The effectiveness of the introduction of new test equipment taking into account the use of the PLP-01M microwave laboratory system

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Abstract. The introduction of the PLP-01M microwave laboratory system introduces a limitation on the number of studies per year, which reduces the capabilities of the measuring device, in cases both for the simultaneously introduced atomic absorption spectrometer "Kvant-2AT" and for the already used atomic absorption spectrometer "Kvant-AFA ". The introduction of the PLP-01M microwave laboratory system will be beneficial if the productivity of the new equipment meets the laboratory's needs in the number of studies. The use of the PLP-01M microwave laboratory system will make it possible to implement one of two options for the pricing policy of the laboratory management: when the estimated price per unit of research is established, the competitiveness in the market for the services provided significantly increases; the establishment of the market price allows increasing revenue by 1.2 times, which will amount to 883 thousand rubles. additional income.

1. Introduction
Ensuring food safety remains an urgent and priority task [1-8]. Assessment of the quality and safety of the developed food products is a prerequisite [9-19]. In the conditions of market relations at any enterprise, including in testing laboratories, the relevance of quality management is determined by its focus on providing such a level of quality of services that can fully satisfy all consumer needs. The lack of updating of measuring instruments, test and auxiliary equipment makes it difficult to ensure a stable quality of services. The processes of updating the laboratory base in modern conditions of the development of scientific and technological progress are objectively necessary [20-26].

The research task is to calculate and analyze the economic efficiency of the introduction of new equipment in the laboratory.

2. Algorithm for the service of the greatest number of requests in the established deadlines
Equipment: microwave laboratory system PLP-01M, devices (Kvant-2AT, Kvant-AFA, Kvant-2AT, Kvant-AFA).

The economic effect of the introduction of new equipment in the ILC is calculated using the formula:
\text{Ent} = PR_2 \times Q_{\text{year}_2} - PR_1 \times Q_{\text{year}_1}, \quad (1)

Where: \( PR_1, PR_2 \) - profit for the implementation of 1 study on the existing equipment and on the newly purchased equipment. \( Q_{\text{year}_1}, Q_{\text{year}_2} \) - annual research volume on existing equipment and on newly purchased equipment.

- Ent "Kvant-2AT" = \( PR \text{ "Kvant-2AT"} \times Q \text{ "Kvant-2AT"} - PR \text{ "Kvant-AFA"} \times Q \text{ "Kvant-AFA"} \);
- Ent "Pan-As" = \( PR \text{ "Pan-As"} \times Q \text{ "Pan-As"} - PR \text{ "KFK-2MP"} \times Q \text{ "KFK-2MP"} \);
- Ent "TA-4" = \( PR \text{ "TA-4"} \times Q \text{ "TA-4"} - PR \text{ "Kvant-AFA"} \times Q \text{ "Kvant-AFA"} \).

3. Results and discussions

The economic effect of the introduction of the "Kvant-2AT" atomic absorption spectrometer will be:

\[ \text{Ent} \text{ "Kvant-2AT"} = 3,633,390.60 - 1,881,541.04 = 1,751,849.56 \text{ rubles.} \]

The economic effect of the introduction of the analyzer "Pan-arsenic" will be:

\[ \text{Ent} \text{ "Pan-As"} = 146,727.00 - 42,137.46 = 104,589.54 \text{ rubles.} \]

The economic effect of introducing the TA-4 voltammetric analyzer will be:

\[ \text{Ent} \text{ "TA-4"} = 701,476.86 - 1,881,541.04 = - 1,180,064.18 \text{ rubles.} \]

The negative value of the indicator of the economic effect of implementation indicates that the introduction of the TA-4 analyzer with a smaller possible volume of research per year than that of the Kvant-AFA atomic absorption spectrometer will not be advisable due to the absence of the need for its performance for performing measurements.

