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Our Aluminum Cooking Utensils
Shall We Discard Them?

By P. Mabel Nelson, Ph. D., Head of Foods and Nutrition Department

It is just one hundred and two years since aluminum was first produced in powdered form by a German chemist. It was then as great a curiosity as radium is today. When exhibited at the International Exposition in Paris in 1885, as aluminum lugs, it was valued at $30 a pound and attracted much attention. At that time, one of the newspapers in Philadelphia, commenting about this new metal, described it as follows, "The metal is white as silver, does not tarnish and is ductile in the highest degree. It is a good conductor and can be melted and cast in the air,—cold and hot water, nitric acid, heat, sulphuric acid do not act upon it." Should this new metal, which has all the good qualities of silver, is as malleable as gold be brought heated in it. You have likewise observed, probably, that silver would have its day for the purpose of domestic life. Cooking utensils, plates and dishes, spoons and forks, drinking cups, will all be of aluminum.

Today, familiar with aluminum utensils of every size, shape and form, realize that that dream of one hundred years ago has been realized a thousand fold. Our modern aluminum utensils are of two kinds, "the heavier utensils made of cast aluminum, such as are frequently used for preserving kettles and frying pans; and the thinner stamped and spun utensils. The latter, the spun utensils, are formed out of sheet aluminum and then shaped and polished by the method known as spinning. The heavier cast utensils usually contain from about 5 to 7 percent of copper alloy. The lighter, stamped and spun utensils are usually approximately pure. Chemical analyses of a large number of utensils, from different manufacturers, showed that the only impurities contained in vessels of this type vary from .1 to .2 percent of iron, with a very small fraction of a percent of silicon. The extreme purity of aluminum utensils is one point very much in favor of the element, as impurities in a metal increase its tendency to corrosion. It follows from the underlying principles governing corrosion that when it takes place soluble substances are likely to be formed which might contaminate the foods that come in contact with them."

You have observed, probably, if the water you have for cooking purposes is hard, that your aluminum utensil shows darkening after hard water has been heated in it. You have likewise doubtless observed that when some acid containing food such as tomatoes, or rhubarb or pickled beets, are cooked, or stand overnight in the aluminum utensil, that the black coloring disappears and the utensil is left bright and shining once more. The salt used in cooking may, with the dilute acid of the foods, seem to have a more decided effect on the utensil than that of the dilute acid alone. What has happened, and will it be harmful to cut the food which has caused this change in the color of the utensil? One cannot help but wonder and then question the advisability of using the food.

Scientific investigations have been undertaken from time to time to answer these questions. The results of an investigation made in 1912 were published in Lancet, a British medical journal. Aluminum utensils of different makes were heated with acids, and alkalies of known concentration, with acid foods and vegetables of many kinds, then carefully examined for evidence of corrosion and attack on the metal, and for evidence of dissolved aluminum in the food, or the liquid contained in the utensil. The conclusions were, that the "aluminum is no more susceptible to action of water and foods than iron," that there was "no evidence that ordinary cooking operations attacks the aluminum so that an objectionable amount of, soluble salts are formed,"—that "traces of aluminum salts only are found with organic and mineral salts in the cooking pan." Finally, that "any suspicion that it may communicate poisonous qualities to food in the process of cooking may safely be dismissed in view of the practical experiments recorded showing that the metal is not appreciably acted upon in cooking operations."

In our own country, similar tests were made by Dr. Cushman, of the Institute of Industrial Research of Washington, D. C., at the request of Good Housekeeping Institute. The results were first published in Good Housekeeping in 1915 and then republished this past year, 1929, in the September number of the journal, under the title, "The Truth About Aluminum."

Dr. Cushman's findings in brief were as follows: "The attack of half percent acetic acid (vinegar) solutions in distilled water on stamped and spun aluminum utensils during an hour's boiling was found to be very small. It was slightly greater, however, if half a percent of salt was also present, and was about the same if the solution of acetic acid and salt was allowed to stand in a vessel cold for two days. No attack apparent to the eye was observed on the metal surface. The action of these dilute solutions when made with distilled water was greater than when most city waters or well waters were used. Also, these test solutions were of much greater acid strength than is occasioned by any ordinary cooking operations. A one-half percent acetic acid solution such as was used in these tests corresponds to a strength of acid which would be represented by mixing one-fifth of a pint of vinegar in a quart of water."

