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Communication

Construction of ThermoKill Database R8100, an Expanded Version of a Microbial Thermal Death Database Developed on the Basis of Information in Research Papers Published from 1981 to 2000

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Following the former version of the database on the thermal death of microorganisms, ThermoKill Database R9100, we constructed an expanded version, ThermoKill Database R8100. This database includes the thermal death data together with as many as 70 items of experimental conditions described in research papers which appeared in 23 academic journals published worldwide from 1981 to 2000. The novel version contains 7,454 records as data sets, 12,261 *D* values, and 2,038 *z* values. Some statistical data based on the data input in the database are presented. The significance of this novel database in practical use is then discussed.

Key words : Thermal death/Microorganism/Database.

The hazard analysis critical control point (HACCP) system has recently been introduced into the manufacturing of several types of food for the establishment of microbiological safety (U. S. Food and Drug Administration, 2005, http://www.cfsan.fda.gov/~lrd/haccp.html; FoodHACCAP, 2006, http://www.foodhaccp.com). In the heat processing of food, the thermal death of microorganisms should be evaluated precisely as well as predicted reliably. For the latter purpose, the predictive modeling of microbial thermal inactivation has been thought to be effective (Fujikawa, 1997; Jagannath and Tsuchido, 2003). For practical use, predictive modeling software, such as the Food Micromodel and Pathogen Modelling Program, have been developed so far (McClure et al. 1994; Tamplin, M. et al., 2004). Although these are surely attractive tools, there seems to be a gap between theoretical and practical situations. One of the reasons for this is that so many factors including temperature, pH, and water activity in not only in the heating process but also in the processes of growth and recovery processes affect the thermal death of microorganisms. Then, at least at present, rather than predictive modeling, a database of thermal death results may be more useful in food manufacturing. Actually, ComBase (U. S. Department of Agriculture, 2006, http://www.combase.cc), developed by the Western Regional Research Center in the U. S. Department of

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Agriculture, has been opened to the public and is easily accessible through the internet. It also contains data for behaviors of microorganisms other than thermal death.

We also have developed a database on the thermal death of microorganisms (TriBioX Laboratories 2003, http://www.h7.dion.ne.jp/~tbx-tkdb), ThermoKill Database, since 1996 (Nakamura et al., 2000). In this database there are two types: ThermoKill Database R based upon references while ThermoKill Database E is derived from systematically designed experiments. As for the former, in 2003, the first version of ThermoKill Database R9100, which contained data from papers published from 1991 to 2000, was commercialized. Afterwards, we built a new expanded version, which additionally included data from papers published from 1981 to 1990 and minor revisions of the R9100 version. The data were collected from papers published in 23 out of 30 national and international academic journals listed in our previous report (Nakamura et al., 2000). The second step of this project was completed and we report here on the new version, ThermoKill Database R8100.

The database building system in R8100 was similar to that of R9100. The thermal death data and conditions collected from the research papers were input into the system designed by using FileMaker Pro version 7.0 (FileMaker Inc.) on a personal computer (PowerMac G5, Apple Computer Inc. Cupertino, CA, USA). The number of items including data and conditions amounted to 77. From these items any objective data or condition can easily be searched and listed.

The characteristics of R8100 are as follows. Firstly, as compared to R9100, the amount of thermal death data was approximately doubled. It contains 7,454 data record sets, 12,261 *D* values and 2,038 *z* values, while R9100 contained 3,436, 7,202, and 1,470, respectively. Secondly, ThermoKill Database R8100 is equipped with a convenient search system for each item including the reference data of the research paper. The search system offers simple search, group search, and individual search options and the display system shows a table list or a detailed layout style. The user can select either of these. The top page of the web site of ThermoKill Database R8100 is shown

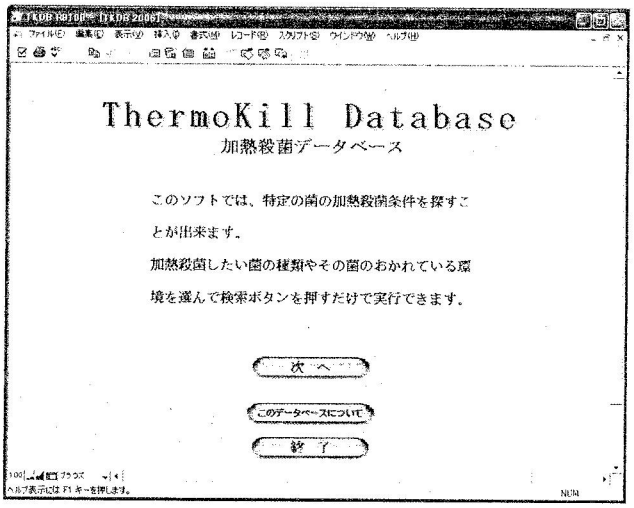

FIG. 1. The top page of the web site of ThermoKill Database R8100.