Ent "Kvant-2AT" with PLP-01M (Unit price = 315 rubles) = \( PR \text{ "Kvant-2AT"} \times Q \text{ "Kvant-2AT"} \times \text{PLP-01M} \) - PR "Kvant-AFA" \times Q "Kvant-AFA".

\[ \text{Ent} \text{ "Kvant-2AT"} \text{ with PLP-01M} = 1,456,989.56 - 1,881,541.04 = - 424,551.48 \text{ rubles.} \]

Ent "Kvant-2AT" with PLP-01M (Unit price = 260 rubles) = \( PR \text{ "Kvant-2AT"} \times Q \text{ "Kvant-2AT"} \times \text{PLP-01M} \) - PR "Kvant-AFA" \times Q "Kvant-AFA".

\[ \text{Ent} \text{ "Kvant-2AT"} \text{ with PLP-01M} = 942,185.98 - 1,881,541.04 = - 939,355.06 \text{ rubles.} \]

The economic effect of the implementation of the PLP-01M microwave laboratory system both in the case of a one-time implementation with an atomic absorption spectrometer "Kvant-2AT", and when using existing equipment and working at "Kvant-AFA", as well as variations taking into account the price for one study RUB 315 and 260 rubles, will be negative. The negative value of this indicator is
due to the limited productivity with the use of PLP-01M (16055 tests per year) in relation to the capabilities of the measuring device - 19388 tests per year for the atomic absorption spectrometer "Kvant-AFA". The introduction of the PLP-01M microwave laboratory system will be beneficial if the productivity of the new equipment meets the laboratory's needs in the number of studies.

The use of the PLP-01M microwave laboratory system will reduce the sample preparation time by 19.5 times, and the cost item for "Raw materials and basic materials" during 1 study will be reduced by 2.6 times. In the case of using the PLP-01M microwave laboratory system, the laboratory management may decide to establish a market price for the study of 315 rubles. instead of calculated by the accounting department at 260 rubles. and thus increasing the net annual income from research by 514.8 thousand rubles.

Upgrading the equipment used from "Kvant-AFA" to "Kvant-2AT" with the simultaneous implementation of the PLP-01M microwave laboratory system will allow not only to improve the used measuring instrument, but also the entire sample preparation system as a whole.

The laboratory management may decide to set the price for one study, calculated by the accounting department, - 260 rubles, in order to increase the competitiveness in the market of the services provided. The main technical and economic indicators of the introduction of new equipment are presented in tables 1 and 2.

Table 1. The main technical and economic indicators of the introduction of new equipment.

| Name of articles                  | Calculation from the implementation of research on the following devices, rub. |   |
|-----------------------------------|---------------------------------------------------------------------------------|---|
|                                   | Kvant-2AT                        | TA-4 | "Panarsenic" | KFK-2PM | Kvant-AFA |
| Price according to the list price, rub. | 315                             | 350  | 350         | 390     | 315       |
| Number of studies per year, nat. units | 32960                           | 9694 | 8078        | 6463    | 19388     |
| Cost per year, rubles             | 4110594.51                      | 2178041.24 | 2565925.05 | 2440533.02 | 2856597.98 |
| Annual revenue, rubles            | 10382400.00                     | 3392900.00 | 2827300.00 | 2520570.00 | 6107220.00 |
| Annual profit, rub.               | 6271805.49                      | 1214858.76 | 261374.95  | 80036.98  | 3250622.02 |
| Total costs, taking into account capital costs for the introduction of new equipment, rubles | 5532094.51                      | 2340141.24 | 2674825.05 | –        | –         |
| Capital investments for the introduction of new equipment, rubles | 1421500                         | 162100 | 108900     | –        | –         |
| Annual net profit, rubles         | 3633390.60                      | 701476.86  | 146727.00  | 42137.46  | 1881541.04 |
| Profitability, %                  | 25                              | 25        | 25         | 25       | 25        |
| Payback period, g                 | 0.88                            | 1.93      | 10.23      | –        | –         |
| Break-even point, number of studies | 29073                          | 18673   | 82668      | –        | –         |
| Economic effect of the introduction of new equipment, rubles | 1751849.56                      | -1180064.18 | 104589.54 | –        | –         |

As a result of the analysis of the main technical and economic indicators, it was found that with the introduction of the Kvant-2AT atomic absorption spectrometer, an increase in the annual volume of measurements from 19 388 studies to 32 960 studies is possible, the revenue will amount to 10.3824 million rubles, the net profit will increase 1.93 times and will amount to 3.633 million rubles, the economic effect of the introduction of the device will be 1.75 million rubles.
With the introduction of the Pan-arsenic analyzer, it is possible to increase the annual volume of measurements from 6,463 studies to 8,078 studies, the revenue will amount to 2.827 million rubles, the net profit will increase 3.48 times and amount to 146.727 thousand rubles, economical the effect of the introduction of the device will be 104.589 thousand rubles. Reducing the cost of research with the introduction of the analyzer "Pan-arsenic" will have a favorable effect on the competitiveness of the ILC.

