Elucidation of complex mechanisms that control food quality by developing novel measurement and analysis methods

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Many of the existing food manufacturing processes are based on empirical rules, and not many are rationally designed and operated based on a sufficient understanding of phenomena occurring during the process. Drying and rehydration processes are one such example. In previous studies on the mechanism of water transfer in foods, a major problem was the inability to measure water transfer directly and with high accuracy. Therefore, we developed a new method to quantitatively measure the transfer behavior of water by paying attention to the phenomenon that the brightness of food changes depending on the moisture content [1)]. The distribution of the moisture content inside the noodles measured by this method has a very peculiar shape, which is very different from what food scientists have imagined so far. By analyzing these results in detail, we clarified a new water transfer mechanism in foods. In addition, we systematized the effects of processing conditions on quality and built a theory for the rational production of high-quality dried foods [2)].

Foods are made from biological resources, and many complex chemical and physical phenomena occur during the manufacturing process, so it is nearly impossible to quantitatively analyze all phenomena. Therefore, as a novel analysis method for understanding such phenomena, we developed the "AI Comprehensive and Reverse Analysis Method" that reproduces all phenomena in artificial intelligence (AI). The effectiveness of this analytical method was verified using the phenomenon that the structure of gluten inside noodles produces texture as an example. In order to improve the prediction accuracy of AI, it is essential to acquire a large amount of high-quality input data. Therefore, we focused on a method that combines sample transparency and fluorescence measurement. Then, we discovered that sodium salicylate can make foods such as noodles transparent, and developed a method that enables measurement of internal structure of foods at high speed and with high spatial resolution [3)]. As a result, we succeeded in elucidating the three-dimensional structure of gluten for the first time and made it possible for AI to comprehensively learn the correlation between inputting structural images of gluten and outputting food texture values such as hardness of noodles. Then, AI can predict the food texture value of noodles from any gluten structure with high accuracy. Next, by reverse-analyzing the learned AI, we searched for gluten structural regions that were strongly recognized by the AI when predicting the output, and discovered multiple characteristic core gluten structures that are the basis for creating food texture. In this way, by reproducing the target phenomenon in AI, it is possible to predict various qualities of food, including food palatability, from factors such as the type and amount of food ingredients and various conditions at the time of production. As described above, we have paved the way for a comprehensive and academic design of arbitrary quality of food.

References

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