GUSTATORY DESENSITISING EFFECTS OF *PSEUDOWINTERA COLORATA*

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A tea made from the leaves of the New Zealand shrub *Pseudowintera colorata* was shown to desensitise sweet tastes while leaving the perception of salty, sour and possibly bitter tastes unaffected. It is likely that eugenol is the substance that is responsible for the effect.

The effect of an extract from the leaves of the tropical plant *Gymnema sylvestre* upon the perception of sweet tastes has been well documented. Warren, Warren and Weninger (1969) and Bartoshuk, Dateo, Vandenbelt, Buttrick and Long (1969) have demonstrated that *G. sylvestre* is in fact a highly specific suppressor of sweetness; sugar crystals on the tongue are reported to be tasteless and feel like sand after exposure to a tea made from the leaves of the plant. Salty, sour and bitter tastes remain unaffected by the extract.

Other preparations have been reported to affect the perception of sweet tastes. Bartoshuk, Lee and Scarpellino (1972) reported that for some individuals, water tastes sweet after the tongue has been exposed to certain constituents of the globe artichoke (*Cynara scolymus*). Bartoshuk, Gentile, Moskowitz and Meiselman (1974) have shown that a preparation made from the berries of the tropical plant *Synsepalum dulcificum* ("Miracle fruit") adds sweetness to the taste of acids; the effect lasts for up to an hour after exposure to the active ingredient, a glucoprotein known as miraculin (Hellekant, Hagstrom, Kasahara and Zotterman, 1974).

A hitherto unreported but possibly equally powerful desensitising effect appears to result from the exposure of the gustatory receptors to extracts from the leaves of the New Zealand shrub *Pseudowintera colorata* ("Horopito" or "Pepperwood"). The following experiment was designed to demonstrate the selective desensitisation effects of *P. colorata* extract on human sensitivity to the four primary taste qualities, sweet, salty, sour and bitter.

METHOD

Eight qualitatively different stimuli were prepared in two concentrations each as shown in Table 1.

The sucrose, sodium chloride, citric acid and quinine sulphate at the higher concentrations shown served, in addition, as standard concentrations that were defined for the subjects at the start of each session as sweet, salty, sour and bitter standards of intensity 100 units on an arbitrary category scale. All judgements of taste intensity were made relative to these four standards so that a response of 100 indicated a

TABLE 1
Composition of stimuli (Weight in grams per litre of deionised water)

	Stronger Concentration	Weaker Concentration
Sucrose	120.00	60.00
Saccharin	0.75	0.37
Sodium Chloride	30.00	15.00
Citric Acid	5.00	2.50
Quinine Sulphate	0.14	0.07
Sucrose/Sodium Chloride mixture	120g Sucrose +30g NaCl	60g Sucrose +15g NaCl
Sucrose/Citric Acid mixture	120g Sucrose +5g Acid	60g Sucrose +2.5g Acid
Sucrose/Quinine Sulphate mixture	120g Sucrose +0.14g Q.S.	60g Sucrose +0.07g Q.S.

solution equal in intensity to the respective standard, while a response of zero indicated none of the particular qualitative type present.

Ten paid volunteer undergraduate students served as subjects. Each subject attended three sessions of approximately one hour during which each of the comparison stimuli in Table 1 was presented three times in random order with each presentation preceded by a mouth rinse as follows: For session one the rinse was deionised water. This provided a base level of responses of the intensities of the 16 stimuli. In session two the rinse was sucrose solution at 120 grams per litre. This enabled us to obtain a measure of the decrement in the perceived intensities of the sweet tastes due to cross-adaptation against which the desensitising effects of *P. colorata* could be compared. In session three the rinse was a decoction prepared by boiling 10 grams of fresh *P. colorata* leaves in water for 20 minutes then diluting the filtered and cooled solution to one litre. This preparation has a strong pepper taste with a bitter component and is similar to the taste obtained by chewing the leaves of *P. colorata.*

