Request for an Opinion

Conservation of the Name *Pediococcus acidilactici* with DSM 20284 as the Neotype Strain and Rejection of the Previous Neotype Strain NCDO 1859 (= IFO 3884 = DSM 20333 = ATCC 33314)

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Strain NCDO 1859 (= IFO 3884) was selected as the neotype strain of *Pediococcus acidilactici* by Garvie in 1974 and was confirmed as such on the Approved Lists in 1980. *P. acidilactici* and *Pediococcus pentosaceus* are difficult to separate by using only phenotypic data, and the choice of NCDO 1859 relied on such data. Subsequently, two independent deoxyribonucleic acid (DNA)-DNA homology studies have shown that the DNA of NCDO 1859 has high levels of homology with the DNAs of strains of *P. pentosaceus*, including the type strain (93 to 100%), but low levels of homology (20 to 34%) with authentic strains of *P. acidilactici*. Moreover, the guanine-plus-cytosine content of the DNA of NCDO 1859 is within the range of *P. pentosaceus* guanine-plus-cytosine contents, which are 4 to 5 mol% below the guanine-plus-cytosine contents of strains of *P. acidilactici*. Clearly, at some point, NCDO 1859 was misidentified by using only phenotypic data and should be rejected as the neotype strain of *P. acidilactici*. In addition, I propose that *Pediococcus acidilactici* should be conserved, with DSM 20284 as the neotype strain. This action is not in line with strict application of the International Code of Nomenclature of Bacteria but will ensure the continuity of nomenclature and avoid the confusion which would result from the alterations necessary if the code were followed in this instance.

In 1974, when Garvie (4) discussed the nomenclatural properties of the pediococci, there was still uncertainty about the species status of *Pediococcus acidilactici*. However, strain NCDO 1859 was proposed as the neotype strain because it was received from the Institute of Fermentation, Osaka, Japan, as strain IFO 3884. When the Approved Lists were prepared (10), *P. acidilactici* was included as a species, and NCDO 1859 was retained as the neotype strain, which was unfortunate in view of the deoxyribonucleic acid (DNA)-DNA homology studies which had been published by Back and Stackebrandt (2). This work showed that *P. acidilactici* is a distinct species, and was confirmed by a second independent study (3). Previously, workers had used morphological and physiological characters, and Nakagawa and Kitahara (8) were the first modern workers to define the species and to separate it from *Pediococcus pentosaceus*. These authors found that *P. acidilactici* grew at 50°C and at pH 8.0, while *P. pentosaceus* grew at 42 to 45°C but not at 50°C and at pH 8.2 but not at pH 8.5. Both species fermented maltose and pentoses. Later this was changed; in Bergy's *Manual of Determinative Bacteriology*, Kitahara (6) stated that *P. pentosaceus* ferments maltose while *P. acidilactici* does not. The properties of NCDO 1859 were given by Garvie (4), and additional properties were given by Back (1). The results of these workers agree where they overlap, but Back showed that NCDO 1859 does not grow at 50°C and does grow at pH 8.5. It seems that NCDO 1859 is more thermophilic than other strains of *P. pentosaceus*, as it grows at 45°C. Both Back (1) and Garvie (4) state that NCDO 1859 ferments maltose. Sugar fermentation reactions have been important properties for separation of lactic acid bacteria into species. These reactions show considerable variation between the strains of a single genospecies in every genus, and the significance of the ability of NCDO 1859 to ferment maltose was not apparent until recently. So far, maltose is the one carbohydrate which is consistently fermented by strains of *P. pentosaceus* but not by strains of *P. acidilactici*. Only phenotypic properties were known in 1974, and at some time, on the basis of these characters, NCDO 1859 was placed in the wrong species. It is unfortunate that because of its history this strain was selected by Garvie as the neotype strain. The error in identification, whenever it happened, illustrates the difficulty in separating *P. acidilactici* from *P. pentosaceus* on the basis of physiological properties.

Back and Stackebrandt (2) used their own isolates as reference strains. The DNAs of *P. pentosaceus* type strain DSM 990 and NCDO 1859 showed 100% homology with the DNA of the reference strain of *P. pentosaceus* but 20 and 17% homology, respectively, with the DNA of the reference strain of *P. acidilactici*, strain DSM 20284. Back and Stackebrandt concluded that "the proposed neotype strain of *P. acidilactici* NCDO 1859, however, has been found to be in reality a genuine *P. pentosaceus*." The same conclusion was reached by Dellaglio et al. (3). In this study, strain ATCC 25742 (= Mundt 170-1W) was used as the reference strain of *P. acidilactici*, and this organism showed high levels of DNA homology with strains ATCC 8042 (= P60) and NISL 7113, both of which Nakagawa and Kitahara placed in *P. acidilactici*. Other strains identified by Mundt as *P. acidilactici* and obtained from the American Type Culture Collection as strains ATCC 25740 and ATCC 25743 fell into the same DNA homology group. On the other hand, DNA from NCDO 1859 showed only 34% homology with the DNA of ATCC 25742, but 93% homology with the DNA of *P. pentosaceus* type strain NCDO 990.

The guanine-plus-cytosine contents of the DNAs of *P. acidilactici* and *P. pentosaceus* differ by 4 to 5 mol%. Kitahara (6) gives values of 44 and 38 mol%, respectively, based on the results of Sakaguchi and Mori (9) and Suzuki and Kitahara (11). The results of other workers vary slightly but are generally between 37 and 39 mol% for *P. pentosaceus*. Strain DSM 20336 (= NCDO 990) (T = type strain) has a guanine-plus-cytosine content of 38.6 mol%.

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and DSM 20333 (= NCDO 1859) has a guanine-plus-cytosine content of 39.2 mol%. There can be no doubt that the present neotype strain of \textit{P. acidilactici} (strain NCDO 1859) is in fact a strain of \textit{P. pentosaceus}. Values for the DNA of \textit{P. acidilactici} also show some variation but are in general agreement with the value given in \\textit{Bergey's Manual}. The guanine-plus-cytosine content of the DNA of DSM 20284 is 42.8 mol% (W. Back and N. Weiss, personal communication).

Detailed physiological properties are not given for the strains used by Dellaglio et al. (3) but are given by Back (1) for strain DSM 20284. These properties place this strain in \textit{P. acidilactici} as defined by Nakagawa and Kitahara. Strict interpretation of the International Code of Nomenclature of Bacteria (7) would mean that NCDO 1859 together with all strains of the same species would become \textit{P. acidilactici} and this name, ascribed to Lindner (1887), would predate \textit{P. pentosaceus} (Mees 1934), which would then be lost. Additionally, \textit{P. acidilactici} predates the type species of the genus, \textit{Pediococcus damnosus} (Claussen 1903) (5), and this would then require changing. To make matters worse, the strains then named \textit{P. acidilactici} would no longer possess the properties given for that species by Nakagawa and Kitahara (7).

Chaos and confusion would result. Therefore, application of the rules of the code are unlikely to be acceptable to anyone who was or is concerned with the pediococci. The names \textit{P. pentosaceus} and \textit{P. acidilactici} have been used without ambiguity for two groups of pediococci for many decades, although only recently has it been shown that these groups are distinct genospecies. Essential phenotypic properties of both species are clearly stated, and there is no sensible reason why the nomenclature should not remain. The most satisfactory action is to reject strain NCDO 1859 as the neotype strain of \textit{P. acidilactici} and to conserve \textit{Pediococcus acidilactici}, with strain DSM 20284 as the neotype strain.

**LITERATURE CITED**