The introduction of the TA-4 voltammetric analyzer will make it possible to carry out 9,694 studies per year, the revenue will amount to 3,3929 million rubles, and the net profit will amount to 701,476 thousand rubles.

Table 2. The main technical and economic indicators of the introduction of new equipment, taking into account the use of the PLP-01M microwave laboratory system.

| Name of articles                        | Calculation from the implementation of research on the following devices, rub. |
|-----------------------------------------|--------------------------------------------------------------------------------|
|                                        | Kvant-2AT                      | Kvant-AFA                 | Kvant-2AT | Kvant-AFA |
| List price. rub.                        | 315                            | 315                       | 260       | 260       |
| Number of studies per year, nat. units | 16055                          | 16055                     | 16055     | 16055     |
| Cost per year, rubles                   | 2538923.53                     | 2228795.36                | 2538923.53| 2228795.36|
| Revenue for the year, rubles            | 5057325.00                     | 4174300.00                | 4174300.00| 4174300.00|
| Annual profit, rub.                     | 2518401.47                     | 1635376.47                | 1945504.64| 1945504.64|
| Total costs, taking into account capital costs for the introduction of new equipment, rubles | 4456713.53                     | 2725085.36                | 2725085.36| 2725085.36|
| Capital investments for the introduction of new equipment, rubles | 1917790                        | 496290                    | 1917790   | 496290    |
| Annual net profit, rub.                 | 1456989.56                     | 1637794.28                | 942185.98 | 1122990.70|
| Profitability. %                        | 25                             | 25                       | 25        | 25        |
| Payback period, g                       | 1.77                           | 0.96                      | 2.73      | 1.40      |
| Breakeven point. number of studies      | 28412                          | 15468                     | 43753     | 22488     |
| Economic effect of the introduction of new equipment, rubles | -424551.48                     | -243746.76                | -939355.06| -758550.34|

The introduction of the PLP-01M microwave laboratory system will make it possible to carry out 16,055 tests per year, with a revenue of 5.057 million rubles. If the market price for research is established, the net profit for a one-time implementation of the Kvant-2AT atomic absorption spectrometer will amount to 1.457 million rubles, while operating on the existing equipment of Kvant-AFA - 1.638 million rubles. If the price for research, calculated by the accounting department, is established, the net profit for the simultaneous implementation of the Kvant-2AT atomic absorption spectrometer will amount to RUB 942.186 thousand, while operating on the existing Kvant-AFA equipment - RUB 1.123 million.

4. Conclusion
It was found that the replacement of the photoelectric concentration colorimeter "KFK-2MP" with the analyzer "Pan-arsenic" in the analysis of samples of food products and food raw materials for arsenic content will be effective.

The introduction of the PLP-01M microwave laboratory system introduces a limitation on the number of studies per year, which reduces the capabilities of the measuring device, in cases both for the simultaneously introduced atomic absorption spectrometer "Kvant-2AT" and for the already used
atomic absorption spectrometer "Kvant-AFA". The introduction of the PLP-01M microwave laboratory system will be beneficial if the productivity of the new equipment meets the laboratory's needs in the number of studies.

The use of the PLP-01M microwave laboratory system will make it possible to implement one of two options for the pricing policy of the laboratory management: when the estimated price per unit of research is established, the competitiveness in the market for the services provided significantly increases; the establishment of the market price allows increasing revenue by 1.2 times, which will amount to 883 thousand rubles. additional income.

Reducing the time spent on preparing a sample for analysis by 19.5 times, as well as cost items for raw materials and basic materials by 2.6 times, is a weighty argument in favor of introducing the PLP-01M microwave laboratory system.

