Indian J Physiol Pharmacol 1991; 35(3): 152-158

TASTE DISORDER IN HYPO AND HYPERTHYROIDISM

S. BHATIA*, S. S. SIRCAR AND B. K. GHORAI

Department of Physiology,
University College of Medical Sciences and G.T.B. Hospital,
Shahdara, Delhi - 110 095

Abstract : Gustatory responses to the basic taste substances (sweet, salty, sour and bitter) were studied in hypothyroid and hyperthyroid subjects. The intensity and hedonic responses were evaluated using "category scaling" for 7 concentrations of glucose, sodium chloride, citric acid and quinine sulphate. The intensity and hedonic values decrease in hyperthyroidism for salt and bitter solution, and sourness is perceived as more unpleasant. In hypothyroid subjects intensity and hedonic value decreases for sweetness, the pleasant responses to salt and bitter increase, though intensity perception decreases for bitter solutions.

Key words : gustatory hypothyroid hyperthyroid category scaling intensity hedonic

INTRODUCTION

Gustatory stimulation produces metabolic anticipatory responses (1,2). A number of conditions cause disorder of taste sensation; these include nutritional (3,4) and endocrine disorders like adrenal cortical insufficiency, cushing's syndrome, cretinism, diabetes mellitus and hypothyroidism (5,6). Even physiological alterations in the internal signals can significantly alter the gustatory preferences (7,8). Internal sodium (9,10) and blood sugar levels are also reported to alter gustatory preferences (11).

These observations naturally lead to a speculation regarding the possible changes in gustatory responses in endocrine disorders in which there are wide spread metabolic alteration. Loss of appetite forms one of the presenting symptoms of hypothyroidism. McConnel (12) reported a high frequency of hypogeusia and dysgeusia in patients of hypothyroidism and felt that the defect in taste could provide an additional explanation for this lack of food intake. So even if thyroid hormone *per se* does not have any effect on taste, some of its metabolic consequences may be involved e.g. alliviation in blood sugar levels and changes in body weight and alteration in food intake (13).

The high frequency of disturbances in taste in untreated patients with hypothyroidism (12,18) suggested that more attention should be paid to this symptom complex in evaluation of patients with thyroid disease.

Past studies have concentrated more on the taste threshold than hedonic (magnitude) estimation. The present study therefore aims at more complete evaluation of the taste changes in thyroid disorders.

METHODS

The study was conducted in 3 groups of subjects as follows: (1) Normal healthy subjects as control (20 females and 80 males), (2) Hypothyroid (20 females and 10 males) and (3) Hyperthyroid subjects (8 females and 12 males). Patients were taken from thyroid clinic in the Department of Haematology and Nuclear Medicine of Safdarjang Hospital. The ultimate diagnostic criteria for thyroid disorders rested on the clinical signs and symptoms and laboratory estimation of the T_3, T_4 and TSH levels. The normal healthy subjects were students and staff of University College of Medical Sciences.

Taste stimuli: For testing the taste intensity and taste hedonic, 7 concentrations each with starting concentration of glucose (2.00M), sodium chloride

*Corresponding Author

(1.00M), citric acid (0.05M) and Quinine sulphate (0.001M) were used with serial half dilution.

For evaluation of taste responses the subjects were presented the test solutions as per method of Moskowitz (14) and then responses were rated using category scaling. The subjects were instructed to taste each concentration of solution twice, and to rate the taste intensity on 0-6 category scale (0 = no taste, 6 = extremely strong taste). The hedonic rating (pleasantness) was provided on a 6 point scale (1 = extremely disliked, 6 = extremely liked). No neutral point was provided to denote indifference, so that the subjects were required to state whether they liked or disliked the stimulus.

RESULTS

Response to glucose solution (Fig. 1): The intensity and hedonic responses were very similar to control subjects in hyperthyroid subjects. The detection threshold of 20% and the recognition threshold of 40% of the hypothyroid subjects exceeded 0.06M. The decreased intensity response in hypothyroid subjects was qualified with respect to the intensity responses of hyperthyroid subjects and it was found that the decrease was significant at concentrations of 0.25M to 1.0M (Table I). Similarly the hedonic response of the hypothyroid subjects were significantly different than those of the hyperthyroids in the concentration range of 0.13M to 0.5M.

