On the Taste of the Salt of Glutamic Acid

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A new primary taste quality.

There are four well defined taste qualities, viz. sweet, sour, bitter and briny. Besides these, there are such qualities as metallic and alkaline, which are less well defined and over which views are divided whether they are to be regarded as simple taste sensations or not. Be it as it may, there is still another quality, which is quite distinct from all these, and which must be considered primary, because it cannot be produced by any combination of other qualities. An attentive taste will find out something common in the complicated taste of asparagus, tomato, cheese and meat, which is quite peculiar and cannot be classed under any of the above mentioned qualities. It is usually so faint and overshadowed by other stronger tastes, that it is often difficult to recognise it unless the attention is specially directed towards it. Had we nothing sweeter than carrots or milk, our idea of the quality 'sweet' would be just as indistinct as it is the case with this peculiar quality. Just as honey and sugar gave us a clear notion of what 'sweet' is, the salts of glutamic acid are destined to give us an equally definite idea of
this peculiar taste quality. Any one who tastes a solution of sodium glutamate will at once recognize its taste to be different from all other well-known qualities. It will at the same time identify it with that indistinctly perceived peculiar quality which ever recur in the complicated taste combinations of his daily food. For this taste quality the name “glutamic taste” is proposed.

The taste of an ion.

Glutamine acid has two replaceable hydrogen atoms and forms two series of salts. The salts of divalent glutamine acid, in which both hydrogen atoms are replaced, do not concern us here, because most of them are difficultly soluble while salts of alkaline metals are strongly alkaline on account of hydrolysis. On the contrary, the salts of monovalent glutamine acid are mostly readily soluble in water and the alkaline salts are amphoterie in reaction. All these soluble salts present the same glutamine taste as far as it is not affected by the taste of the metallic radicals.

The glutamine taste of these salts are so strong that a minute quantity dissolved in a large volume of water impart to it a perceptible taste. The threshold value for some of these salts has been determined in the following manner. In order to avoid any extraneous suggestion the experiment was blindfolded and a series of dozen or more test tubes with 20 cc. of the solution or of water were handed to him one after another to taste. The liquids were heated to 38° beforehand and about one half of the volume was taken at once to the mouth. He had then to decide whether the liquid contained a glutamate or not. Between each trial the mouth was rinsed abundantly with water warmed to the
same temperature. The water employed was not distilled but ordinary tap-water. This was also used in the preparation of the solutions. The answers given by the experimenters were tabulated, and when a majority of them were correct both in positive and negative senses, the concentration of the solution was deemed to be above the threshold value. In order to avoid the effect of personal idiosyncrasy, my assistant and I took up the role of the experimenters alternately. We did not smoke and I abstained from smoking for some weeks. Our health was excellent. At first there was some difference in our results, but after some exercises it disappeared. Glutamates of sodium, potassium, calcium, magnesium and barium were examined. They gave all identical results. When the concentration was $\frac{1}{2500}$ normal a difference between the solution and water could be distinctly perceived, while at $\frac{1}{5000}$ normal it became uncertain. The threshold value for all these salts is therefore $\frac{1}{2500}$ normal. It must be remarked that the distinctive glutamic quality ceased to be perceived at somewhat greater concentration, perhaps at a few millinormal. Below this it was difficult to decide whether it was sweet or glutamic.

From the fact that all soluble salts of monovalent glutamic acid present even at great dilutions the same glutamic taste, we may safely conclude that this is the taste of the anion $\text{C}_6\text{H}_5\text{NO}_2^-$. This is further confirmed by the identity of the threshold value for different salts and the smallness of its absolute value in comparison to other salts. That the taste of neutral salts must, at least partly, be due to their ions has long been supposed; but in default of exact observations this could not be strictly demonstrated. The bitter taste of the sulphate may be cited as a good example.
This taste is, however, common to so many inorganic salts, that it can not be asserted that the bitter taste is due to the amin S4.

In the case of the glutamic acid, there is no such complicacy, because the taste is of very peculiar quality. As there is no sensitive chemical test known for glutamic acid, the taste is very serviceable for the purpose of detection. Yet it must not be understood that there are no other substances which possess similar taste, because this is quite probable, and many compounds having this particular quality may be found among amino-acids.

A short remark on the taste of glutamic acid itself may be inserted here in this place. Fischer has observed that this acid presents at first a sour, and then a peculiar sweetish taste (eine eigentümlich freudigen Geschmack). By this last expression is probably meant the glutamic taste. My own observation confirms his statement; only the glutamic taste is much more pronounced than the acid. The explanation may be sought in the greater diffusibility of hydrogen ion and its subsequent neutralisation in the tissue, because the concentration of hydrogen ion, which causes the sensation of an acid taste in the first moment, will naturally be much smaller than that of the glutamic ion which comes afterwards.

Occurrence of the salts of glutamic acid in nature.

