

VII—In an isothermal decomposition of petroleum hydrocarbons, maximum yields of gas and minimum yields of tar are characteristic of equilibrium compositions.

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THE EFFECT OF THE MINERAL CONTENT OF WATER ON CANNED FOODS

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The quality of canned foods produced by certain factories is always superior to that produced by other factories. To be convinced of this fact it is only necessary to examine the product of a number of factories. It will become apparent that this difference is always present. In general, the character of the products put out by each factory is the same from year to year.

Canned-food brokers, who probably examine more canned food than any other class of people, often remark upon the consistent difference in quality, and frequently raise the question as to why it should exist.

There are, of course, numerous causes which may lead to differences in the quality of canned foods, such as climate conditions, character of the soil, mode of handling the crops, factory management, character of the water used in the process, etc. The climatic conditions and the character of the soil cannot be controlled, whereas the others may be entirely corrected in a scientifically managed factory.

One of the factors which may affect the quality of canned foods is the water used in processing. Water is used extensively in the canning industry for washing, soaking, blanching and making of brines and syrups. The foods are also sterilized in autoclaves in the presence of water and the action of its mineral constituents is probably greater here than at any other step in the process of canning.

With the hope that some important information may be gathered, whereby the quality of canned foods can be improved, we have begun a systematic investigation of the action of various salts occurring in water on canned foods.

Because beans could be canned during the winter months and also because baked beans are canned in far greater quantities than any other class of soaked vegetables, the preliminary investigation was made with beans. Beans were canned with distilled water and with University of Illinois tap water to determine the effect which would be produced by the presence of the salts in the water. The analysis of the University supply is shown in the accompanying table.

The beans canned with the University water were harder than those canned with distilled water and their color was very much darker. This shows that the dissolved salts in the water affect the quality of canned beans. To study the effect of the individual salts,

pure salts dissolved in distilled water were used in experiments.

In canning beans, they are soaked over night, washed, placed in cans and covered with a syrup, the composition of which varies widely. Usually the syrup consists of water, salt, brown sugar and molasses.

IONS	Parts per mil.	HYPOTHETICAL COMBINATIONS	Parts per mil.	Grains per gal.
Potassium, K	2.6	Potassium nitrate, KNO ₃	1.1	0.06
Sodium, Na	29.0	Potassium chloride, KCl	2.9	0.17
Ammonium, NH ₄	2.3	Sodium chloride, NaCl	3.5	0.20
Magnesium, Mg	34.9	Sodium sulfate, Na ₂ SO ₄	3.6	0.21
Calcium, Ca	70.1	Sodium carbonate, Na ₂ CO ₃	60.5	3.52
Iron, Fe	1.0	Ammonium carbonate, (NH ₄) ₂ CO ₃	6.1	0.36
Aluminum, Al	1.3	Magnesium carbonate, MgCO ₃	121.2	7.07
Nitrate, NO ₃	0.7	Calcium carbonate, CaCO ₃	175.2	10.22
Chlorine, Cl	3.5	Iron carbonate, FeCO ₃	2.1	0.12
Sulfate, SO ₄	2.3	Alumina, Al ₂ O ₃	2.5	0.15
Silica, SiO ₂	18.9	Silica, SiO ₂	18.9	1.10
TOTAL.....			397.6	23.18

Many brands are put up with tomato ketchup. In the soaking process the beans absorb a large amount of water, according to their dryness. The beans which were used in these experiments took up very nearly their own weight of water.

The beans were canned in 250 cc. flasks closed with cotton plugs. These containers were found very convenient for experimental work, and the method was found satisfactory. Beans canned simultaneously in the flasks and in regular No. 2 tin cans could not be distinguished from each other. The method of canning was as follows: 50 g. of dry navy beans were completely covered with water in a 250 cc. Florence flask and allowed to soak over night (about 12 hours). The excess water was then poured off and the beans rinsed several times. There were added 50 cc. of syrup, which was prepared as follows: 20 g. brown sugar, 2.5 g. NaCl, 5 cc. New Orleans molasses and water to make 100 cc. The flasks were plugged with cotton and sterilized in an autoclave for 65 minutes at 14 pounds pressure. The only variable in the experiments was the composition of the water which was changed in order that the effect of the soluble salts could be observed.

In the first series we used waters containing quantities of CaCl₂ ranging from 0 (distilled water) to 1000 parts per million, with differences of 100 parts per million between the samples. The results showed in a very striking manner a gradation in the hardness of the beans. The sample which had been processed with the distilled water was very tender and would grade "strictly fancy." Those processed with water containing 100 and with 200 parts per million of CaCl₂ were hard and tough and the criticism would be, "underprocessed." Beans of this character are often found on the market and are graded as "standards." The remaining samples, processed with water containing from 300 to 1000 parts per million of CaCl₂, were extremely hard and practically unmerchantable. The sample processed with 1000 parts per million of CaCl₂ was almost as hard as the uncooked beans. These differences were so marked that the samples could easily be placed in their proper order by one who did not know the quantities of CaCl₂ used. The experiment was repeated several times with the same results.