Response to sodium chloride (Fig. 2): The intensity responses of hyperthyroid subjects were uniformly slightly less than those of normal subjects in the entire range of 0.02M to 1.0M. However, their hedonic responses are strikingly different. They rated salt concentration of 0.02M to 0.13M as marginally pleasant and 0.25M to 1.0M as increasingly unpleasant, i.e. they had 'break point' as 0.13M as com-

TABLE I : Taste responses to glucose solutions in control, hypo and hyperthyroid subjects.

Glucose concentration (Moles/lit)	*Intensity Responses*			*Hedonic Responses*		
	Control	*Hypothyroid*	*Hyperthyroid*	*Control*	*Hypothyroid*	*Hyperthyroid*
0.03	0.75±0.54	0.70±0.22	0.85±0.17	3.40±0.42	3.70±0.78	3.60±0.84
0.06	1.65±0.81	1.35±0.57	1.55±0.48	3.5±0.36	3.70±0.92	3.7±0.87
0.13	2.85±0.67	2.40±0.68	2.55±0.71	4.15±0.69	3.80±0.42	4.25±0.58*
0.25	3.35±0.76	2.90±0.37	3.40±0.41**	4.75±1.23	3.90±0.53	4.75±0.66**
0.50	4.4±1.03	3.70±0.52	4.40±0.48**	4.85±1.17	4.50±0.68	5.40±0.53**
1.00	5.9±0.78	4.50±0.36	5.35±0.29***	5.40±0.99	5.25±0.72	5.55±0.49
2.00	5.55±0.31	5.20±0.76	5.90±0.80*	4.35±2.40	4.30±0.69	4.55±0.86

* <0.05, ** <0.01, *** <0.001

TABLE II : Taste intensity and hedonic responses in control, hypo and hyper thyroid subjects.

Sodium chloride concentrationn (Moles/lit)	*Intensity Responses*			*Hedonic Responses*		
	Control	*Hypothyroid*	*Hyperthyroid*	*Control*	*Hypothyroid*	*Hyperthyroid*
0.02	*1.45*±0.56	1.80±1.01	1.10±0.82	3.63±0.37	3.70±0.38	3.80±0.29
0.03	2.45±0.71	2.55±0.49	1.80±0.63**	3.76±0.69	4.20±0.43	3.75±0.29**
0.06	2.80±0.69	3.05±0.53	2.50±0.69*	4.25±0.91	4.60±0.42	4.00±0.37**
0.13	3.80±0.81	3.85±0.51	3.50±0.49	4.35±0.93	4.90±0.83	3.70±0.71**
0.25	4.30±1.08	4.65±0.65	4.30±0.38	4.97±1.12	5.30±1.13	2.80±1.72***
0.50	5.40±0.59	5.50±0.79	4.95±0.93	4.10±0.73	5.00±2.07	2.00±1.68***
1.00	5.85±0.43	5.90±1.23	5.65±1.37	2.80±2.32	3.50±2.61	1.10±1.48**