Upgrading the equipment used from Kvant-AFA to Kvant-2AT with the simultaneous introduction of the PLP-01M microwave laboratory system will not only improve the used measuring instrument, but also the entire sample preparation system as a whole.

References
[1] Anichkina O, Tatochenko A, Tatochenko I and Chernegov N 2019 Development strategy of agricultural enterprises in the production of high-tech products IOP Conference Series Earth and Environmental Science 403 012133
[2] Akhmetova S, Suleimenova M and Rebezov M 2019 Mechanism of an improvement of business processes management system for food production: case of meat products enterprise Entrepreneurship and Sustainability Issues 7(2) 1015-35 DOI 10.9770/jesi.2019.7.2(16)
[3] Kuramshina N, Rebezov M, Kuramshin E, Krasnogorskaya N, Tretyak L, Somova Yu, Dolmatova I, Zaitseva T, Grigoryeva I and Bakirova L 2018 Heavy Metals Contamination of Soil in Urban Areas of Southern Ural Region of Russia International Journal of Engineering and Technology (UAE) 7(4.42) 14-8 DOI: 10.14419/ij.et.v7i4.42.25536
[4] Kuramshina N, Rebezov M, Kuramshin E, Tretyak L, Topuria G, Kulikov D, Evtushenko A, Harlap S and Okuskhanova E 2019 Heavy metals content in meat and milk of Orenburg region of Russia International Journal of Pharmaceutical Research 11(1) 1301-05 DOI: 10.21668/health.risk/2019.2.04.ENG
[5] Rebezov M, Shariati M, Bogonosova I, Sepiashvili E and Ryskina E 2020 IOP Conf. Series: Earth and Environmental Science 613 012123 doi:10.1088/1755-1315/613/1/012123
[6] Imran M et al. 2020 Lycopene as a Natural Antioxidant Used to Prevent Human Health Disorders Antioxidants 9(8) 706 doi:10.3390/antiox9080706
[7] Rebezov M, Naumova N, Lukin A, Alkhamova G and Khayrullin M 2011 Food behavior of consumers (for example, Chelyabinsk) Voprosy Pitaniia 80(6) 23-26
[8] Ahsan S et al. 2020 Safety assessment of milk and indigenous milk products from different areas of Faisalabad J Microbiol Biotech Food Sci 9(6) 1197-203 DOI: 10.15414/jmbfs.2020.9.6.1197-1203
[9] Temerbayeva M et al. 2018 Development of Yoghurt from Combination of Goat and Cow Milk Annual Research & Review in Biology 23(6) 1–7 DOI: 10.9734/arrb/2018/38800
[10] Temerbayeva M et al. 2018 Technology of Sour Milk Product For Elderly Nutrition Research Journal of Pharmaceutical, Biological and Chemical Sciences 9(1) 291–5
[11] Serikova A, Smolnikova F, Rebezov M, Okushkanova E, Temerbayeva M, Gorelik O, Kharlap S, Baitukanova Sh, Baitukanova S and Tumbasova Y 2018 Development Of Technology Of Fermented Milk Drink With Immune Stimulating Properties Research Journal of Pharmaceutical, Biological and Chemical Sciences 9(4) 495–500 WOS:000438848100062
[12] Smolnikova F, RebezovM, Shaydullin R, Knysy I, Yudina O, Nikolaeva N, Sorokin A, Zubtsova Yu and Kozlov V 2020 Vegetable stabilizers used in the production of fermented milk drinks and yogurts International Journal of Psychosocial Rehabilitation 24(6) 7663-7 DOI: 10.37200/ijpr/v24i6/PR260775
[13] Kassymov S, Rebezov M, Ikonnikova A, Fedin I, Rodionov I, Rukhadze S and Bokuchava O 2020 Using of pumpkin and carrot powder in production of meat cutlets: effect on chemical and sensory properties International Journal of Psychosocial Rehabilitation 24(4) 1663-70 DOI: 10.37200/IJPR/V24I4/PR201274

[14] Gavrilova N, Chernopolskaya N, Molyboga E, Shipkova K, Dolmatova I, Demidova V, Rebezov M, Kuznetsova E and Ponomareva L 2019 Biotechnology application in production of specialized dairy products using probiotic cultures immobilization International Journal of Innovative Technology and Exploring Engineering 8(6) 642-8