In Japan and China a large quantity of Laminaria japonica, a sort of a brown sea-weed, is consumed as food. Its dection is much employed to impart an agreeable taste to soups and other articles of food. The taste of this dection is a rather complicated one. It is owing on account of much common salt contained in it, it is sweet, as a large quantity of mannite is present, but what makes it valuable is its strong glutamic taste. In 1907 I undertook to find out
the substance to which this taste is due. For this purpose, several kilograms of the dried sea-weed were extracted with water. The greater part of mannite and sodium chloride was removed by crystallization. The taste imparting substance was retained in the mother liquor. By a few preliminary tests it was soon found out that the substance must be a salt of an organic acid. On adding lead nitrate to the mother liquor a resinous precipitate was obtained, which contained much chloride, some phosphate and sulphate together with the lead salt of the unknown acid. (It is a peculiarity of soluble glutamic acid to form with a lead salt a readily fusible resinous precipitate in the presence of much chloride.) The powdered precipitate was treated with hydrogen sulphide in the presence of water and baryum carbonate. The baryum salt of the unknown acid mixed with chloride was thus obtained in solution. By adding silver sulphate dissolved in a large volume of hot water baryum chloride was completely removed. The unknown acid was liberated by precipitating baryum with sulphurous acid. The solution was then concentrated and left to crystallize; crystals of spherical habit then made their appearance and grew very slowly. By repeating these operations several times about 30 grains of the acid was obtained from about 12 kilograms of the dried sea-weed. The melting point was about 195°. The equivalent weight determined by titration with standard alkali; the molecular weight determined by the chilc-vivere method and the elemental analysis led to the molecular formula C_5 H_9 N_2 O_4. It was then recognized to be glutamic acid. This was confirmed by preparing and analysing the characteristic copper and baryum salts. Various soluble salts were then prepared from the acid obtained from the laminae and from the acid obtained by the hydrolysis of glutin. These were all found to have intense glutamic taste.
By employing an analytical method, which was devised some
time ago, the amount of glutamic acid in one of the best sort of the
Laminaria has been determined and found to amount to about 1% of the dried sea-weed. But its distribution is not uniform through-
out the whole leaf, which reaches several meters in length. The acid
exists in greater concentration near the base and towards the top of the leaf; it is far less. Now it is at the base that the growth
of the leaf takes place and the synthesis or decomposition of proteins
must be here most vigorous. It is therefore not to be wondered,
that glutamic acid, one of the most important proximate components of
proteins, should be found here in a larger quantity than in the other parts of the leaf.

Such a large accumulation of glutamic acid as in
Laminaria japonica will be rare, but that it should be
found in minute quantities in almost every part of plants and
animals, where active metabolism is going on, is but natural.
As the taste imparting power of a glutamic acid is so great, it is to
be expected that the glutamic taste will be found in great many
articles of food, even where analytical chemistry can not
"demonstrate its existence.

A new flavoring substance.

Of the existence of the specific taste quality, which we have
been considering, I was long convinced, and I was of the opinion
that a pure flavoring substance should be provided for satisfying
the natural demand for it. The investigation on the essential constitu-
tions of Laminaria japonica was undertaken expressly for this purpose.
As the substance sought turned out to be so easily accessible,
my object was attained without much further trouble. Of
all the glutamates of non-poisonous metallic salts the-
sodium salt alone was found to combine all the properties

essential or desirable in an article of daily consumption. This is a white salt with one molecule of water of crystallization, readily soluble in water, yet perfectly non-lucent. As its solubility varies greatly with temperature, it can be easily purified by recrystallization. When pure it is perfectly odorless. It is not hygroscopic and can be kept indefinitely. It has certainly some nutritive value, but as glutamic acid is supplied to the system by the digestive product of vegetable proteins, its value in this respect should not be overrated. Its flavoring power is so great that two or three grams dissolved in one liter of water impart to it a very agreeable taste. It is especially palatable in combination with common salt. Thus we see that sodium glutamate is an almost ideal flavoring substance for the glutamic taste.

Impure flavoring substances for the glutamic taste were known of old. In this country, besides Lentinaria japonica, canned and prepared fishes were used for this purpose from ancient times. In Europe and America Liebig's meat-extract and allied preparations are essentially flavorings of the same category. The Japanese soy, which is now much consumed in the oastern world, owes its value partly to the glutamate contained in it.

How it is that certain taste qualities cause pleasant sensations while others are disagreeable to us, is an exceedingly interesting problem, to which we can at present give only proinute teleological answers. Taste sensation must have been developed as a guide in choice of food. Hence, agreeable taste must be such as accompany nutritious substances of natural origin occurrence, while disagreeable taste must go hand in hand with harmful substances. The latter is exemplified in the repugnance felt towards the bitter taste, which warn us
against poisonous plants. Why being sweet in moderate intensity is agreeable can be explained by the natural demand for sodium chloride, continual loss of which from the blood must be promptly compensated; sweet taste is agreeable because sugars are not only in themselves nutritious, but usually accompanying nourishment of vegetable origin. The reason why we find glutamic taste so pleasant must be sought in the fact that glutamates are often present in nutritive quantities in nutritious matter of albuminous nature, and mostly of animal origin. Since, the appetite for these three taste qualities are quite normal. Since many generations, pure salt and pure sugar are the flavoring substances for the two qualities, and in the future a pure glutamic must from the principal flavoring substance for the third.

Chemical industry of the decomposition products of albuminous matters.*

From the foregoing, it is probable that the manufacture of the glutamates will develop to a great industry in the future. Synthetical processes of making are of course conceivable, but industrially it must be obtained from the hydrolytic products of proteins. Since three years Mr. Sukeno, a chemical manufacturer in Tokyo, is producing sodium glutamate under the trade name of Aji-no-moto, a product or quintessence of flavor. At present yearly output is about 25 tons, but it is steadily increasing.

The manufacture of the glutamates will doubtless inaugurate a new branch of chemical industry, that of the decomposition products of albuminous matters. The scientific foundation has

* A process of making flavoring matter consisting essentially of glutamates, and processes of working up hydrolytic products of proteins, invented by me, have been patented in several countries.
been laid by a series of the eminent German and American chemists, but there are still much to be done both by scientists and manufacturers. The utilisation of the components other than the glutamic is a very interesting problem and full of possibilities. The recent researches on nutrition by the physiological chemists are specially suggestive in this respect. It is, however, not my object to work out the programme in this place, but to call the attention of my colleagues to a promising new branch of chemical industry.