"The actual loss in weight suffered by the aluminum ware were in these experiments, as the average of a number of separate tests, was equal to about 0.3 of a grain of aluminum per pound of the acid water used, and about 0.35 of a grain per pound of the salted acid water used. The ruling of the Food Inspection Board of the U. S. Department of Agriculture with respect to the allowable quantity of tin salts permitted in canned food products sets a permissible maximum of 300 milligrams of tin salts per kilogram of food contained in the can (2.1 grains per pound of material). In view of the fact, therefore, that aluminum salts are not considered as poisonous as the salts of tin, it can readily be seen that even under the conditions of this test, and with these comparatively extreme acid liquors, the attack upon the aluminum was of such small magnitude that it could not be considered as dangerous or deleterious to health. In addition to this, it is well known that on boiling very dilute solutions of aluminum salts, the insoluble hydroxide is precipitated, which is held by the leading authorities on toxicology to be non-poisonous in its nature. If, however, any considerable quantity of aluminum was taken into solution, this point might be considered as open to debate, as it has been held that aluminum hydrate is redissolved by the hydrochloric of the gastric juice, forming chloride of aluminum, some of which might be absorbed."

"The next test was to determine the effect of dilute alkalies upon aluminum. An alkali is in effect the opposite of an acid principle. That is to say, when an alkaline substance is mixed in the proper proportion with an acid substance, the acidity and alkalinity are both destroyed, and the resulting substance is known as salt. In the same way metals may be acted upon by acids and alkalies; and the resulting substance is a salt. Thus, if acetic acid acts upon aluminum, (Continued on page 6)
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aluminum acetate is formed, and this is, in the chemical sense, a salt. Some metals are vigorously acted upon by acids, but are quite resistant to the attack of alkaline solutions. It is characteristic of aluminum, however, that it resists the attack of most acids more successfully than the attack of alkalies. For this reason it would appear that if any danger or difficulty is to be met with in the use of aluminum for cooking utensils, it would be principally in those cases where non-acid or alkaline liquids or substances were being cooked. The scientific investigations were made in exactly the same manner as those for the acid liquids. A half-percent alkaline solution was made by dissolving about two level teaspoonsful of cooking soda in a quart of water. Upon being boiled for one hour in such a solution, the alkaline liquid showed an attack upon the aluminum metal four times greater than that produced by the acid liquids. This same solution, however, either with or without the addition of half a percent of salt, showed no action at all upon the metal after standing in contact with it for two days in the cold. These results indicate that even with these strong alkaline solutions, the solubility of aluminum is not excessive to the point where any danger in the use of aluminum vessels is indicated. Dr. Cushman then discusses why the aluminum discolors. "Alkaline liquids or substances which are boiled or cooked in aluminum vessels produce a brown discoloration on the surface of the stamped and spun metal, and a greenish black discoloration on the cast ware, which contains copper. This discoloration of aluminum in use with certain waters has long been observed, but the actual reason for this effect has not heretofore been explained. Many water supplies throughout the United States contain lime in solution and are technically known as hard waters. Such waters are always slightly alkaline in reaction, due to the fact that lime itself is an alkaline base. In addition, many rivers and lakes used as city water supplies are slightly alkaline, due to the presence of compounds of soda and potash, which are also strong alkaline bases. It is for this reason that aluminum used for cooking utensils has been found to discolor much more rapidly in certain sections of the country than in others."