* <0.05, ** <0.01, *** <0.001

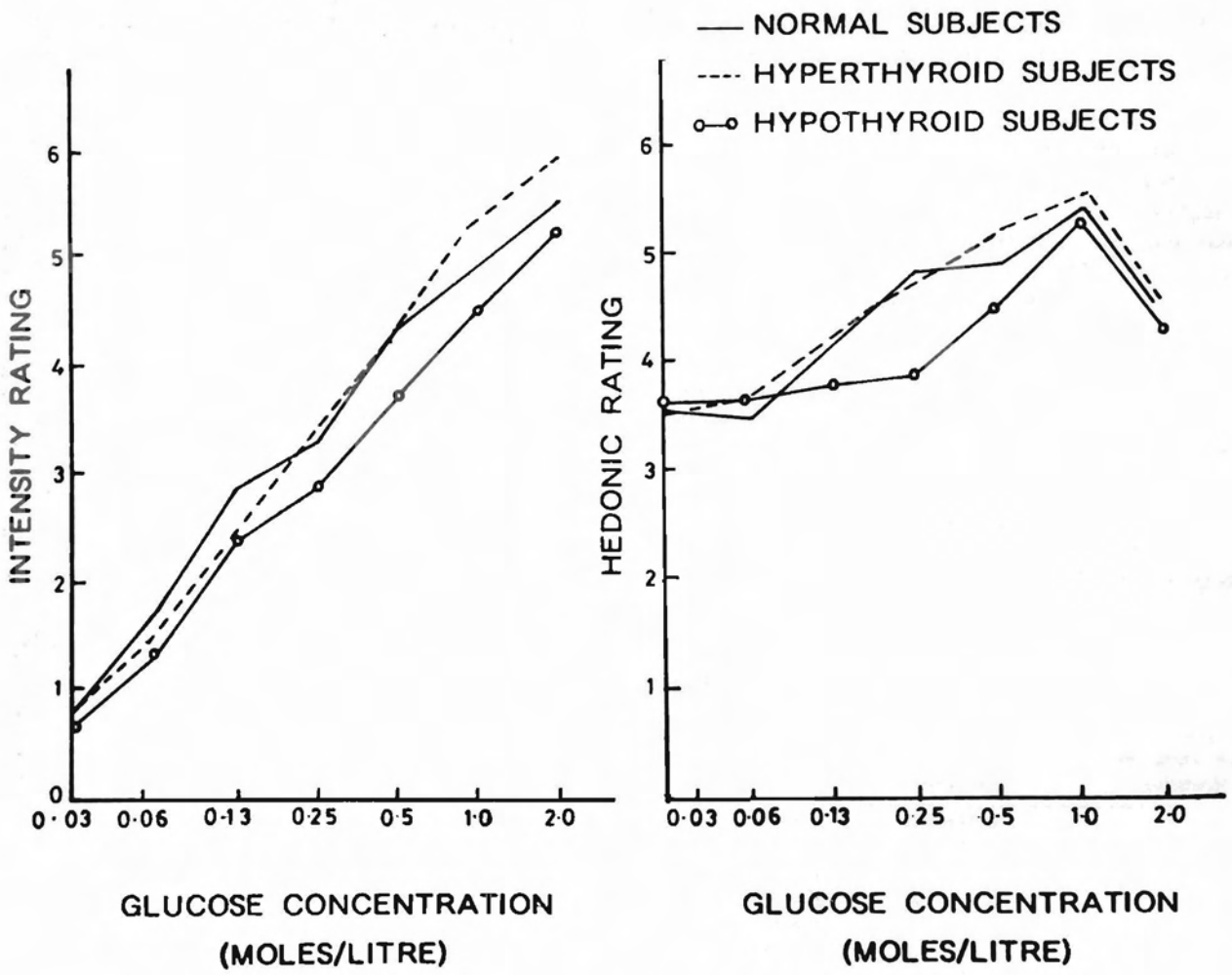

Fig. 1: Intensity and hedonic responses to glucose solution in control, hyper and hypothyroid subjects.

TABLE III : Taste responses to quinine sulphate solution in control, hypo and hyper thyroid subjects.

Quinine sulphate concentrationn (Moles/lit)	*Intensity Responses*			*Hedonic Responses*		
	Control	*Hypothyroid*	*Hyperthyroid*	*Control*	*Hypothyroid*	*Hyperthyroid*
0.000016	0.70±0.38	0.05±0.31	0.60±0.37***	3.75±0.61	3.70±0.53	3.35±0.23*
0.000031	1.45±0.61	0.10±0.43	1.20±0.59***	3.35±0.63	3.80±1.49	2.80±0.67*
0.000063	2.25±1.19	0.40±0.98	2.20±0.85***	3.20±0.76	3.55±1.63	2.45±0.58
0.00013	3.0±1.36	1.0±0.9	2.80±1.15***	2.50±0.79	3.20±1.67	1.70±0.86**
0.00025	4.15±1.17	2.0±1.55	3.80±1.03**	2.25±1.15	2.90±0.69	1.90±0.53***
0.0005	5.40±0.76	2.50±1.66	4.80±1.29**	1.60±1.28	2.10±0.59	1.15±0.76**
0.001	5.50±0.53	3.40±2.03	5.75±1.83**	1.30±2.45	1.50±0.63	1.03±0.81