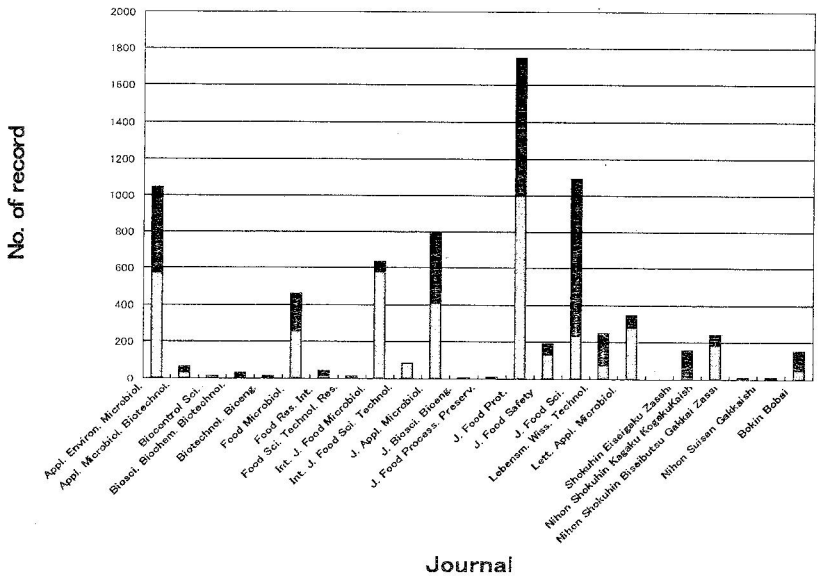

FIG. 2. Histograms of data-set records in terms of the journal from which the data were extracted in ThermoKill Database R8100. The black bar indicates the number of the records obtained from data published from 1981 to 1990 and the gray bar from 1991 to 2000.

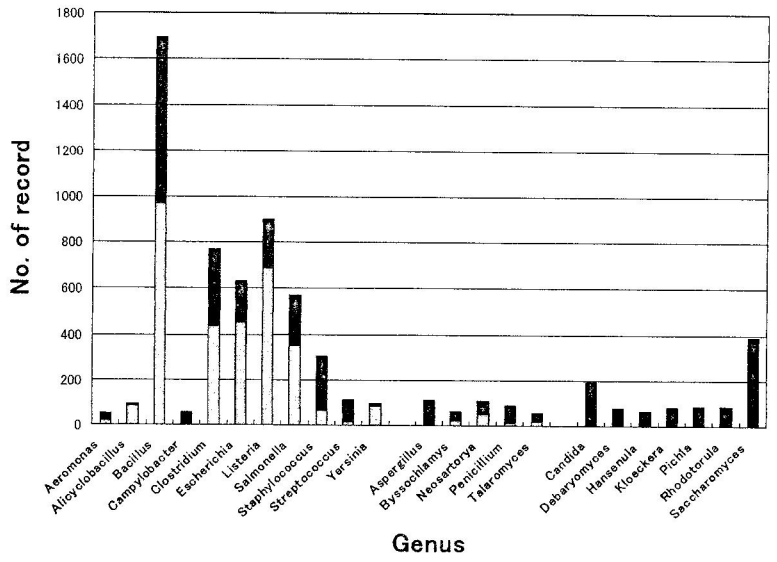

FIG. 3. Histograms of data-set records for major genera of the microorganisms in ThermoKill Database R8100. See the legend to Fig. 2 for explanation about the black and gray bars.

in Fig.1.

