RESEARCH ARTICLE

A comparative study on the physiological taste threshold in hypothyroidism and normal controls

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ABSTRACT

Background: Taste, one of the five special senses, is the sensory impression of various substances on the tongue. There are five basic taste modalities such as sweet, salt, sour, bitter, and umami. The physiological taste threshold of the individual gets altered in hypothyroidism. Aims and Objectives: The present study was undertaken to test and compare the physiological taste threshold for the five primary taste modalities such as umami, salt, sweet, sour, and bitter in hypothyroid patients and the normal healthy controls. Materials and Methods: Thirty hypothyroid patients aged between 20 and 50 years and 30 age, sex, and anthropometrically matched apparently healthy individuals as control were included in the study. The tests for the threshold of all the five primary tastes were performed in both the groups and the results were compared. Results: The taste threshold for the sweet taste modality has been increased significantly (P < 0.05) in hypothyroid patients compared to controls. No difference could be observed in case of other taste modalities. Conclusion: The significant increase in the physiological taste threshold of sweet modality in hypothyroid patients compared to the controls suggests that hypothyroid patients may have a decreased sensitivity for the sweet taste. Thus, the taste dysfunction should be detected in them by proper screening. Timely management/treatment and counseling can help them to get back their normal taste threshold along with attaining the euthyroid status.

KEY WORDS: Physiological Taste Threshold; Primary Taste Modalities; Taste Sensitivity; Hypothyroidism; Taste Dysfunction

INTRODUCTION

Taste/gustation is the perception produced when a substance in the mouth reacts chemically with taste receptor cells located on the taste buds in the oral cavity. It is one of the five special senses. Taste plays a major role in appetite of an individual and influences the nutritional status of the same. For human beings, taste sensation means recognizing and distinguishing the basic tastes – sweet, salt, sour, bitter, and umami.¹ There are additional qualities such as fatty, metallic, starchy, and others that might also be considered as basic tastes.²⁻³

The taste threshold can be altered by a number of factors such as age and ethnic backgrounds; consumption of alcohol, smoking, and chewing tobacco; local and systemic diseases; and certain drugs.⁴ One of such conditions, where the physiological taste threshold of and individual gets altered, is hypothyroidism. Thyroid gland, an important endocrine gland, secretes thyroxine (T₄) and triiodothyronine (T₃) which exert effect on almost all the tissues in the body. The most prevalent disease condition of the thyroid gland is hypothyroidism.⁵ Hypothyroidism is a common endocrine
disorder in which thyroid hormone secretion is reduced. It can be primary hypothyroidism, where the pathology is in the thyroid gland itself. In secondary hypothyroidism, its trophic hormone (TSH) secretion from the anterior pituitary is deficient leading to reduce thyroid hormone secretion. It can be tertiary hypothyroidism where thyrotropin-releasing hormone from hypothalamus is deficient. Hypothyroidism can cause an overall reduction in the metabolic activities of the body. There will be increased body weight and fatigue, extreme somnolence, muscular, and mental sluggishness.[1]

The high frequency of taste disturbances in untreated patients with hypothyroidism suggested that more attention should be paid to this symptom complex in evaluation of patients with thyroid disease.[3]

Many studies have been conducted on alteration of taste sensation in hypothyroidism mainly on four primary sensations of taste, without considering the fifth and newly added umami taste in their study frame. Nevertheless, no comprehensive information is available on alteration of physiological taste threshold for different taste modalities, including umami taste in hypothyroidism.

Thus, the present study is undertaken with the objective to compare the alteration in threshold for five primary taste sensations – umami, salt, sweet, sour, and bitter in hypothyroidism with normal controls. Most of the previous studies have used electrogustometry as the principal tool of investigation. However, in the present study, the chemical gustometry method is used. It is more feasible method for testing the patients on outpatient basis.

**MATERIALS AND METHODS**

The taste threshold for five primary taste sensations has been determined in the hypothyroid patients, visiting medicine, surgery, dermatology, and gynecology OPDs and IPDs of “KIMS,” Hubballi, and in the control group, having age, sex, and anthropometrically matched normal healthy individuals.