* <0.05, ** <0.01, *** <0.001

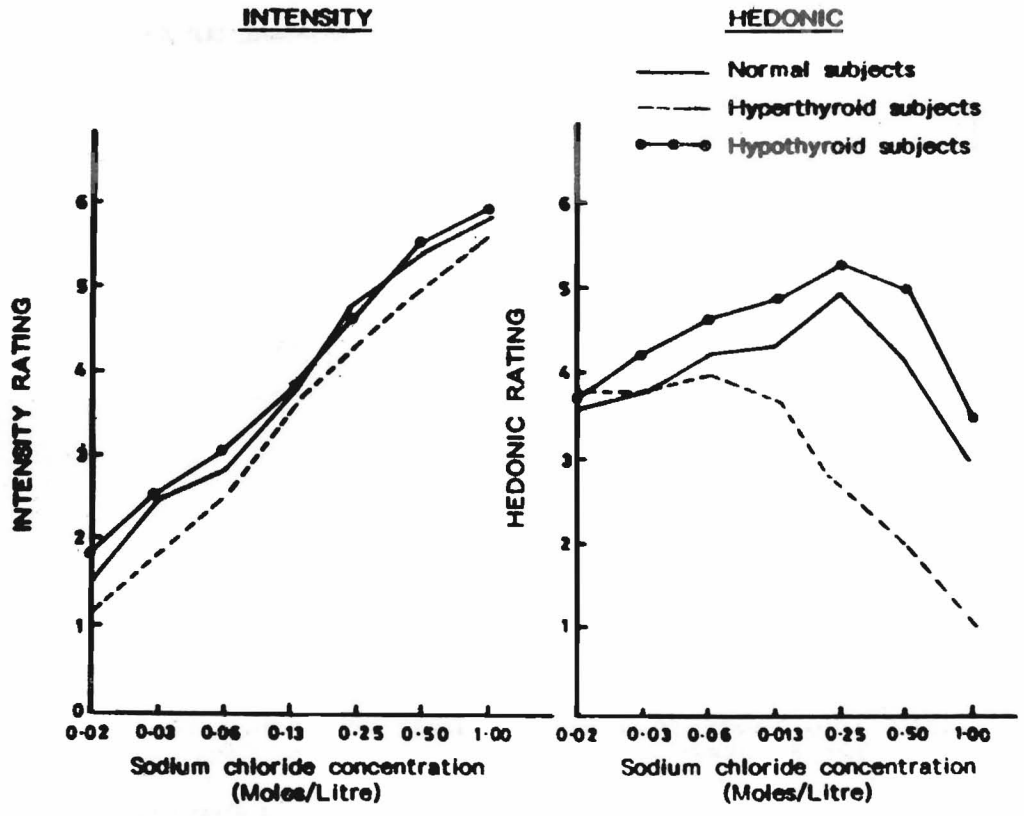

Fig. 2: Responses to sodium chloride solution in control, hyper and hypothyroidism.

pared to 0.25M in control and hypo-thyroid subjects (Table II). The hypothyroid subjects rated the salt solutions as consistently more unpleasant than normal through the entire range of concentration.

Response to citric acid solution (Fig. 3): The intensity responses to citric acid were by and large almost the same in all the three groups of subjects. The hedonic responses to citric acid were similar for the control and hypothyroid subjects. The hyperthyroids rated sourness more unpleasant than control which was statistically significant as compared to hypothyroids, only in the concentration range of 0.0125 to 0.05M.

