"Nature's Laws in Cheese Making"

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It is interesting but highly unprofitable to try to imagine the origin of cheese. Probably it was the result of an accident. But the development of the art of cheese-making was not an accident but rather the result of thousands of observations over a period of many years. Certain treatments were followed by definite effects and gradually the rules of cheese-making, as we know them now, were evolved. The various changes in the curd which take place during the manufacture of cheese are the result of action of natural laws. But what is a natural law?

If we observe a series of events and their effects, which we have not noticed before, we learn new things. Perhaps these isolated bits of knowledge have certain features in common with each other. If this is true we can summarize this common aspect in a generalization which we call a "law of Nature". Actually the laws of Nature are made by man. Civic laws express commands or duties but natural laws are descriptions of facts.

Laws are valuable because they are short cuts to learning. They summarize the experiences of others. They are concise statements of truths which can be proved by experiments or otherwise.

We may be inclined to question the reason for the existence of a law. In order to do so we often resort to

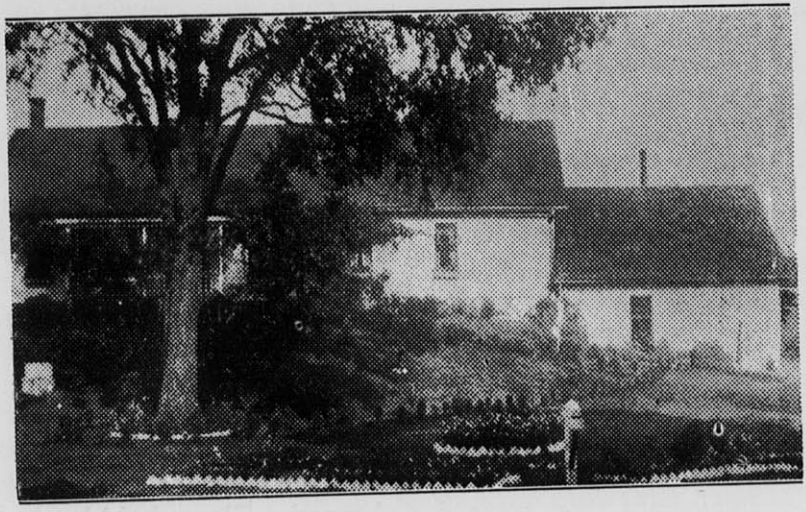
theory. Theories may or may not express facts which may or may not be observed in the future. When a theory has been proved it becomes a law so that a theory is really knowledge in the state of formation. First comes the theory and then the law. Each is essential in the development of systematic knowledge.

We are getting more and more away from the instinctive methods of cheese-making as more of the facts concerning the processes are understood. I would like to speak for a moment about a theory concerned with the manufacture of Swiss cheese that was developed by William Mansfield Clark (Jr. Dairy Science Vol. 1, pages 91-113, 1917) several years ago.

Mr. Clark calls attention to the three main types of holes that develop in Swiss cheese: the small, Nissler type, the large blow holes, and the regular eyes. There are various theories which might account for the formation of these holes. Workers have shown that regardless of their size these holes are formed by gas. The question arises "Why should there be many small holes in some instances, and fewer and larger holes in other cases?"

Could the difference in the size of the holes be explained by assuming that the holes occur where the bacteria are grouped together? If this were true then examination of the cheese with the regular eye formation should show the presence of the bacteria in and around the eyes themselves. Microscopic examination by many careful workers has shown that this is not the case. It is true that the bacteria occur in clumps in the cheese but there is no tendency for these clumps to occur exclusively in the vicinity of the eyes. They are uniformly distributed throughout the cheese.

If these organisms are distributed through the cheese they must produce gas wherever they occur. If this is so then how and why does this gas find its way to the certain spots in the cheese where the eyes are formed? Clark was familiar with certain natural laws which made him believe that the gas which each organism developed,



ADVANCE CHEESE FACTORY IN CLARNO

diffused through the cheese until it encountered a favorable spot for expanding the curd to form a hole. He argued that this would occur for much the same reason that a large soap bubble at one end of a tube grows at the expense of a small bubble at the other end of the tube.

In order to prove to himself that this was so even in the curd where no tubes were visible, he performed an experiment. He took a closed flask in which he had placed a sterile, jelly-like medium, which was suitable for the growth of the gas producing organisms. He suspended a small collodion bag in this medium and placed a culture of the gas producing bacteria in this sack along with some more of the jelly-like medium. Thru the top of the flask he inserted a long glass tube which extended below the surface of the medium but **outside** of the collodion bag. This collodion sack was sufficiently thick to prevent the escape of the bacteria into the medium surrounding it and yet it was not so thick that the gas which these organism produced could not penetrate it. At the beginning of the experiment the medium was allowed to cool slowly until a bubble or two of air could be blown into it thru the long tube without reaching the surface. This was possible because the medium solidified as it cooled and thus trapped the bubbles near the end of the tube where they were first formed. These bubbles remained fixed, therefore, in the gel while the bacteria were growing inside the sack. Gradually the bubbles of air began to increase in size. Although there were no bubbles of gas within the collodion sack, it was evident that bacterial growth caused the development of gas which diffused thru the sack and the intervening gel in order to reach the bubbles which had been made by blowing through the tube. This experiment was successful only when the gas was formed slowly. When the gas production was rapid, many small holes were formed in the flask of solidified medium.

And so Clark was ready to apply his knowledge to

an explanation of the formation of the holes is Swiss cheese. He argued that rapid gas formation should produce many small holes in the cheese and pointed to the work of Freudenreich, who had demonstrated that Nisslers were formed while the cheese were in the press. Slow gas formation on the other hand would result in the formation of fewer and larger eyes and again Clark referred to the work of the eminent bacteriologist Freudenreich who had shown that the largest holes were formed after the cheese was many days removed from the press.

In 1896, an experienced Swiss cheesemaker, named Baechler, expressed the belief that the holes in Swiss formed between particles of curd where whey was trapped in the pressing and which resulted in the formation of small weak spots in the body of the cheese. Clark argued that if this were so then the bubbles of gas in the curd should be formed **outside** of the original particles. To prove this idea he used a clever procedure. He dyed the **outside** of the curd particles red. Then he pointed out that if the holes were formed outside of the curd particles then the eyes should be lined with red walls. And so it was. When the gas holes were of the Nissler type, however, they were formed both inside and outside of the curd particles because some of the holes were lined with the red color while others were colorless. But the slow forming eyes of the Swiss were uniformly colored with the red dye.

And so Clark proved his theory and by the application of this proof we are able to understand something more of the complicated process of Swiss cheesemaking.

This is an outstanding example of the result of careful observations and study of a problem, thru an appreciation of the general application of the laws of Nature. But it doesn't always take a scientist to develop a theory and prove it. Careful observations and thoughtful minds will always be responsible for advances in the art and in the science of cheesemaking regardless of whether the worker finds himself in a laboratory or in a cheese factory.