**Inclusion Criteria**

Thirty, newly diagnosed patients with hypothyroid profile of both sexes with the age ranging between 20 and 50 years, who are not under treatment[6] and 30, normal healthy individuals, having age, sex, and anthropometrically matched with hypothyroid patients were included in the study.

**Exclusion Criteria**

Pregnant and lactating women were excluded; smokers and alcoholics were not included; subjects with herpes zoster infection, gum infections, and upper respiratory tract infection and those suffering from nutritional deficiencies, especially Vitamin B12 and Zn, were screened and excluded; subjects with h/o intake of various medicines such as antibiotics, antidepressants, antihypertensives, 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. Details of the test procedure were explained to the subjects and patients in their vernacular language, and informed consent was taken. Instructions were given to the subjects before performing the taste test. The results were tabulated for analysis.

**Materials**

Various chemicals are used in its purified form to test the taste threshold of different taste modalities. For umami, L-glutamic acid monosodium salt in white crystal form was used; for salt, extra pure white solid sodium chloride in powder form 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 airtight plastic bottles and stored as recommended by the manufacturer.

Two milliliters 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.[7,8]

**Method**

Permission from ethical clearance committee has obtained before starting the study.

**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 monosodium 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.[7,8]
These prepared serial concentrations of the solutions are given to the subjects by placing a drop or two of that particular solution in subject/patient’s mouth. Lowest concentration of each of the above taste will be dropped into the mouth/dorsum of the tongue of the subject. The subject will be asked to 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. Mouth rinsed with distilled water will be recommended after each taste test is finished, but will not be permissible during the same taste test. Rinsing of the mouth was repeated till the volunteer feels that no taste of previously tasted solution lingers in the mouth.[7,8] 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.[7,8]

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 hypothyroid patients and the data were compared with that of the age and anthropometrically matched 30 controls, including both males and females. The results are summarized in Table 2.

Among controls and hypothyroid study subjects as shown in Table 2, there is no significant alteration in the physiological taste threshold of all the four primary taste modalities such as umami, salt, sour, and bitter. However, there is a significant increase in the physiological taste threshold of sweet modality in hypothyroid patients compared to the controls.

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

During this study period of 1 year, a total of 30 hypothyroid 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 controls including both males and females.

In this study, it was observed that the taste threshold for the sweet taste modality has been significantly increased \( (P<0.05) \) in the hypothyroid patients compared to controls. However, there is no significant difference in the taste threshold of other four primary taste modalities such as umami, salt, sour, and bitter. The study showed that hypothyroid patients may have a decrease in the sensitivity for the sweet taste modality. These findings of the present study are well in agreement with the previous studies conducted by various researchers.

Uchiyama et al. presented a case report, where a 74-year-old male presented with a total loss of taste sensation for 10 weeks. He could not detect saturated sugar and salt solutions but his acuity for smell was normal. Laboratory

| Table 1: The concentrations obtained after seven serial dilutions |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Conc. No.       | Umami (M)       | Salt (M)        | Sweet (M)       | Sour (M)        | Bitter (M)      |
| 1.              | 0.01562         | 0.01562         | 0.03125         | 0.000781        | 0.00001562      |
| 2.              | 0.03125         | 0.03125         | 0.0625          | 0.001562        | 0.00003125      |
| 3.              | 0.0625          | 0.0625          | 0.125           | 0.003125        | 0.0000625       |
| 4.              | 0.125           | 0.125           | 0.25            | 0.00625         | 0.000125        |
| 5.              | 0.25            | 0.25            | 0.5             | 0.0125          | 0.00025         |
| 6.              | 0.5             | 0.5             | 1               | 0.025           | 0.0005          |
| 7.              | 1               | 1               | 2               | 0.05            | 0.001           |

| Table 2: Taste threshold of controls and hypothyroid patients for the five primary taste modalities |
|-----------------|-----------------|-----------------|-----------------|
| Taste modalities| Threshold of the control (mean±SD) | Threshold of the hypothyroid patients (mean±SD) | Significance |
| Umami           | 2.4±1.003       | 2.13±0.78       | NS \( (P=0.2534) \) |
| Salt            | 2.17±0.65       | 2.47±0.73       | NS \( (P=0.5654) \) |
| Sweet           | 2.53±0.63       | 3.1±0.93        | S \( (P=0.0073) \) |
| Sour            | 2.77±0.57       | 2.7±0.84        | NS \( (P=0.7194) \) |
| Bitter          | 1.43±0.73       | 1.43±0.63       | NS \( (P=1) \)   |