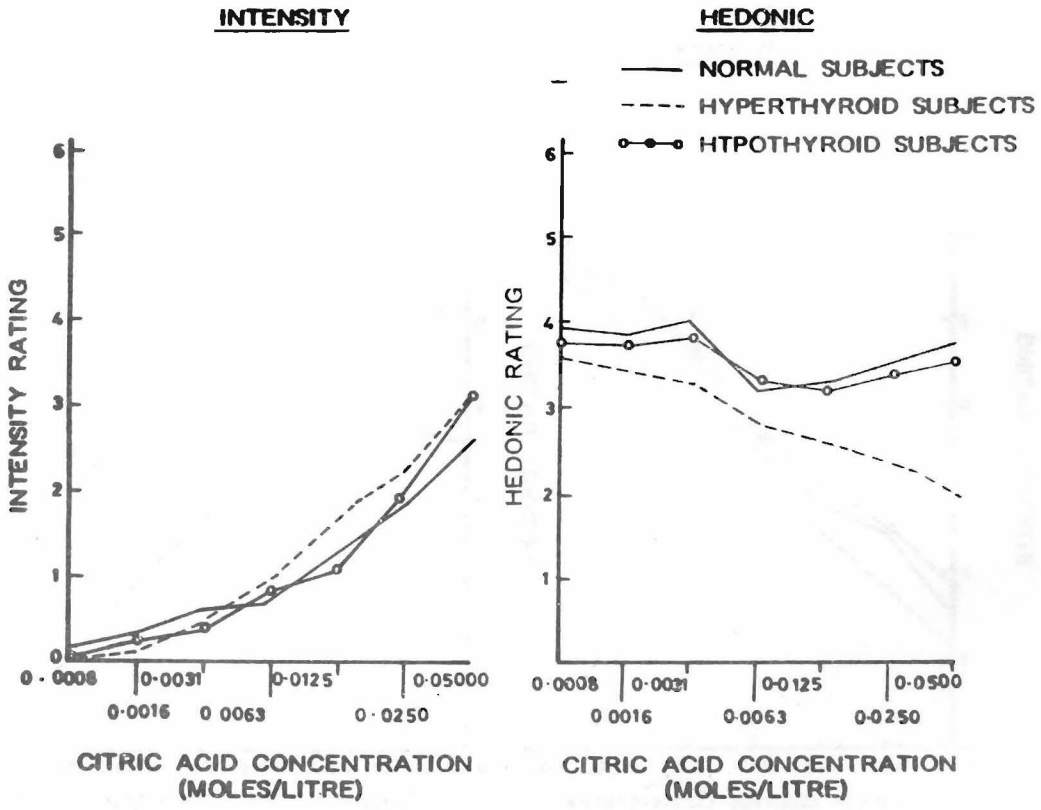

Fig. 3: Taste responses of control, hyperthyroid and hypothyroid subjects to increasing concentrations of citric acid.

Response to quinine sulphate solution (Fig. 4): The intensity responses of the hypothyroids were significantly less than control at all concentrations in the range of 0.00006M to 0.001M. The diminution being more towards the higher concentration (Table III). In the hypothyroid group, only 60% had a detection threshold less than 0.00063M. and only 70% had a recognition threshold less than 0.00013M. The hedonic responses for quinine sulphate were significantly different in hypo and hyperthyroid subjects.

DISCUSSION

The results of the various tests conducted in human subjects indicate that there are some consistent changes in taste response in patients having thyroid discorders. These are (a) the intensity (increase threshold) and hedonic values for sweetness diminished in hypothyroidism, (b) the hedonic value for saltiness increases in hypothyroidism as compared to the control, (c) sourness is perceived as