Tests were further made to determine if by any possibility copper could be present in the solution used, but not a trace could be detected. The oxide, as well as the hydroxide, of aluminum is blue in color, and it became an interesting subject of scientific investigation to determine the reason for the formation of the black stains which appear when alkaline liquids or substances are being boiled or cooked in aluminum vessels. If such a strong mineral acid as muriatic or hydrochloric acid is allowed to act upon aluminum, it dissolves it very rapidly and leaves a sooty, black encrustation. When chemically analyzed, this black deposit was found to be a compound of aluminum together with iron. Further investigation has shown that only very small quantities of iron are necessary in order to show up a black deposit on aluminum. Aluminum is etched by any attacking medium. It has already been stated that even the spun aluminum ware contains a small percentage of iron as an impurity. In addition to this, many waters contain some iron, so that there appears to be always iron enough present to produce the dark stains when any considerable etching action takes place upon the surface of aluminum. This darkening or stain on the aluminum ware is not shown by the acid liquids, but only when the reaction is slightly alkaline." I wish that the manufacturers of aluminum would find some way of treating their utensils so the iron of the hard water would not cause them to darken on use. My only reason for objecting to aluminum utensils is because of the psychological effect that this darkening of color has on the user. I am confident from the results of the scientific tests quoted that the use of aluminum utensils in home cookery is harmless, but I would be happier if the aluminum utensils were so treated that they would maintain their brightness in spite of the hardness of the cooking water. You recall the old steel knives that stained so badly and that we had to always scour after use. The stainless steel knives of today are such an improvement over the others and such a joy to use, I would like to express equal joy from the use of aluminum. I know I am not alone in my feeling in this matter. Also, I know that when we women want things badly enough we usually get them, so it is up to us, so to speak, to tell the manufacturers of aluminum ware what we want and also what we do not want.

Much of the dispute of earlier years as to the harmfulness of aluminum centered around its intake in the body as an ingredient of baking powders. There is no need for us, today, to review the pros and cons of that old controversy except to note the decision of the U. S. Department of Agriculture Referee Board, of which Dr. Ira Remsen, who was at that time president of Johns Hopkins University, was chairman. This board decided that "Aluminum compounds, when used in the preparation of foods, did not injure the nutritive value of the food nor contribute any poisonous effect which would render the food injurious." This decision was reaffirmed later by Averill of the Federal Trade Commission. Smith, in his recent book, reviews the situation in great detail, then makes this statement, "Despite more than a quarter of a century of research by the opponents of S. A. S. baking powders, the facts remain today as they were then. On the basis of theoretical and general knowledge, certain experts maintain that serious results might follow the consumption of food leavened with baking powders. However, they have brought forth no information or knowledge of any recorded instances in which functional disorders or disease or impairment of the digestion and general health had resulted to any human being, from the food prepared with such powders." The chemical technic for the determination of aluminum in tissues of all kinds has been improved in recent years and as a result reports of new investigations have been published. These recent papers are of more importance to us than the earlier work, which was the result of less uniform methods of investigation and technic.

Dr. Eddy, in a recent paper, "The Metals in Our Food—What They Are—Do We Need Them?" says, "I have recently gone over in detail both the researches prior to the Royal Baking Powder hearing before the Federal Trade Commission in 1916 and new studies made since. Among this new material, I find work by Dr. E. V. McCollum of John Hopkins University, which purports to show that a daily intake of aluminum of 0.06 parts per million in the diet is handled by test animals without any sign of bodily injury. I find, on the other hand, that Schaefler of France reports claims of definite injury to animals with aluminum administered as a Baking Powder. His amounts, however, were definitely larger than those McCollum used. Schwartze of the Mellon Institute, using a soluble aluminum salt, prepared by him, found that animals could eat a certain amount without visible injury. Larger amounts produced damage. Victor Meyer and his co-workers at Western Reserve University have studied intensively, with a new technic, the distribution of aluminum in animal tissues and blood, and the effect of variation in amounts ingested. Their work seems to show that rats fed natural foodstuffs with no baking powder in addition always show some aluminum to be present in such natural foods. When their rats received increased dosage of aluminum, however, the tissues did not show a corresponding increase in stored aluminum. Apparently the excess fed is excreted to a large degree. Failure to store aluminum is, of course, not proof of harmless-
ness, but in one series of tests the diet of rats was actually supplemented with two milligrams of aluminum per day and these rats ran through four generations with no signs of ill health. The persons in a rat's diet represent a higher percentage than would 150 milligrams in our diet. The latter amount, the Renssen Board found without harmful effect in its 1914 studies.\footnote{Continued on page 16}

