

AT LOWER TEMPERATURES, INCREASE IN  
POLARITY RESULTS IN ADHESION OF  
METAL TO TONGUE PAPILLAE

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[Why does the tongue stick to metal in winters?]

**[24<sup>th</sup> Feb 2010]**

## AT LOWER TEMPERATURES, INCREASE IN POLARITY RESULTS IN ADHESION OF METAL TO TONGUE PAPILLAE

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### KEYWORDS

- Temperature, pH, Polarity, Conductivity, Tongue papillae, Microvilli, Amino acids, Enzyme, Displacement reaction, Nernst Equation, Adhesion

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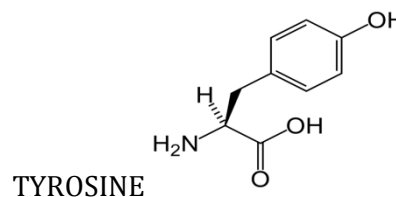
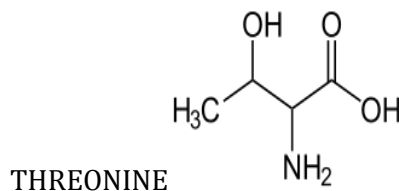
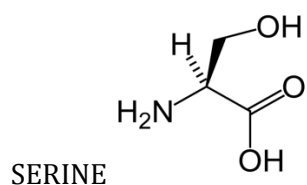
### ABSTRACT

The adhesion of the surface of the tongue to a metal is significantly enhanced at lower temperatures. We have proposed that a decrease in temperature accompanied by a corresponding increase in the pH of the saliva causes the formation of  $\text{Fe}(\text{OH})_2$ , which is a highly polar molecule. These polar molecules bind to receptors on the microvilli in the tongue papillae which results in strong adhesion of tongue to a metal.

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### INTRODUCTION

The tongue is a muscle on the floor of the mouth that is the primary organ of taste. The oral part of the tongue is covered with small bumpy projections called papillae. It is sensitive and kept moist by saliva. A major constituent of saliva is the enzyme amylase, which initiates the breakdown of starch into smaller carbohydrate units. This enzyme is made abundantly with the polar amino acids serine, threonine and tyrosine residues.



At lower temperatures it is known that pH of a solution increases by the argument that follows use of the Nernst equation. With context to the mouth, at lower temperatures, thus the pH of saliva increases. This paper explores the physiological consequences of this pH rise and its result in adhesion of iron based metal to the tongue.

## MATERIALS AND METHODS

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**In-Silico Protein Structure Modelling:** The 3-D Crystallographic structure of the alpha amylase has been solved. We used this structure to determine the presence of strong polar residues in the enzyme. The protein database software SPDBV was used.

**Test of temperature on saliva's pH:** An inverse trend was observed when pH was measured as a function of temperature.

On studying the trend that followed, under experimental errors, it was seen that the values were in confirmation with the Nernst equation.

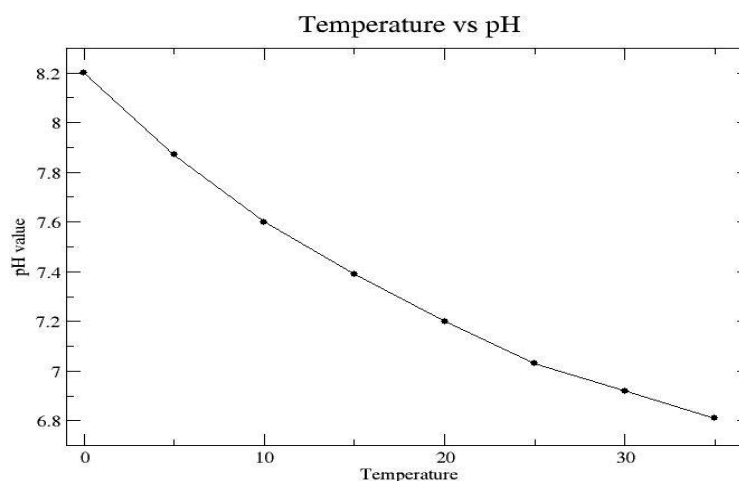
Hence, we conclude that pH varies inversely with temperature.

**Conductivity Test:** Using conductivity tests, employing a standard conductivity meter, presence of  $\text{Fe}^{2+}$  is confirmed.

## RESULTS

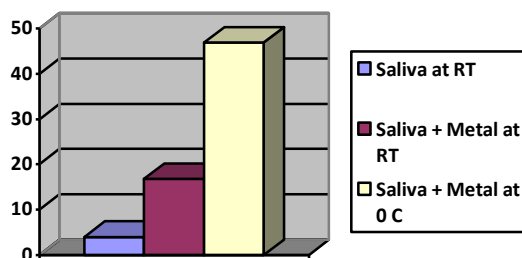
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**Temp and pH relationship:** The plot shows the correlation of temperature of saliva with its pH value. We deduce this from this curve that as temperature is lowered, pH showed a significant increase in its value.



**To establish the formation of polar  $\text{Fe}(\text{OH})_2$  compound:** Due to the presence of enzyme with the amino acids serine, threonine and tyrosine residues, it is seen that in the range of higher pH, **displacement reaction** takes place. The  $\text{Fe}^{+2}$  present on the surface of metal, being highly electropositive, has a high affinity for the hydroxyl (OH) group in the amino acids, and hence binds to it, forming a highly polar  $\text{Fe}(\text{OH})_2$ . This molecule is primarily seen to be the culprit for such an absurd behavior at low temperatures. In order to confirm this, conductivity test is done on the saliva.

In the first experiments, conductivity of the pure saliva sample was measured. In the second one, some iron chips were added to two samples before performing the test, at room temp and at  $0^\circ\text{C}$ . It was observed that the second and third sample showed increased conductivity values, wherein, the third sample showed a significantly higher conductivity as compared to the second one.



This clearly states the presence of  $\text{Fe}^{2+}$  ions and polar molecules  $\text{Fe}(\text{OH})_2$ , and an excess of them at low temperature. Hence, we can safely deduce that the iron ionises to form polar  $\text{Fe}(\text{OH})_2$  from the saliva, which are in excess at low temp.

## DISCUSSION

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Assumption: We are dealing with Iron based metal surfaces

We propose that the decrease in temperature leads to an increase in the pH value of saliva and hence increases the concentration of the hydroxyl ions.  $\text{Fe}^{+2}$  present in the metal (as given in the assumption) surface in contact with the tongue, being strongly electropositive forms a bond with the highly electronegative hydroxyl (OH) ions, thereby forming  $\text{Fe}(\text{OH})_2$ . The  $\text{Fe}(\text{OH})_2$  hence formed is highly polar. As we know, polar molecules do not enter the taste cells (papillae), but bind to receptors on the microvilli in the taste pore, thereby causing bonding to tongue.

Hence, we establish that the tongue binds to iron based metallic surfaces at low temperature.