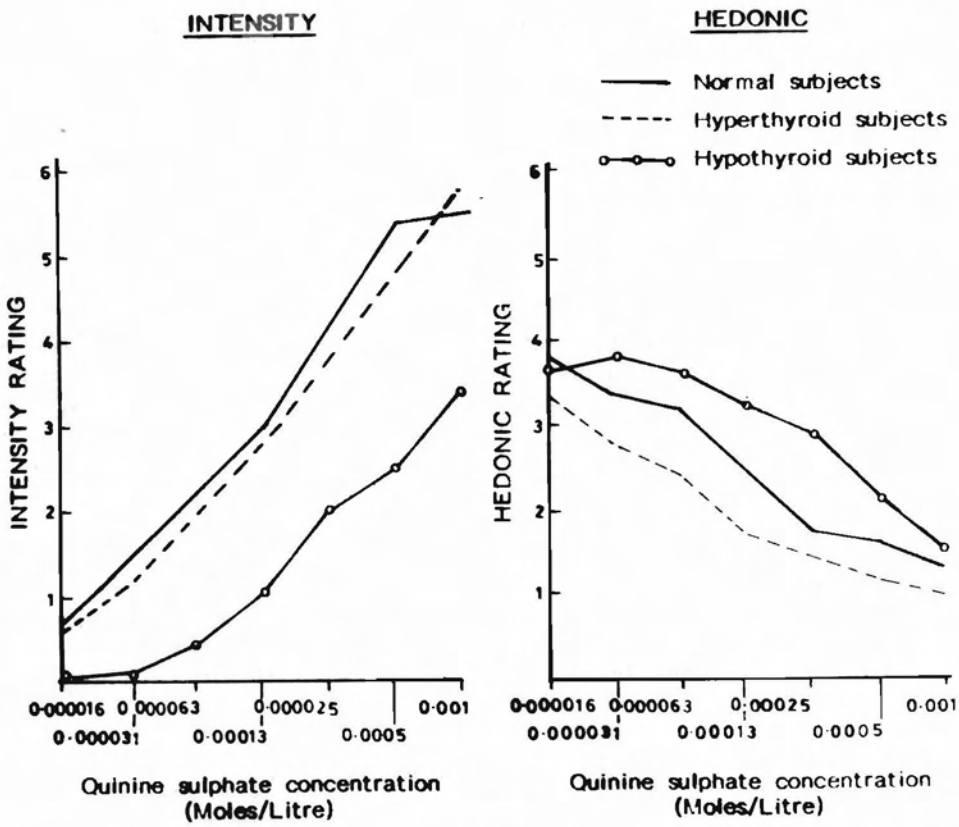

Fig. 4: Intensity and hedonic ratings in control, hyper and hypothyroid subjects to quinine sulphate solutions.

more unpleasant than usual in hyperthyroidism, (d) the intensity perception of bitterness decreases in hypothyroidism as compared to the control, also it is less unpleasant in hypothyroid, and more unpleasant in hyperthyroids, than in control subjects.

Decreased taste responses for glucose in hypothyroid subjects were compared with rats rendered hypothyroid in our experimental study also shows the decrease in consumption for sweet solution. While no perception changes for sweet taste have been reported in thyroixin treated rats (15). Generally gustatory symptoms developed concommitantly with the other symptoms of hypothyroidism, like hypogeusia (17). Defects similar to those observed in patients with hypothyroidism have been reproduced in Holtzman rats, rendered hypothyroid with large doses of radioactive iodine (18). These animals drink less of sucrose than do normal animals.

In hyperthyroidism, salt solutions are perceived as more unpleasant than usual at higher concentration. Such a change is also associated with a decrease in intensity perception. In hypothyroids, only the hedonic tone increases. These changes are reflected in the animal experiment too, where rats consume more salt solution in hypothyroidism and less in hyperthyroidism (19), are not contradictory to an earlier observation by Fregley et al (20) that hypothyroid rats show a preference for saline. The answer to these findings may be in the known abnormalities of cortisol metabolism and observation by Taylor and Fregley (21) that hypothyroid rats are less responsive to administered aldosterone. This become more probable considering that salt appetite is

a very robust phenomenon (8,9) and can manifest even when the serum sodium levels have not altered, significantly.

In hypothyroidism, the bitter solution was rated as less intense (reversal threshold) and also less unpleasant than usual. In hyperthyroidism, however, an opposite change in hedonic response i.e. intensification of unpleasantness was observed without concommitant change in intensity perception. MaConnel et al (12) also emphasized that the most commonly observed taste deficit in patients of hypothyroidism was the loss of taste for bitter stimuli.

The pathogenesis of the defects in the gustatory perception of the basic taste sensations in patients with hypothyroidism is not known. The role of zinc and vitamin 'A' (22,23) in altering the taste responses in hypothyroidism cannot be ruled out. Lastly the changes in hunger and satiety also effects the taste responses.

ACKNOWLEDGEMENTS

The authors are thankful to Prof. K.N. Sharma, Head of the Department of Physiology for his keen interest in the study and providing facilities for this work.