Three parallel series were then run with waters containing CaCl_2 , MgCl_2 and Na_2CO_3 , respectively. The concentrations again ranged from 0 to 1000 parts per million with differences of 100 parts per million between samples. The results from the CaCl_2 series were the same as in previous experiments. The results from the MgCl_2 series were very similar, although the differences were not so marked. The beans were harder as the concentration of the MgCl_2 increased, and the samples could easily be placed in their proper order by one who did not know the quantities of MgCl_2 used.

The Na_2CO_3 in the water was found to have a softening action. This fact is quite commonly known. No information, however, could be found concerning the concentration which might be advantageously used. The results showed a gradation in softness from the sample processed with distilled water to that processed with water containing 1000 parts per million Na_2CO_3 . The former appeared to have received the proper amount of cooking, while the latter appeared to be greatly overcooked. The time of cooking these samples might have been adjusted so that the product in each case would have been "fancy." As the concentration of Na_2CO_3 increased it was also observed that the beans were darker in color. The use of Na_2CO_3 undoubtedly has some advantages, but this subject needs further investigation.

In order that a careful comparison could be made between effects of substances commonly found in waters, parallel series were run simultaneously, using waters containing CaCl_2 , CaSO_4 , $\text{Ca}(\text{HCO}_3)_2$, MgCl_2 , MgSO_4 , $\text{Mg}(\text{HCO}_3)_2$, Na_2CO_3 and NaHCO_3 . The waters were made up with concentrations of 0, 50, 100, 200, 300, 500 parts per million expressed as CaCO_3 .

The results indicate that the magnesium and calcium salts, when they are present in any of the forms above mentioned, have a hardening effect on the beans; that is, no difference could be detected in beans processed with water containing equivalent concentrations of calcium or magnesium whether a chloride, sulfate or bicarbonate. With bicarbonates of calcium or magnesium the gradation in hardness was not so marked and consistent as with the chlorides or sulfates. This may be due to the fact that calcium bicarbonate and magnesium bicarbonate solutions are unstable, causing the concentration to change during the soaking and heating. No difference could be detected between the beans canned with water containing magnesium salts and those canned with water containing calcium salts, when the quantities of the salts in solution were equivalent. It would seem, therefore, that the effects of the magnesium ion and of the calcium ion are identical.

The beans canned with the water containing Na_2CO_3 and those canned in water containing NaHCO_3 were compared and practically no difference could be detected. The same softening effect was observed in the cases when water containing NaHCO_3 was used as when Na_2CO_3 was used.

The authors expect to continue this work. Experi-

ments will be made with various kinds of beans and other soaked vegetables as well as fresh vegetables, fruits and berries.

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THE USE OF COPPER SULFATE IN THE PURIFICATION OF SWIMMING POOLS

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Within the past two or three years, numerous articles have been written relating to the sanitary conditions of indoor swimming pools. Studies have been made by Dr. William J. Lyster at the University of Pennsylvania, Dr. M. P. Ravenel of the University of Wisconsin, and by various other workers throughout our eastern colleges and universities. One fact is emphasized by all these authorities—that the danger of transmission of zymotic disease through the swimming pool is *real*. It is easy to see how a person suffering with walking typhoid may infect the limited amount of water in the pool and thus transfer the disease to many bathers, who consciously or unconsciously take the water into their mouths. This is but an example. We might carry it further and show how readily diphtheria, cholera, skin diseases, colds, and in fact almost any of our bacterial diseases may be contracted through this medium. It is not my intention to go into the subject of the general care and upkeep of a pool. The *American Physical Education Review* of December, 1912, and February, 1913, has several excellent articles in this connection. The fact is indisputable that, besides such general precautions as preliminary bathing with soap, inspection of the bather, and rejection of dirty bathing suits, etc., some chemical treatment of the water is necessary to safeguard the health of the bathers. What this chemical shall be is the question I shall attempt to answer.

Excellent articles have been written by Dr. Ravenel,¹ Mr. S. C. Markley² and others, recommending hypochlorite of lime as the disinfectant. As a precautionary treatment of public water supplies, there is no doubt that this chemical is without a peer. Innumerable examples could be given to show its efficacy. But it must be borne in mind that in the treatment of a public water supply more than 2 parts per million of "hypochlorite" is seldom necessary. This means about 0.6 part per million of available chlorine. When this maximum amount is used aeration of the water is necessary to remove the disagreeable odor and taste of the "hypochlorite." Now consider the use of this chemical in a swimming pool. Dr. Ravenel found that 1 part per million of available chlorine was necessary to sterilize the water. That means 3 parts per million of the hypochlorite, and as the usual method proposed is to dissolve the salt in the pool directly one can imagine the unpleasant odor and taste of the water. "Aeration" is effected, it is true, but "aera-

¹ Dr. M. P. Ravenel, "The Hygiene of Swimming Pools," *Proceedings of the Sixth Congress of the American School Hygiene Association*.

² S. C. Markley, "The Use of Chloride of Lime in the Purification of Swimming Pools," *American Physical Education Review*, VIII, 2.