

Taste recognition threshold in different phases of menstrual cycle

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Abstract:

Taste, a neurochemical modality, plays an important role in maintaining appropriate nutritional balance. Taste threshold vary with age and sex of the individual. Taste threshold also varies with the phase of menstrual cycle. The aim of the present study was to assess the relationship between different phase of menstrual cycle and taste threshold for four basic taste modalities (i.e. sweet, salt, sour and bitter). We studied taste threshold in 50 female subjects. The study was carried out in 3 phases, i.e. menstrual, follicular and luteal phases. The taste threshold was evaluated using 7 different serially half diluted concentrations of glucose (2.00 M- 0.031 M), NaCl (1.00 M- 0.0156 M), citric acid (0.05 M- 0.0007 M) and quinine sulphate (0.001 M- 0.000015 M). All taste modalities show alternation in different phases of menstrual cycle ($p < 0.05$) except for sour ($p > 0.05$). Thus the cyclical variations of hormones during menstrual cycle affect the taste threshold.

Keywords: Taste threshold, Menstrual phase, Follicular phase, Luteal phase.

Introduction:

Taste, a neurochemical modality, plays an important role in maintaining appropriate nutritional balance (1). Considerable variation is found in the distribution of four basic types of taste buds in various species and amongst the individual of a given species (2). Taste thresholds of women are generally lower than those of men and they vary during different phases of menstrual cycle with increased sensitivity at mid-cycle (3). Female hormones undergo quantitative changes during critical periods of their life i.e. menstrual cycle, pregnancy and menopause. The menstrual cycle is a time of many widespread changes affecting both body and mind (4). The menstrual cycle is the term for the physiological changes that can occur in fertile women for the purposes of sexual reproduction and fertilization. The menstrual cycle is under the control of the endocrine system, is necessary for reproduction. The menstrual cycle is a complex interaction between the reproductive system and the endocrine system. This interaction is dedicated to the maintenance of the productive function and an appropriate hormonal balance in women.

It is documented that gustatory and food habits change during menstrual cycle (5-6). Variation in preference for sucrose during different phases of menstrual cycle has been very well documented (7). Increase in salt appetite or intake during pregnancy and lactation in animal and in human is also very well documented (8), but there is scarce data related to sour and bitter preference during different phases of menstrual cycle. Also, less data is available on taste recognition threshold during menstrual cycle for Indian population. So we formulated the present study to compare the variations in taste recognizing threshold during different phases of menstrual cycle for all four basic taste modalities.

Material and Methods:

The present study was conducted in the Department of Physiology, Government Medical College & Hospital, Nagpur after taking approval from Institutional Ethics Committee. Subjects included were 50 female volunteers of 18 to 20 years of age.

Inclusion criteria are:

1) All non-obese females having regular menses (28–30 days) for 3 previous cycles without history of any significant illness were selected for the study (9).

Exclusion criteria are:

- 1) Pregnant and lactating women (9, 10).
- 2) Those who are on oral contraceptive and any prescribed medicine (9).
- 3) Mental, gynaecological disorders and disorder related to eating (9).
- 4) Smoking and alcoholics (11).

Taste recognition threshold done was done during three phases of menstrual cycle i.e. menstrual phase (day 1–6), follicular phase (day 7–14) and luteal phases (day 15–28 to 30) in this study. All the taste parameters were recorded during these 3 phases (8).

Precautions:

Following precautions were taken before starting the experiment (12).

- 1) The subjects were asked not to eat or drink anything except water at least for one hour before the threshold measurements.
- 2) At the time of testing the entire procedure was explained to each subject.
- 3) Tests were carried out in the morning time between 8 to 11 am.

Taste stimuli: Stimulus representing the four classical basic

Original Article

tastes was included for tasting the recognition taste threshold for particular taste. Seven serial half dilutions of the stock concentration were made for each taste solution, by using deionised distilled water and used for experiment (13). The starting concentrations were glucose (2.00 M), sodium chloride (1.00 M), citric acid (0.05 M), and Quinine sulphate (0.001 M). The taste threshold for each solution was investigated as per Harris and Kalmus method assisted by forced choice and up down tracking procedure for better output and result (14). Subjects were given two or three drop of the solution of lowest concentration on the dorsum of tongue to taste first and then tasted successive higher solution until a definite taste was identified. Distilled water was used in between two solutions for rinsing. Rinsing of mouth was repeated till the subject volunteer said that no taste of the previously tasted concentration lingers on. Accordingly the actual threshold concentration was determined and the bottle number noted. Standard sequence was followed for taste recognition threshold i.e. sweet first followed by salt, sour and bitter taste solution (15). The statistical analysis was done by using Kruskal-Wallis test.

