What is the Role of Salt in Taste?

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Table salt (sodium chloride) is used as a flavoring agent in the cuisines of many cultures. Despite health advisories, maintaining a no-salt or reduced-salt diet has proven difficult for many. A common complaint is that foods taste bland and insipid without sufficient salting. It is widely believed that salt intensifies the desirable flavors in food. For example, salting a slice of watermelon appears to make the watermelon taste sweeter. Another view holds that the value of salt is in its ability to mask undesirable flavors, and in this way, the food tastes better. This laboratory exercise investigates the effect of salt upon taste by using a simplified model. The students participate in a blind taste test. Bitter (e.g. urea), sweet (sucrose), salt, bitter/salt, and sweet/salt solutions are prepared prior to class time. Invariably, bitterness is no longer detected when the salt is combined with urea yet the sucrose /salt solution is always ranked as not as sweet as the sucrose alone. Salt is shown to make food taste more palatable by suppressing unpleasant flavors. This exercise can be readily incorporated with the standard taste mapping exercise taught in most Anatomy and Physiology laboratory classes and adds an experimental approach to the study of taste.

Procedure

Each student is given a sample of a number of unknown solutions. Before tasting the unknown samples, each student should rinse his/her mouth four times with room temperature water. The student should rinse his/her mouth at least twice between each sample. Each student is asked to sip the test solution and then expectorate (the *sip and spit* method) back into the paper cup. Each student then assesses the taste of the solution as to sweetness, bitterness, or 'other' and then ranks the solutions (assigning 1 as strongest) according to the degree of sweetness or bitterness (Table 1). After the entire class has sampled the unknown solutions and recorded their taste assessments, the instructor will reveal the identity of the solutions.

Questions for Discussion

1. What effect does NaCl have on the taste of sucrose? Is the sweetness of the sucrose/salt mixture enhanced when compared to sucrose alone? Or is the sweetness decreased?
2. What effect does NaCl have on the bitter solutions (urea, quinine, and caffeine)? Was the bitterness of the mixed solutions (bitter/salt) enhanced compared to the solutions containing the bitter substance alone? Or was it decreased? Did you observe the same general effect for all bitter substances?
3. How was taste modified in the sweet/bitter combinations? What happened when salt was added to the mixture? What conclusion can be drawn about the role of salt in taste? Is it correct to state that salt acts as a flavor enhancer? Why or why not?
4. How could you determine if the flavor modifying effects of salt are due to the sodium or the chloride ion? Design an experiment to determine the causative agent. (Hint: potassium chloride, sodium gluconate, and sodium acetate have been tried in similar taste experiments and are available in the laboratory.)
5. The salt taste sensation is known to begin with an inflow of sodium ions through the membrane channels of taste receptor cells. Taste receptor cells are located within a taste bud. Amiloride is a sodium channel blocker; it does not allow sodium to pass into the taste receptors cells. Predict the taste of a NaCl/amiloride mixture. Explain.
6. What do you think would be the effect of an amiloride/urea/NaCl mixture? Predict the taste. Explain.
7. According to the dietary guidelines for Americans, daily salt intake should be reduced for a healthier lifestyle yet many find it difficult to live on low-salt foods. Salt-substitutes have proven disappointing. Based on the results of these experiments, what approach would you take to reduce or replace the desire for salt in foods?

Notes to the Instructor

We found that NaCl suppressed the bitter flavor of urea almost completely. Results were not as striking for quinine/salt solutions and even less so for caffeine/salt solutions.

Stock Solutions

Solutions were made with distilled water, but bottled spring water or deionized water may also be used. Pick the water supply that has the least taste. Stock solutions were prepared by making *double* the concentrations required in the taste solutions.

20.0 mM Caffeine ($C_8H_{10}N_4O_2$) FW 194.2
1.0 M Sodium Chloride (NaCl) FW 58.44
1.0 M Sucrose ($C_{12}H_{22}O_{11}$) FW 342.3
2.0 mM Quinine hydrochloride ($C_{20}H_{24}N_2O_2 \bullet HCl$) FW 360.9
2.0 M Urea (CH_4N_2O) FW 60.6

Test Solutions

When a sample containing two compounds was required, equal volumes of the double-strength solutions were mixed. When a sample containing one compound was required, the double strength solution was mixed with an equal volume of water.

Concentrations reported below are the *final concentrations* in the test solutions.

10.0 mM caffeine	10.0 mM caffeine + 0.5 M NaCl
0.5 M sucrose	0.5 M sucrose + 0.5 M NaCl
0.5 M sucrose + 1.0 M urea	1.0 mM quinine hydrochloride
1.0 M urea + 0.5 M NaCl	1.0 M urea
1.0 mM quinine hydrochloride + 0.5 M NaCl	

Table 1. Taste assessment of unknown solutions.

Unknown Solution	Taste (sweet, bitter, other)	Degree of Sweetness (1 = strongest)	Degree of Bitterness (1 = strongest)

References

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