A study on physiological taste threshold in hyperthyroidism

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ABSTRACT

Background: Taste is the perception produced when a substance in the mouth reacts chemically with taste receptors located on taste buds in the oral cavity. The five basic taste modalities are sweet, salt, sour, bitter, and umami. Disorders of taste can result from various diseases and use of various drugs. Hyperthyroidism is one among them which affects the taste sensation and threshold. Aim and Objectives: The study was conducted to assess the physiological taste threshold for the five primary taste modalities in hyperthyroid patients and to compare their taste thresholds with that of the normal healthy controls. Materials and Methods: Investigations were carried out in 30 hyperthyroid patients aged between 20 and 50 years and in age, sex, and anthropometrically matched control groups of 30, who were apparently healthy. The statistical analysis was done by student’s t-test. Results: There is no difference in the physiological threshold of all the basic tastes but salt. A significant ($P < 0.05$) increase in the taste threshold for salt taste can be seen in hyperthyroid patients compared to that of controls. Conclusion: The threshold for salt taste was altered in hyperthyroidism, which can be detected by proper screening. Taste dysfunction leads to reduced food intake and poor nutrition. Proper treatment and counseling can help them to get back their normal taste threshold along with normal thyroid status.

KEY WORDS: Physiological Taste Threshold; Sweet; Salt; Sour; Bitter; Umami; Hyperthyroidism; Taste Dysfunction

INTRODUCTION

Taste, one of the five special senses, is the sensory impression of food or other substances on the tongue. Taste plays a major role in appetite of an individual and thus it influences the nutritional status of the same. The sensation of taste is recognizing and differentiating the primary tastes—sweet, salt, sour, bitter, and umami.¹ There are additional taste sensations such as fatty, metallic, starchy, and others that can also be considered as basic tastes.²³ The taste threshold can be altered by factors such as old age; consumption of alcohol, chewing tobacco, and smoking; local and systemic diseases and certain drugs.⁴ One of such conditions, where the physiological taste threshold of an individual gets altered is hyperthyroidism. Even if thyroid hormone per se does not have any effect on taste, some of its metabolic consequences may be involved in this.⁵

Hyperthyroidism results from excessive production of thyroid hormone. It can be primary hyperthyroidism, in which there is some abnormality in the thyroid gland which leads to increased hormone secretion, or can be secondary hyperthyroidism, in which, there is increased TSH secretion from anterior pituitary, which in turn, can cause increase in thyroid hormone secretion, or can be tertiary hyperthyroidism where there is increased secretion of TRH from hypothalamus leading to increase in thyroid hormone secretion.¹ Hyperthyroidism can cause an overall increase

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in the metabolic activities of the body. There will be a high state of excitability, calorigenesis, and intolerance to heat excessive sweating, weight loss, etc.\[1\]

Few studies were conducted on the alteration of four primary taste sensations in hyperthyroidism, without including umami taste in their study. Nevertheless, no comprehensive information is available on alteration of physiological taste threshold for different taste modalities, including umami taste in hyperthyroidism.

Thus, the present study is undertaken with the objective to assess the alteration in threshold for five primary taste sensations – umami, salt, sweet, sour, and bitter in hyperthyroidism.

MATERIALS AND METHODS

The physiological threshold for five primary taste sensations was determined among hyperthyroid patients, visiting Medicine, Surgery, Dermatology, and Gynaecology Outpatient Departments and IPDs of KIMS, Hubballi and in the control group, having age, sex, and anthropometrically matched normal healthy individuals.

Inclusion Criteria

Thirty, hyperthyroid patients of both sexes with the age ranging between 20 and 50 years, diagnosed at least 2 years before study\[6\] and 30 normal healthy individuals, having age, sex, and anthropometrically matched with hyperthyroid patients were taken up for this study.

Exclusion Criteria

Pregnant and lactating women were excluded from the study; smokers and alcoholics were not included in the study; subjects with Herpes Zoster infection, gum infections, and upper respiratory tract infection and those suffering from nutritional deficiencies, especially Vitamin B\(_{12}\) and Zn were screened and excluded from the study; subjects with h/o intake of various medicines such as antibiotics, antidepressants, anti-hypertensives, lithium, and diuretics were excluded from the study; hypothyroid patients under treatment and with normal thyroid profile and subjects with diabetes mellitus, Parkinson’s disease, and Sjogren’s syndrome were excluded from the study.

Study Design

Method of collection of data

After considering the inclusion and exclusion criteria, the study groups were selected. The test procedure was explained to the subjects and patients and informed consent was taken. Instructions were given to them before performing the taste test. The results were noted down for analysis.

Materials

Various chemicals are used in its purified form to test the taste threshold of different taste modalities. L-glutamic acid monosodium salt in white crystal form was used for umami; extra pure white solid sodium chloride in powder form for salt and for sweet extra pure white solid dextrose anhydrous in powder form was used. White solid citric acid in crystal form for sour and for bitter, quinine sulfate in white fine powder form was used.

All tastants were kept in air tight plastic bottles and stored as recommended by the manufacturer.