These newer studies would seem to support the view that in the case of aluminum, as with other metals, copper, calcium and iron, there is a minimum amount that you and I actually need, a certain amount we can swallow with impunity because our machinery knows how to get rid of excess over need, but that there is also an amount that our defense mechanisms are powerless to reduce below the injury point. Quoting again from Dr. Eddy:

"When McCollum says that alum baking powders would have to approach 25 percent of my entire diet to carry me over 600 parts per million, my personal reaction will be that in my use of baking powders in my own house I would never exceed this quantity and hence I may be indifferent to the kind my cook bays. On the other hand, when I am shown that practically all foods contain some aluminum, I can not ignore the possibility that the selection I made of my baking powders might be a determining factor in pushing me over my safe limit."

The effects of aluminum on the human body have been studied by Dr. Frank P. Underhill and his associates in Yale University. They found that aluminum occurs in the blood and tissues of normal animals that are fasting; that it is regularly absorbed into the body in small quantities when taken in food, and that the body apparently takes up only a certain amount, after which it ceases to absorb the aluminum. The aluminum that is absorbed circulates in the blood and is settled in some of the tissues. The excess of aluminum is excreted usually in the bile. In the blood of normal men, aluminum occurs in small quantities in many instances, although it does not occur in all men. It varies from time to time in the blood of the person in whom it occurs and it may be excreted by way of the bladder as well as by way of the bile.

The tissues of persons coming from various parts of the United States were studied and it was found that persons living in some districts have more aluminum in their organs than persons living in other districts. This is, apparently, to be traced to the diet, the water supply, and the type of soil in the district in question.

Another interesting observation of Underhill and his associates was that the amount of aluminum in the body seemed to increase with advancing age. Also, there was no apparent relationship that could be found between hardening of the arteries and the aluminum content of the blood. Aluminum in human beings is, apparently, a normal constituent of the blood.

As a part of this study, many foods were examined for their content of aluminum. Cherries, both Connecticut Sour and California Sweet, and onions were found to contain the largest amounts of aluminum. Lettuce, milk, flour and liver (emf's and pig's liver) were found to contain fairly large quantities, i.e., between one and two milligrams of aluminum per one hundred grams of food substance.

One of the vegetables, string beans, beets, cantaloup, sweet corn, potatoes; and of the fruits, peaches and pears, were found to contain aluminum. Very little aluminum was found in apples, egges, oranges and watermelon. With so many of our foods containing aluminum, it is obvious that a diet containing liberal amounts of fresh fruits and vegetables may contain a significant quantity of aluminum. This may account for the aluminum found at times in the blood of normal men.

Using rats, guinea pigs and rabbits for the test animals, substantial injections of aluminum salts were made to determine the lethal or death producing dosages for each animal. These dosages were fairly large; that is, in comparison with the quantities in which the aluminum is found in the foods and in the human body. With man, an organism much larger in size than the test animals studied, the amount which would constitute an over-dosage would probably be as much larger in proportion, and hence probably far in excess of the amounts which are apt to be ingested with the food. Aluminum, like iron, iodine and copper, apparently is extremely important in body economy in traces, yet may be undesirable in over-large quantities.

More recent than Underhill's report is that of Rose and Catherwood, from the laboratory of Physiological Chemistry of the University of Illinois. They have studied the matter with the intent of answering the question, "Do baking powder residues exert injurious effects upon growth and nutrition?" They have shown that a calcium phosphate-sodium aluminum phosphate baking powder when fed to white rats as a constituent of their diet through two generations, did not indicate deleterious effects. At least, chemical analysis of the blood and histological examination of the kidneys revealed none.

The rats of the second generation were fed twice the quantity of baking powder fed the first generation and made more rapid growth than the rats of the first generation. The doses of aluminum from the phosphate-aluminum baking powder (i.e., 2.5 grams of aluminum) were enormously greater in proportion to weight than could be obtained by the human subject in the use of baking powder alone. The baking powders (for two kinds other than the aluminum containing powder were tried) were used to prepare a bread which had twice and three times the amount of leavening ordinarily used in breadmaking and this was fed to the rats and readily eaten by them.