NS: Not significant, S: Significant \( (P<0.05) \)
Another study was conducted by Rivlin et al. which compared the pleasant response to bitterness in hypothyroidism as diminished and the hedonic values for saltiness increased. They concluded that the intensity and hedonic values for sweetness in hypothyroidism should be considered as one of the possible causes in taste defect. [9]

A study conducted by McConnell et al. reported that high frequency of hypogeusia and dysgeusia was observed in patients with hypothyroidism and they suggested that the defect in taste could provide an additional explanation for the lack of food intake. [5]

Similarly, another study conducted by McConnell who indicated that taste defects are common abnormalities in primary hypothyroidism which may contribute to the anorexia and lack appetite. They observed that the most common abnormality in those patients were in detection and recognition of bitter taste. [10]

Deniz et al. conducted a study to establish the relation between hypothyroidism and olfactory and gustatory loss where he selected primary hypothyroid patients who are not under treatment and treatment with L-thyroxin for 3–6 months and controls as normal healthy individuals. Bitter and sweet taste scores, olfactory discrimination, and threshold were significantly lower in untreated hypothyroid patients compared to controls. Three months of treatment revealed significant improvement in identification, threshold, and discrimination of smell and taste functions. They concluded that primary hypothyroidism was found to have a negative effect on smell and taste. They suggested the future workup of patients with smell/taste loss should include investigations for thyroid functions. [15,16]

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. The high frequency of taste disturbances in untreated patients with hypothyroidism suggested that more attention should be paid to this symptom complex in evaluation of patients with thyroid disease. [5]

A study conducted by Bhatia in hypothyroid subjects concluded that the intensity and hedonic values for sweetness diminished and the hedonic values for saltiness increase and the pleasant response to bitter increases in hypothyroidism as compared to controls. [11]

Another study was conducted by Rivlin et al. in hypothyroid rats and they concluded that hypothyroid rats have significantly low taste preference toward sucrose and have significantly high taste preference for quinine sulfate and sodium chloride. However, taste preference for hydrochloric acid was not significantly altered. [12]

The functions of the salivary glands are regulated by nervous system which influences salivary circulation. Moreover, the volume of secreted saliva depends on the humoral agents including thyroid hormones. [13] Patients with thyroid disorders can have salivation abnormalities like hyposalivation, [13,14] which can reduce the taste perception and thus lead to an increase in the physiological taste threshold.

Peripheral neuropathy is usually seen in severe, long-term, untreated hypothyroidism. Hypothyroidism causes fluid retention and the swollen tissues exert pressure on peripheral nerves. [13,16] The taste buds present in the anterior two-thirds of the tongue perceive more of sweet and salt taste sensations among the five basic tastes even though all tastes can be sensed in the anterior two-thirds of the tongue. [17] The neuropathy of chordae tympani, the peripheral branch of facial nerve which takes the taste sensations from the anterior two-thirds of the tongue alters more of sweet and salt taste sensation which was observed in hypothyroid patients in the present study.

Few studies have been done on taste sensation alteration in hypothyroidism with four primary sensations of taste, without including the fifth primary taste umami. Even now, no comprehensive information is available on alteration in taste threshold for different taste modalities, including umami taste in hypothyroidism.

Thus, the present study is undertaken with the objective to compare the alteration in threshold for all the five primary taste sensations – umami, salt, sweet, sour, and bitter in hypothyroidism with normal controls. Most previous studies have used electrogustometry as the principal tool of investigation. We have used chemical gustometry as study tool in this study. It is more feasible method for testing the patients on outpatient basis.

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. [6]

**CONCLUSION**

The physiological taste threshold for the primary taste modalities such as umami, salt, sour, and bitter has not shown any significant change in hypothyroid patients compared to the controls. However, threshold for sweet taste was...
significantly increased in hypothyroid patents compared to that of controls.

Thus, in the present study, it is concluded that hypogeusia, especially for sweet taste sensations, is present in hypothyroidism.

REFERENCES


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