REFERENCES

1. Le Magnen J. Advances in studies on the physiological control and regulation of food intake. *Prog Physiol Psychol* 1971a; 4: 203-261.
2. Nicolaidis S. Sensory neuroendocrine reflexes and their an anticipatory and optimizing role on metabolism. In "The chemical senses and Nutrition" (Kare MR and Muller O.Eds.) *Academic Press New York* 1977; 124-143.
3. Schiffman SS. Taste and smell in diseases. *N Eng J Med* 1983a; 308(2) Part I:1275-1279.
4. Schiffman SS. Taste and smell in diseases. *N Eng J Med* 1983b; 308(22) Part II: 1337-1343.
5. Denton DA, Abraham SF, Blaine EG, McKinley MJ, Nelson JF, Weisinger RS, Whipp GT. Taste and hormones. *Clin Exp Pharm Physiol* 1976; 3:375-381.
6. Brief DJ, Davis JD. Diabetes enhances the palatability of glycerol and glucose. *Physiol Behave* 1982; 29(3):561-566.
7. Cabance M and Duclauz R. Specificity of internal signals in producing satiety for taste stimuli. *Nature (London)* 1970; 227:966-967.
8. Denton DA. Salt Appetite. In "Handbook of Physiology" Vol. I *Am Physiol Soc Wash D.C.*
9. Richter CP. Salt appetite of mammals: Its dependence on instinct and metabolism. In "Li Instinct dans le Compartment Des Animaux et de l 'Home' (M.Autoried.) Masson, Paris. 1956; 577-629.
10. Richter CP, Campbell KH. Sucrose taste thresholds of rats and humans. *Am J Physiol* 1940a;128:291-97.
11. Mayer-Gross W, Walker JW. Taste and selection of food in hypoglycaemia. *Br J Exp Path* 1946; 27:297-305.
12. McConnel RJ, Menendez CE, Smith FR, Henkin RJ, Rivlin RS. Defects of taste and smell in patients with hypothyroidism. *Am J Med* 1975; 50:354-364.
13. Scherr S, King KR. Sensory and metabolic feedback in the modification of taste hedonics. *Physiol Behave* 1982; 29:827-832.
14. Moskowitz HR, Kumaraiah V, Sharma KN, Jacobs HL, Sharma SD. Effects of hunger, satiety and glucose load upon taste intensity and taste hedonics. *Physiol Behav* 1976b; 16:471-475.
15. Vasudev R and Dua-Sharma S. Gustatory metabolic consequences of thyroixine treated rats. *Prof Int Union Physiol Sc XXVI Int Cong New Delhi* 1974; Vol. XI:232.
16. Jacobe HL, Sharma KN. Taste vs Calories: Sensory and metabolic signals in the controls of food intake. *Ann NY Acad Sci* 157:1084-1125.
17. Henkin RI, Schechter PJ, Hoye R, Mattern CFT. Idiopathic hypogeusia with dysgeusia, hypoosmia and dysosmia. A new syndrome. *JAMA* 1971; 217:434.
18. McConnel RJ, Menendez CE, Osnos M, Rosenthal S, Rivlin RS and Henkin RK. Clinical and laboratory studies on defect of taste or smell in hypothyroidism (abstract). *Presented at the Annual Meeting of the American Thyroid Association*, September, 18-21, 1974; St. Louis, Missouri.
19. Bellow AA, Covian MR. Effect of the excess of thyroid in hormone administration on water and sodium chloride intake in the rat. *Physiol and Behave* 1988; 43:155-157.
20. Frigley MJ, Galindo O, Cool KM. Spontaneous sodium chloride appetite of goitrogen-treated rats: Effects of hypophysectomy and adrenalactomy. *Endocrinology* 1961; 69:1060.
21. Taylor RE Jr, Fregley MJ. Renal responses of propylthiouracil treated rats to injected mineralocorticoids. *Endocrinology* 1964; 75:33.
22. Bernard RA, Halpern BP, Kare MR. Effect of vitamin 'A' deficiency on taste. *Proc Soc Exp Biol Med* 1961; 108:784.
23. Bernard RA, Halpern BP. Taste changes in vitamin 'A' deficiency. *J Gen Physiol* 1968; 52:444.