RESULTS

The intensity ratings were pooled both within and between subjects to yield Figure 1. A separate two-way analysis of variance with repeated measures on both factors was conducted for each combination of the eight qualitatively different stimuli (Table 1) with each of the four intensity scales (sweetness, saltiness, sourness and bitterness). The two factors in each analysis were "type-of-rinse" (water, sucrose or pepperwood extract) and "concentration of the stimulus". The stimulus-concentration factor was included to provide a check that subjects were able to respond systematically to at least two intensities of each stimulus. The concentration factor reached at least the .05 level of significance for all stimuli on their corresponding scales with the exception of quinine sulphate (judged along the bitterness-intensity scale) indicating that, with this one exception, the two different intensity levels for each stimulus were discriminated.

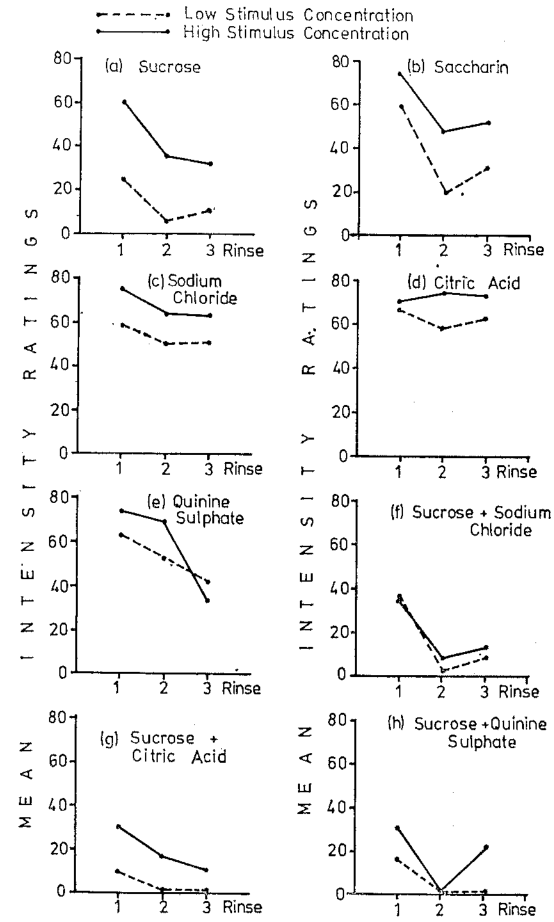

Figure 1. Mean judged intensities of stimuli following (1) water rinse, (2) sucrose rinse, and (3) pepperwood rinse.

Figure 1(a) shows the effect of the rinses on the perceived intensities of the two sucrose stimuli. Repeated-measures t-tests indicate that, for both concentrations of the sucrose stimulus, the sucrose rinse produced a significant decrement in judged intensity of the sucrose stimulus compared to the judged intensities obtained with the water rinse ($t(9) = 3.07$, $p < .01$ for the higher concentration of the sucrose stimulus, $t(9) = 5.02$, $p < .001$ for the lower concentration). Similarly, the pepperwood rinse produced a significant decrement in judged sweetness of sucrose over the judged sweetness reported after water rinse ($t(9) = 3.91$, $p < .01$ for the higher concentration of sucrose, $t(9) = 4.96$, $p < .001$ for the lower concentration). There were no significant differences between the judged intensities of the sucrose stimuli when judged after the sucrose rinse as compared with judgements on the sucrose stimuli made following the pepperwood rinse ($t(9) = 0.77$ for the higher concentration of sucrose, $t(9) = 1.29$ for the lower concentration). The overall result then, was that the pepperwood rinse produced a desensitisation to sucrose that was approximately equivalent in magnitude to adaptation to a sucrose solution of 120 grams per litre.