Two ml Eppendorf tubes, 5 ml of sterile disposable syringes, and deionized water were used to prepare the stock solutions and their seven serial dilutions. Fresh solutions were prepared and used within 24 h of preparation. Different droppers were used for each tastant.\[4-5\]

Methods

Determination of taste threshold

“Taste test” with whole mouth method was employed. For testing the taste intensity and taste hedonic, seven serial concentrations/half dilutions of the stock concentration were made for each five taste modalities, using deionized water. The starting concentrations of glucose (2.00 M) for sweet, sodium chloride (1.00 M) for salt, citric acid (0.05 M) for sour, quinine sulfate (0.001 M) for bitter, and mono sodium glutamate (6.00 M) for umami were used. The concentrations obtained after seven serial dilutions are given in Table 1. For each solution, the sensitivity of taste was tested using Harris–Kalmus method along with forced choice and up-down tracking procedure.\[4-5\]

A drop or two of these prepared serial concentrations of the taste solutions is placed on subject/patient’s tongue. The lowest concentration of each of the above taste will be dropped into the mouth/dorsum of the tongue of the subject. The subject should identify the particular taste and to spit out the solution. If the subject could not make out the taste, then the next higher concentration would be applied. The subjects were asked to rinse their mouth with distilled water after each taste test is finished, but not during the same taste test. Rinsing of the mouth was repeated till the volunteer feels no taste of previously tasted solution lingers in the mouth.\[4-5\]

For every subject, taste sensitivity is tested in the order: Umami, salty, sweet, sour, and bitter. The level at which the subject/patient identifies the particular taste sensation was noted down and was compared among normal controls and hypothyroid patients to get the result.\[4-5\]

Statistical Analysis

It is a cross-sectional study, in which, the statistical analysis was done using student’s \(t\)-test, to compare the thresholds of
different taste parameters with the help of “SPSS software.” $P < 0.05$ was taken as statistically significant.

**RESULTS**

In this study, the taste threshold for different taste modalities is assessed in 30 hyperthyroid patients and the data were compared with that of the age and anthropometrically matched 30 controls, including both males and females. Among controls and hyperthyroid study subjects, as given in Table, there is no significant alteration in the physiological taste threshold of all the four primary taste modalities such as umami, sweet, sour, and bitter. There presents a significant increase in the physiological taste threshold of salt taste modality in hyperthyroid study subjects compared to the controls [Table 2].

**DISCUSSION**

Thyroid disorder is one of the common endocrine disorders worldwide and it has various effects on the different systems and metabolism of the body. Smell and taste are known to be influenced by changes in the thyroid function status. However, many thyroid patients are unaware of their dysosmia and dygeusia.[6]

During this study period of 1 year, 30 hyperthyroid patients were tested for the taste threshold for the five primary taste modalities and were compared with that of the age, sex, and anthropometrically matched control group including both males and females.

Even though so many studies support the fact that thyroid disorders affect taste sensation, the exact underlying cause for taste impairment in these disorders is still unclear. Even if thyroid hormone per se does not have any effect on taste, some of its metabolic consequences may be involved in this.[5]

Thyroid hormones affect myelination of neurons, therefore, increased levels of thyroid hormones lead to oxidative damage to the myelin membrane and the oligodendroglial cells.[7]

The salivary glands secretion is regulated by both nervous system and hormones including thyroid hormones.[8] Mayer-Parka D conducted a study to determine the quantity of the resting secretion and stimulated salivary secretion in women with autoimmune thyroid diseases (AITD) depending on the function of the thyroid gland (hyperthyroidism, hypothyroidism, and euthyroidism). Hyperthyroid women showed a decrease in volumes of resting (57.14%) and stimulated (89.29%) saliva. In conclusion, AITD may be associated with disturbances in salivary secretion which depends on thyroid hormones production.[9] Muralidharan et al. conducted a study in newly diagnosed subjects, who had hypothyroidism or hyperthyroidism, and analyzed that the salivary parameters such as stimulated salivary flow rate, pH, and buffering capacity were performed at the time of diagnosis (baseline) of disease condition, on attaining euthyroid state and then 3 months thereafter. They concluded that thyroid dysfunction affects salivary gland function.[9]

Similarly, animal studies have shown that thyroid dysfunction affects salivary gland functioning.[10] The oral manifestations of thyrotoxicosis include burning mouth syndrome.[11] Patients with thyroid disorders can have salivation abnormalities such as hyposalivation,[8,10] which can reduce the taste perception and thus lead to an increase in the physiological taste threshold. Thyroid disorders are also associated with

| Table 1: The concentrations obtained after seven serial dilutions |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Conc. No | Umami (M) | Salt (M) | Sweet (M) | Sour (M) |
| 1 | 0.01562 | 0.01562 | 0.03125 | 0.000781 |
| 2 | 0.03125 | 0.03125 | 0.0625 | 0.001562 |
| 3 | 0.0625 | 0.0625 | 0.125 | 0.003125 |
| 4 | 0.125 | 0.125 | 0.25 | 0.00625 |
| 5 | 0.25 | 0.25 | 0.5 | 0.0125 |
| 6 | 0.5 | 0.5 | 1 | 0.025 |
| 7 | 1 | 1 | 2 | 0.05 |