Rose and Catherwood criticize the findings of Schaeffer and his associates, the French investigators, who claim to have produced deleterious effects in rats by feeding them a sodium aluminum sulfate-calcium acid phosphate baking powder. The Frenchmen used excessive amounts of baking powder in their diets and probably, as Rose and Catherwood say, "even a necessary inorganic dietary component like sodium chloride might inhibit growth if included in a diet at a 15 percent level." Yet, in spite of the excessive doses, the rats in Schaeffer's experiments grew at only somewhat slower rates than the control animals. The control rats were not as carefully controlled as to their diet as they should have been, either, as another variable, bone meal, was added to their diet instead of omitting the aluminum salt, as should have been done. One hesitates to give too much weight to experiments that are not carefully controlled.

In conclusion, let me say that the medical profession assures us that there isn't the slightest scientific evidence that the cooking of food in aluminum utensils is in any way related to the incidence of cancer. There has been malicious propaganda of that type spread about the country. All our cooking utensils, copper, glass, enameled ware, etc., have been accused in their turn of being the cause of cancer.

We all know that cancer has been seemingly on the increase of late years, and because of that fact, many different groups of medical men have set about to discover the cause. These investigators are attacking the problem from several angles and we have every reason to feel confident of their ultimate success. One has only to think of the conquests of yellow fever, malaria, typhoid, tuberculosis, and various other infectious diseases that were the main causes of death in the years past, to be reassured that our fine scientific and medical men will solve this problem also in due time.

Apparently, aluminum kitchen utensils have come to stay. Let us no longer fret our souls because they darken in hard water and brighten with acid.

The story of aluminum and its function in nutrition, is, like the story of the other metals of our foods, not completely nor entirely understood.
you may simply pad it well and get a smooth contour in that way. A few tacks, a large needle and some coarse thread will help hold the padding in place. Don’t overstuff it, but use just enough padding to cover the sharp edges of the wood and fill in the hollows. An old comforter, cut in pieces, is easy to manage and makes a good padding.

You are now ready for your lovely material, your tape line, your scissors. Just one word of warning, make generous allowances for all seams and inlets. After you have cut the pieces for the back, sides, arms and seat, you can turn them wrong side out and pin the seams, fitting the slip cover to the padded chair just as you would fit a dress. After all the seams are pinned, remove from the chair, baste and try on again before stitching. The slip cover should not fit too snugly. A loose cushion in the seat of the chair not only adds to its appearance and comfort, but saves strain on the slip cover and helps keep it in place.

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(Continued from page 7) judge would say, ‘‘the evidence is not all in and therefore a decision cannot be rendered.’’ But for the present it would seem that we may summarize thus:—we ingest more or less of the aluminum compounds in our foods daily, that they are apparently absorbed and also excreted, that in the quantities likely to be ingested in the course of normal nutrition, they are harmless, whereas if ingested in excessive amounts or introduced into the body by injection they may cause disturbances in proportion to the method, dosage and technique employed.

Health and Hygiene

(Continued from page 3) washed twice a day at least and three times, if possible, in the approved way.

Regularity enters into the subject of exercise. What is the good of violent outbursts on the tennis courts at hit-or-miss times, or a hike of five or ten miles with every leg muscle rebelling at the abuse? Although all college girls need exercise, they do not get much good from that kind. Exercises can easily be taken in the morning or at night just before retiring. Every girl needs more exercise than just walking. A habit could be easily formed and would be very beneficial to her.

One of the important items a college girl must consider is her clothes. Are they comfortable and just warm enough? Does she make wise and sudden changes in clothing? The college girl must make her own decisions and try to promote health.

There are habits she must form to protect her health. No girl can have good health if she does not get enough rest. (Too many dates and too many extra curricular activities are bad habits in a sense and college girls must guard against them.)—Harriet Hudson.

After the college girl has started upon this road of good habits she will be glad, because it will make it easier for her in every way. Habits are powerful, so they should be made good habits for health and happiness.

In all science, error предedes the truth and it is better it should go first than last.—Horace Walpole.

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