Similar results were obtained for the two concentrations of saccharin. Compared with the intensity ratings for saccharin stimuli following a water rinse, there was a decrease in mean rating following the sucrose rinse (Figure 1 (b); $t(9) = 4.62$, $p < .01$ for the stronger concentration, $t(9) = 7.00$, $p < .001$ for the weaker concentration), and a similar decrement following the pepperwood rinse ($t(9) = 4.01$, $p < 0.1$ and $t(9) = 6.56$, $p < .001$ for the two concentrations of saccharin). There was likewise no significant change for the pepperwood rinse when compared against the effects of the sucrose rinse for the saccharin stimuli ($t(9) = 0.46$ and $t(9) = 1.62$ for the stronger and weaker solutions respectively). I therefore conclude that the desensitisiing effect is not specific to sucrose; the same effect occurs with saccharin.

The two-way analysis of variance of the ratings of sodium chloride on the saltiness scale yielded an F-ratio of 2.30 (2,45) on the type-of-rinse factor, indicating no change in judged saltiness (Figure 1 (c)). Likewise the ratings of citric acid on the sourness scale (Figure 1 (d)) produced a non-significant F-ratio ($F(2,45) = 0.05$) again indicating no effect of the rinses on the perceived sourness of citric acid. However, quinine sulphate, when rated on the bitterness scale yielded a significant F-ratio ($F(2,45) = 18.77$, $p < .001$) suggesting an effect of the rinses on perceived bitterness (Figure 1 (e)). Similar effects were initially reported with *Gymnema sylvestre* (Shore, 1892); more recent research indicates that the apparent suppression of bitterness was an artifact of cross-adaptation (Bartoshuk *et al.*, 1969). The pepperwood extract used here had a strongly bitter component and the present results may be likewise confounded by cross-adaptation. This point requires further investigation.

Analyses of the intensity ratings made on the three pairs of mixtures (Table 1) confirm the results already noted: All three mixtures yielded significant F-ratios on the type-of-rinse factor for the analyses of variance conducted on ratings made on the intensity-of-sweetness scale. For convenience, the two concentrations of each stimulus are pooled in the following analyses.

For all comparisons with both the sucrose rinse and the pepperwood rinse against the baselevel produced under the water rinse, the decreases in perceived sweetness of the mixtures were significant beyond the .01 level ($t(19)$ ranged between 3.07 and 8.00). However, only in the case of the sweet/sour mixture rated on the sweetness scale was there a nonsignificant difference between the ratings made following sucrose rinse and the ratings made following the pepperwood rinse (Figure 1(g)). With both sweet/salty and sweet/bitter mixtures the sucrose rinse produced a significantly greater decrement in perceived intensity than the pepperwood rinse ((t(19) = 2.85, p<.01 for sweet/salty mixture, t(19) = 2.30, p<.01 for the sweet/bitter mixture). In these latter two cases then, adaptation to sucrose yielded a significantly greater decrement in sensitivity to sweetness than the effect produced by the pepperwood rinse (Figures 1(f) and 1(h)).

DISCUSSION

There are clear indications that pepperwood extract induces a specific desensitisation of the sweetness receptors while leaving the saltiness and sourness receptors unaffected. The degree of desensitisation for the concentration of pepperwood extract used is approximately equivalent to adaptation to a solution of sucrose of 120 grams per litre. The effect of pepperwood extract on the bitterness receptors remains uncertain until the effect of cross-adaptation to the bitter component in the rinse is partialled out.

It appears likely that eugenol is the component responsible for the observed effect. The essential oil of *P. colorata* has been analysed on several occasions (Corbett and Young, 1963) and eugenol is certainly present (Brooker, Cain and Cambie, 1963). This compound is largely responsible for the hot taste of cloves (*Eugenia caryophyllata*) and is also present in the other New Zealand peppertree *Macropiper excelsum* ("Kawakawa"). Its mild analgesic properties may account for another name for pepperwood, "Bushman's Pain-killer". (*P. colorata* leaves were sometimes chewed as a cure for toothache).

A rough phenomenological check suggests that pure eugenol in aqueous suspension possesses a similar taste to the pepperwood extract used here. Further research is required to elucidate the biochemical mechanism involved in the selective desensitisation reported—perhaps the compound enters into an irreversible combination with the proteins present at the receptor site for sweet tastes. However, the extremely unpalatable taste of eugenol raises ethical objections for the continuation of this line of research on human subjects.

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