| Table 2: Taste threshold of controls and hyperthyroid patients for the five primary taste modalities |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Taste modalities | Threshold of the control (mean±SD) | Threshold of the hyperthyroid patients (mean±SD) | Significance |
| Umami | 2.4±1.003 | 2.4±0.86 | NS (P=1) |
| Salt | 2.17±0.65 | 3.17±1.67 | S (P=0.0033) |
| Sweet | 2.53±0.63 | 2.4±0.68 | NS (P=0.6952) |
| Sour | 2.77±0.57 | 2.6±0.89 | NS (P=0.4919) |
| Bitter | 1.43±0.73 | 1.53±0.73 | NS (P=0.5973) |

NS: Not Significant, S: Significant (P<0.05); n=30
Peripheral neuropathy of the sensory nerves.\textsuperscript{[7,12]} Hence, it can affect the sensory nerves which carry information from the tongue and also can lead to a reduction in sensing the taste and increase the taste threshold.

In the present study, it was observed that the threshold for salt taste was significantly increased ($P < 0.05$) in hyperthyroid patients compared to that of the controls, which shows that in hyperthyroid patients, there is a decrease in the taste sensitivity for salt. However, other four primary taste modalities were not found to be significantly altered in hyperthyroid patients compared to controls.

These findings in the present study are well in agreement with the observations of the previous studies conducted by various researchers. However, there were not many studies available for taste sensation in hyperthyroidism alone.

A study conducted by Bhatia S in hyperthyroid subjects concluded that the intensity and hedonic values decrease for salt and bitter taste, and sourness is perceived as more unpleasant in hyperthyroidism as compared to controls.\textsuperscript{[13]}

Denton and Abraham conducted a study in hyperthyroid patients and concluded that in hyperthyroidism, sourness and bitterness are perceived as more unpleasant than in control subjects.\textsuperscript{[14]}

On the other hand, the present study was conducted in hyperthyroid patients, wherein the primary taste modality, umami was also included, which was not considered previously by any other researchers, who worked on the taste threshold in hyperthyroid patients. The present study revealed that the threshold for only salt taste modality has been altered in hyperthyroid patients, but not for other taste modalities such as umami, sweet, sour, and bitter.

Peripheral facial palsy is a common among the neuropathies that are seen in hypothyroidism which includes the neuropathy of chordae tympani branch which is the peripheral branch of facial nerve which takes the taste sensations from the anterior two-thirds of the tongue.\textsuperscript{[15]} The taste buds present in the anterior two-thirds of the tongue perceive more of sweet and salt taste sensation among the five basic tastes even though all tastes can be sensed in the anterior two-thirds of the tongue.\textsuperscript{[16]} This may suggest that chordae tympani neuropathy, which involves the anterior two-thirds of the tongue, alters more of sweet and salt taste sensation.

Another study conducted by Pittman and Beschi stated that four out of ten hyperthyroid patients showed low threshold for one or more of the substances tested; one for NaCl and KCl; second for NaCl, KCl, and urea; third one for NaCl and sucrose; and the fourth for NaCl, KCl, and NaHCO$_3$.\textsuperscript{[17]}

Similarly, Bhatia S conducted a study to find out the gustatory difference in Phenyl thiocarbamide tasters and non-tasters in hypothyroid and hyperthyroid subjects. Among hyperthyroid subjects 60% and among the hypothyroid 40% were tasters. The hypothyroid subjects showed more gustatory differences as compared to hyperthyroid.\textsuperscript{[19]}

Finally, there is no definite management strategy for the altered taste threshold in thyroid disorders. Counseling and reassurance can be done and the flavor of the food can be enhanced. Increasing the flavor of the food helps in increasing the appetite, in turn increases the health and immunity of the patient. In thyroid patients, treating them with the corresponding medications to bring back the thyroid status to normal level can help in getting back the taste sensitivity to almost normal level.\textsuperscript{[6]}

**CONCLUSION**

The physiological taste threshold for salt was significantly increased in hyperthyroid patients compared to that of controls. However, all the other four taste modalities-umami, sweet, sour, and bitter have not shown any significant alteration in hyperthyroid patients compared to the controls. This can be probably due to reduced salivation, peripheral neuropathy of nerves involved in carrying salt taste sensation, dry mouth, burning mouth syndrome, and other metabolic consequences that accompany hyperthyroidism.

Smell and taste are known to be influenced by changes in thyroid status. However, many thyroid patients and physicians are unaware of dysosmia and dysgeusia and so it remains largely undiagnosed and not managed well. Thus, frequent taste threshold assessment and management becomes necessary in these patients. Counseling, reassurance, providing food with enhanced flavor, and treatment with the drugs to cure the underlying thyroid disorder can bring down this symptom complex to almost normal level and can improve the health status of the affected individuals.

**REFERENCES**

3. Hamzelou J. There is Now a Sixth taste-and it explains why we Love Crabs. New Scientist; 2016.


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