[15] Gavrilova N, Chernopolskaya N, Rebezov M, Moisejkina D, Dolmatova I, Mironova I, Peshcherov G, Gorelik O and Derkho M 2019 Advanced Biotechnology of Specialized Fermented Milk Products International Journal of Recent Technology and Engineering 8(2) 2718-22 DOI: 10.35940/ijrte.B3158.078219

[16] Rozhnov E, Kazarskikh A, Shkolnikova M, Tretyak L, Voytsekhovskiy V, Maksimiuk N, Khayrullin M, Rebezov M and Yessimbekov Zh 2019 Investigation of the conditions for the formation of 5-Hydroxymethylfurfural in the production of honey wines and sea-buckthorn wine drinks Research Journal of Pharmacy and Technology 12(7) 3501-6 DOI: 10.5958/0974-360X.2019.00595.X

[17] Chernopolskaya N, Gavrilova N, Rebezov M, Harlap S, Nigmatyanov A, Peshcherov G, Bychkova T, Vlasova K and Karapetyan I 2019 Biotechnology of specialized product for elderly nutrition International Journal of Pharmacy and Advanced Technology 8(4) 40-5 DOI: 10.35940/ijrte.B3158.078219

[18] Chernopolskaya N, Gavrilova N, Rebezov M, Harlap S, Nigmatyanov A, Peshcherov G, Bychkova T, Vlasova K and Karapetyan I 2019 Biotechnology of specialized fermented product for elderly nutrition International Journal of Pharmaceutical Research 11(1) 545-50 DOI: 10.35940/ijrte.B3158.078219

[19] Nesterenko A, Kenijz N, Rebezov M, Omarov R and Shlykov S 2020 Production technology for smoked sausages using protein-fat emulsion International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies 11(12) 1-8 http://DOI.ORG/10.14456/ITJEMAST.2020.226

[20] Rebezov M et al. 2020 Improvement of Laboratory Services When using Sample Preparation in Microwave System International Journal of Current Research and Review 12(16) 29-33 doi:10.31782/IJCRR.2020.12167

[21] Zykova I, Maksimuk N, Rebezov M, Derkho M, Sereda T, Kazhibayeva G, Somova Yu and Zaitseva T 2019 Interaction between heavy metals and microorganisms during wastewater treatment by activated sludge Journal of Engineering and Applied Sciences 14(11) 2139-45

[22] Assenova B, Okushkanova E, Rebezov M, Korzhikeno N, Yessimbekov Zh and Dragoev S 2016 Trace and toxic elements in meat of maral (red deer) grazing in Kazakhstan Research Journal of Pharmaceutical, Biological and Chemical Sciences 7(1) 1425-33

[23] Duysssembaev S, Serikova A, Okushkanova E, Ibragimov N, Bekturova N, Ikimbayeva N, Rebezov Y, Gorelik O and Baybalinova M 2017 Determination of Cs-137 Concentration in Some Environmental Samples around the Semipalatinsk Nuclear Test Site in the Republic of Kazakhstan Annual Research & Review in Biology 15(4) 1-8 DOI: 10.9734/ARRB/2017/35239

[24] Somova Yu, Degodia E, Gladysheva M, Zueva T, Peryatinskiy A, Ilyina O, Valyaeva G, Yaroslavtsev A, Pelageina A and Rebezov M 2018 Sludge deoiling of bottom sediments: laboratory installation for carrying out automated scientific research International Journal of Mechanical Engineering and Technology 9(5) 498–505

[25] Konushkin S V et al. 2020 Study of the physicochemical and biological properties of the new promising Ti–20Nb–13Ta–5Zr alloy for biomedical applications Materials Chemistry and Physics 30 July 2020 123557 doi:10.1016/j.matchemphys.2020.123557
[26] Osintseva D et al. 2017 Ozonation and microwave treatments as new pest management methods for grain crop cleaning and Disinfection *Annual Research & Review in Biology* 20(5) 1-6 DOI: 10.9734/ARRB/2017/37741