator of the alveograph, allowing to assess the balance of elastic properties of flour, is the ratio of the elasticity of the dough to its extensibility that characterizes such indicator as the curve shape indicator $P / L$.

Herewith, in the group of $P/L < 1$, the wafer diameter and hardness are influenced most significantly by the gluten content and quality out of all flour quality indicators, and the strain energy out of the dough rheological properties by an alveograph.

The value of the indicator $1 \leq P/L < 2$ characterizes the dough that has the balanced ratio of extensibility and elasticity. In bread baking, the preference is given to flour, which forms a dough with precisely this ratio of elasticity and extensibility. Such a dough is quite plastic and at the same time restores its shape does not spread.

The performed correlation analysis for the range of $1 \leq P/L < 2$ even in a rather narrowed data range due to the limitation by the dough rheological properties, namely, the ratio of the dough elasticity and extensibility, showed a significant dependence of the wafer sheet quality indicators we developed. These are hardness, the average diameter and texture grade, from the flour quality indicators, which are the gluten content and quality, the falling-number value, as well as from a number of indicators of the dough rheological properties by an alveograph.

The value of the indicator $P/L \geq 2$ characterizes the dough that does not have the balanced ratio of extensibility and elasticity. Such dough is characterized by insufficient elasticity; in it, elasticity prevails over plasticity and extensibility. Apparently, such elastic properties of the dough are undesirable for the purpose of obtaining thin wafer sheets. Thus, wheat flour with an alveograph curve shape indicator of more than 2 cannot be recommended for the production of wafers.

5. Conclusion
The conducted study proves the possibility of using existing standardized indicators of the wheat flour quality and the alveograph rheological properties of the dough to create quality requirements for such flour confectionery products as wafer sheets.

Using correlation analysis, the most significant indicators for assessing wafer sheets were identified:
- wheat flour quality: gluten content and quality, falling-number value;
- dough rheological properties: strain energy, curve shape indicator, maximum positive pressure;
- wafer sheets quality: average diameter, hardness indicator, indicators of organoleptic assessment.

The grouping according to the curve shape indicator made it possible to obtain the characteristics of wheat flour that allow one to obtain finished products of standard quality and that correspond to the actual level of grain and wheat flour quality. The recommended range of the curve shape indicator by an alveograph is $1 \leq P L < 2$. For $P/L < 1$, the dough has excessive fluidity; for $P/L \geq 2$, wafer sheets are characterized by excessive hardness.
The obtained quality ranges allow us to continue the work on creating restrictive standards for wheat flour and wheat grain according to a number of their quality indicators, rheological properties of the dough and finished products.

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