

XXX. THE EFFECT OF HALOGEN SALTS ON SALIVARY DIGESTION.

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THE experiments described in this paper were suggested by a mishap in an examination. The problem set the students was to find the effect of a given solution on the rate of salivary digestion of starch. The solution was to have been normal potassium fluoride. From experiments previously carried out in the laboratory this was found to delay the appearance of the achromic point considerably, so that instead of its showing in 3-8 minutes it took over 1 hour. For the examination it was necessary to buy a fresh supply of the fluoride, and for reasons of economy it was decided to obtain the sodium salt.

A normal solution of this sodium fluoride was made and used by the fourteen students in the examination. To the surprise of the examiners the vast majority of the class found the fluoride to have no effect on the rate of salivary digestion. This negative result was confirmed by members of the laboratory staff at the time and it was decided to investigate the problem of differences between the action of the sodium and potassium salts. With three separate samples of sodium and potassium fluorides similar results were obtained; namely, no alteration of the time required to reach the achromic point with the sodium salt, and a very delayed action with the potassium salt. It was then thought advisable to see if the salts of the other halogens would show similar differences.

Experimental Method.

Normal solutions of NaCl, KCl, NH_4Cl , CaCl_2 and of the corresponding bromides, iodides and fluorides were made. In the case of calcium fluoride which is practically insoluble, a saturated solution was used, but results with this salt are necessarily unreliable owing to the minute amount in solution.

A 0.5 % solution of soluble starch in distilled water was also prepared, and some saliva collected directly into distilled water as described by Cole [1920, 1]. The solutions were warmed separately in a water-bath at 37° , and when at this temperature were mixed in the following proportions: 10 cc. starch; 2 cc. dist. water or salt soln.; 2 cc. saliva. The test-tube was then inverted to mix the contents, returned to the bath, and the time noted on a

stop watch. At intervals of about 0.25 min. a drop of the digestion mixture was taken and added to a drop of weak iodine solution on a white tile. The achromic point was taken as occurring when the drop of digestion mixture and iodine and a drop of distilled water and iodine, placed side by side on the tile, were identical in colour. This was the end point taken in the experiments, and the time was noted on the stop watch.

Thus these experiments were carried out on saliva with its natural salt content, and not on ptyalin itself. The need for stressing this point was shown by Cole [1903]. It was thought better to use saliva as such, since it is impossible to obtain an absolutely pure ferment, and also because salivary digestion is normally carried out by saliva and not by a dialysed extract.

Experimental Results.

Chlorides.

Standard with water	...	(1)	8.0 mins.
		(2)	8.0 "
NaCl	...	(1)	3.75 "
		(2)	3.55 "
KCl	...	(1)	3.75 "
		(2)	3.75 "
NH ₄ Cl	...	(1)	4.80 "
		(2)	5.0 "
CaCl ₂	...	(1)	3.75 "
		(2)	3.75 "

Hence all these chlorides, as previously shown by many workers, accelerated diastatic action.

Fluorides.

Standard with water	...	(1)	8.0 mins.
		(2)	8.2 "
NaF	...	(1)	8.5 "
		(2)	8.3 "
KF	...	(1)	120.0 "
		(2)	125.0 "
NH ₄ F	...	(1)	162.0 "
		(2)	180.0 "

This ammonium salt mixture seemed to be very acid, therefore ammonium hydroxide was added till it was markedly alkaline. The figures then were:

NH ₄ F + NH ₄ OH	...	(1)	56.0 mins.
		(2)	62.0 "
CaF ₂	...	(1)	8.0 "
		(2)	8.3 "

Here there is a marked difference in the various fluorides, sodium fluoride being inert, whilst potassium and ammonium fluorides exert a marked slowing effect. As stated before, owing to its insolubility, the experiments with calcium fluoride are not comparable and are inconclusive.

Bromides.

Standard with water	...	(1)	8.0 mins.
		(2)	8.0 "
NaBr, KBr, NH ₄ Br, CaBr ₂	...		8.0-8.2 mins.

Hence the bromides were without any action whatever on the rate of salivary digestion.

Iodides.

Standard with water	...	(1)	12.0	mins.
		(2)	12.0	"
NaI		(1)	12.0	"
		(2)	12.0	"
KI		(1)	12.25	"
		(2)	12.75	"
NH ₄ I		(1)	19.25	"
		(2)	20.0	"
CaI ₂		(1)	44.0	"
		(2)	44.75	"

Here, as with the fluorides, there is a marked difference, the sodium and potassium salts being inert as regards effect on the rate of salivary digestion, whilst the ammonium and calcium salts delay it to a marked extent.

It was then thought that the differences might be due to variations in the acidity of the salt solutions since this factor is so important in physiological reactions, and the salt solutions were known to show large differences in their behaviour to indicators.

Accordingly the hydrogen ion concentration of these salts was estimated by Cole's comparator method [1920, 2] using phenol red as the indicator. The results are given in the following table:

Effect of salts on rate of Salivary Digestion.

Hastened action		Unaltered action		Delayed action	
NaCl	<i>p_H</i> 7.0	NaF	<i>p_H</i> 7.6	NH ₄ I	<i>p_H</i> 5.6
KCl	6.6	*(CaF ₂)	7.2	CaI ₂	8.0
NH ₄ Cl	5.6	NaI	8.0	KF	7.8
CaCl ₂	7.2	KI	7.0	NH ₄ F	6.6
		NaBr	6.8	NH ₄ F + NH ₄ OH	8.0
		KBr	6.8		
		NH ₄ Br	5.8		
		CaBr ₂	8.0		

* Very insoluble, and therefore not really comparable.

From this table it appears that the chlorine ion exerts a definite accelerating action on salivary digestion rate, that the bromine ion is inert, and that the metallic ion is relatively unimportant in this connection.

With the fluorides and iodides there are marked differences, some of the salts delaying digestion, whilst others are inert. This difference does not seem to be due either to the metallic ion, or to the hydrogen ion concentration of the salt solution, but to be a definite effect of the salt as a whole, independent of the hydrogen ion concentration or the position of the ions in the periodic system.

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