

INTERPRETATION OF BACTERIOLOGICAL AND PCR RESULTS IN THE DETECTION OF *SALMONELLA* SPP.

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Abstract: *This literature-based review examines the principles for interpreting bacteriological and PCR results. Differences in the analytical targets, control status, and assessment of discordant findings are summarized.*

Keywords: *Salmonella spp., bacteriology, PCR, result interpretation, internal control.*

Annotatsiya. *Adabiyotlar tahliliga asoslangan ushbu sharhda bakteriologik tekshiruvlar va polimeraza zanjir reaksiyasi (PZR) natijalarini talqin qilish tamoyillari ko'rib chiqiladi. Usullar yordamida aniqlanadigan nishonlar o'rtasidagi farqlar, nazorat ko'rsatkichlarining holati hamda bir-biriga mos kelmaydigan natijalarni baholash yondashuvlari umumlashtiriladi.*

Kalit so'zlar: *Salmonella spp., bakteriologiya, PZR, natijalarni talqin qilish, ichki nazorat.*

Аннотация. *В настоящем обзоре, основанном на анализе литературы, рассматриваются принципы интерпретации результатов бактериологических исследований и полимеразной цепной реакции (ПЦР). Обобщены различия в аналитических мишенях методов, состояние контрольных показателей и подходы к оценке несовпадающих результатов.*

Ключевые слова: *Salmonella spp., бактериология, ПЦР, интерпретация результатов, внутренний контроль.*

Introduction. Correct interpretation of results obtained when testing meat and meat products for *Salmonella* spp. is important for assessing microbiological safety. The meaning of a positive or negative result depends on the detection principle of the method, sample preparation conditions, and correct performance of the test. Results should therefore be evaluated together with the stages that produced them, rather than solely as final outcomes. Bacteriological testing involves growing the microorganism on culture media, isolating a pure culture, and confirming that it belongs to the genus *Salmonella*. The polymerase chain reaction (PCR) detects a DNA sequence specific to *Salmonella*. This distinction is important when comparing results obtained by the two methods. The aim of this work is to synthesize literature on the principles for interpreting bacteriological and PCR results and to describe factors relevant to the assessment of discordant findings.

Materials and Methods. The review materials comprised GOST 31659-2024, scientific publications on PCR detection of *Salmonella* and comparison with culture methods, and FDA guidance on evaluating results [1–4]. The sources were examined through comparative analysis and synthesis of evidence within a narrative literature review. The analysis focused on culture confirmation in bacteriological testing, evaluation of target signals and controls in PCR, and the meaning of positive and negative results. Information on sample preparation, bacterial cell condition, and factors interfering with the reaction was synthesized to explain differences between results. Published evidence was analyzed; no new laboratory results were generated.

Results. Under GOST 31659-2024, the detection of suspect colonies during bacteriological examination provides a basis for further testing. A

final positive result is issued after the recovered culture has been confirmed as belonging to the genus *Salmonella*. The result applies to the amount of sample examined and does not directly indicate the number of bacteria in the product [1]. Thus, observing a suspect colony and confirming *Salmonella* represent different stages of the examination.

PCR results are evaluated using both the *Salmonella*-specific signal and quality controls. An internal amplification control helps identify possible inhibition or failure of the reaction. If no target signal is observed but the internal control fails to meet the acceptance criteria, the result cannot be accepted as a reliable negative. Technical causes should then be investigated and testing repeated according to the assay instructions [2]. Differences between bacteriological and PCR results may also be associated with biological factors. Uyttendaele et al. reported false-negative results in some rapid tests when examining *Salmonella* cells severely injured by cold and freezing [3]. This observation suggests that bacterial cell condition and preparation before testing may affect the outcome. Uneven distribution of bacteria within a product may also produce different results in individual samples. FDA guidance states that a confirmed positive result should not automatically be overturned by a subsequent negative test [4]. A negative result from one sample is therefore insufficient to invalidate an earlier confirmed positive finding.

Discussion. Discordance between the two methods does not immediately establish the superiority of either one. The origin of the samples, preparation conditions, and amounts examined should first be compared. Completion of bacteriological confirmation and the validity of PCR controls should then be assessed. Without this information, attributing the difference solely to a limitation of one method is not justified. When PCR is positive but culture is negative, the distinction

between DNA detection and recovery of a viable culture must be considered. A positive signal from conventional DNA-based PCR does not, by itself, establish bacterial viability. Possible reasons for failure to recover a culture should be examined in relation to sample composition, bacterial cell condition, and growth conditions. Possible contamination with extraneous DNA during PCR should also be investigated. When *Salmonella* is confirmed by culture but PCR is negative, DNA extraction quality, reaction inhibitors, and the characteristics of the selected assay should be examined. The internal control provides useful information but does not fully establish that all sampling and preparation stages were performed correctly. Each possible cause requires supporting evidence. In comparative studies, bacteriological and PCR results should be recorded separately for each sample. Records should also include confirmation status, control results, and the need for repeat testing. Excluding technically invalid outcomes from the negative category and retaining discordant findings with explanatory notes helps support a sound assessment of agreement between methods.

Conclusion. The literature indicates that bacteriological and PCR results should be interpreted together with their detection principles, quality controls, and testing conditions. Bacteriological methods enable recovery and confirmation of viable cultures, whereas PCR detects *Salmonella*-specific DNA. This distinction should be considered when interpreting positive and negative results. When results are discordant, sample preparation, bacterial cell condition, DNA extraction quality, and control validity should be evaluated systematically. Recording positive, negative, and technically invalid results separately supports a sound basis for future comparative studies. Investigating the causes of

discordance can also identify areas for improvement in the testing algorithm.

References

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