Statistical data were obtained from the R8100 database and are depicted in the following figures. Figure 2 shows the histograms of data-set records in terms of the journals from which the data was extracted. The largest data source was the Journal of Food Protection, which is published by the Society for Food Protection in U. S. A. The distribution of the records in terms of the genus of microorganisms in the database is shown in Fig. 3. *Bacillus* was the most abundant genus followed by *Listeria, Clostridium, Escherichia*, and salmonellae. Figure 4 shows the record histograms for the heating menstruum. According to these, although the model systems including growth medium and buffers are most often used, food systems for practical use are also employed in many experiments. Furthermore, the use of the substratum surface for the evaluation of the heat resistance of biofilms and attached microorganisms has increasingly emerged as a recent topic.

It can be expected that ThermoKill Database R8100, which is an expanded version of R9100, will be widely used in the experimental laboratory, in pilot-scale or practical studies on heat processing in food manufacturing. The manufacturer can apply data obtained from the database to the HACCP system. For example, some alteration in the heating conditions or food components needs novel and appropriate data to maintain food safety assurance, and the database may be useful for such a process revision. Of course, it can give a fundamental basis for the predictive modeling of thermal process and conversely

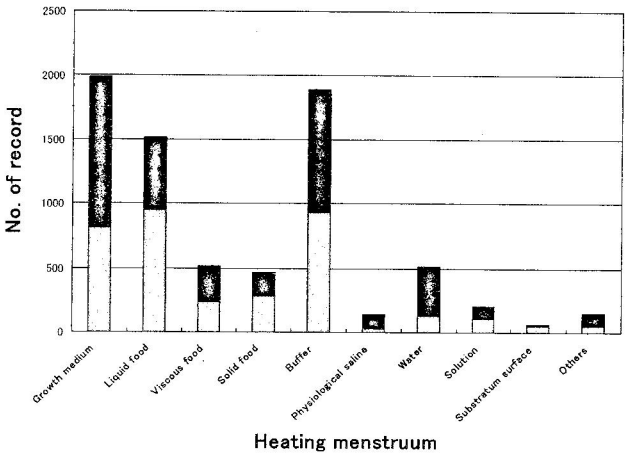

FIG. 4. Histograms of data-set record for the type of heating menstruum in ThermoKill Database R8100. See the legend to Fig. 2 for explanation about the black and gray bars.

be used to compare data predicted from models with the data in ThermoKill Database R8100, like an example reported by Jagannath et al. (2003). Moreover, the education of microbiology in food safety for workers in food manufacturing factories is necessary, and from the viewpoints of heat sterilization and pasteurization this database may be helpful for understanding of how each microorganism is resistant or conversely sensitive to heat. At present, we are continuing to expand of the database to include data from recent papers published after 2001 to further increase its practical potential.

REFERENCES

Fujikawa, H. (1997) Mathematical models for thermal death of microorganisms (in Japanese). *J. Antibact. Antifung. Agents, Jpn.*, **9**, 519-533.

Jagannath, A., Nakamura, I., and Tsuchido, T. (2003) Modelling the combined effect of pH, temperature, and sodium chloride stresses on the thermal inactivation of *Bacillus subtilis* spores in a buffer system. *J. Appl. Microbiol.*, **95**, 135-141.

Jagannath, A., and Tsuchido, T.(2003) Predictive microbiology. A review. *Biocontrol Sci.*, **8**, 1-7 (2003).

McClure, P. J., Blackburn, C. de W., Cole, M. B., Curtis, P. S., Jones, J. E., Legan, J. D., Ogden, I. D., Peck, M. W., Roberts, T. A., Sutherland, J. P., and Walker, S. J. (1994) Modelling the growth, survival and death of microorganisms in foods: the UK Food Micromodel approach. *Int. J. Food Microbiol.*, **23**, 265-275.

Nakamura, I., Yokohara, T., and Tsuchido, T. (2000) Database on microbial thermal death: Its construction design based on data from published papers and from experiments performed under defined conditions. *Biocontrol Sci.*, **5**, 61-64.

Tamplin, M., Baranyi, J., and Paoli, G.: Software programs to increase the utility of predictive microbiology information. In *Modeling Microbial Responses in Food* (McKellar, R. C. and Lu, X., eds.), pp. 233-242. CRC Press.

Tsuchido, T., Abe, T., and Nakamura, I. (2004) A database software of heat sterilization, ThermoKill Database R9100 and its application (in Japanese). *Food Industry (Shokuhin Kogyo)*, **47**, 37-44.