Results:

Taste recognition threshold for sweet taste :

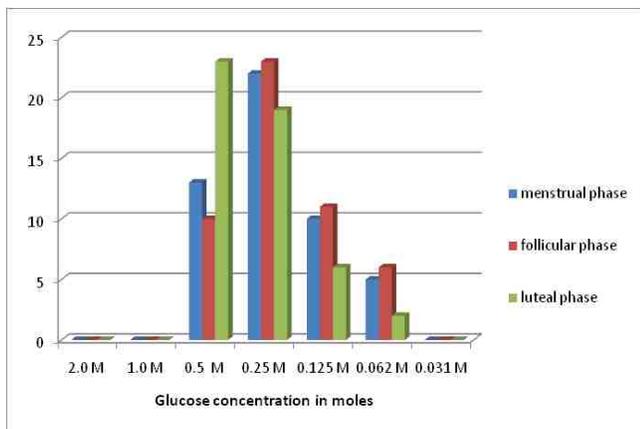


Figure 1: Sweet taste response in different phases of menstrual cycle

It was observed that at 0.125 molar and lower concentrations in follicular phase seventeen subjects were able to recognize sweet taste properly while in menstrual phase fifteen subject and in luteal phase eight subjects were able to recognize sweet taste properly. For higher concentration that is 0.25 molar and above, thirty three subjects in follicular phase while thirty five subjects in menstrual phase and forty two subjects in luteal phase were able to recognize sweet taste properly. In general luteal phases subjects show statistically significant raised threshold than follicular phase subjects ($p < 0.01$), while no statistically significant difference is seen between menstrual and follicular phase and also in between menstrual and luteal phase ($p > 0.05$). (Figure 1)

Taste recognition threshold for salt taste :

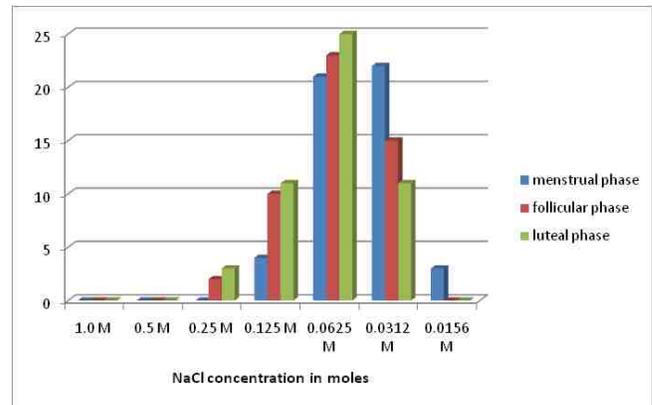


Figure 2: Salt taste response in different phases of menstrual cycle

It was observed that at 0.0312 molar and lower concentrations, in menstrual phase twenty five subjects were able to recognize salt taste properly while follicular phase and luteal phase fifteen and eleven subjects were able to recognize salt taste properly. For higher concentration that is 0.625 molar and above, menstrual phase twenty five subjects were able to recognize salt taste properly while follicular phase and luteal phase thirty five and thirty nine subjects were able to recognize salt taste properly. In general follicular phase ($p < 0.05$) and luteal phase ($p < 0.01$) subjects show statistically significant raised threshold than menstrual phase subjects. (Figure 2)

Taste recognition threshold for sour taste (Figure 3):

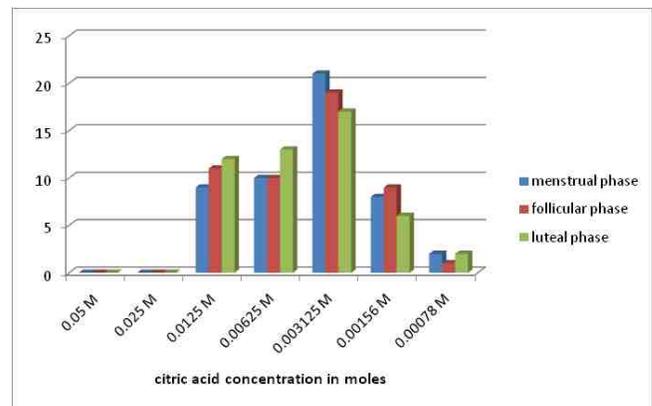


Figure 3: Sour taste response in different phases of menstrual cycle

It was observed that at 0.003125 molar and lower concentrations in menstrual phase thirty one subjects were able to recognize sour taste properly while follicular phase and luteal phase twenty nine and twenty five subjects were able to recognize sour taste properly. For higher concentration that is 0.00625 molar and above, menstrual phase nineteen subjects were able to recognize sour taste

properly while follicular phase and luteal phase twenty one and twenty five subjects were able to recognize sour taste properly. In general sour taste threshold do not show statistically significant alteration in different phases of menstrual cycle ($p > 0.05$). However, sour taste threshold is seen to be increase in luteal phase. (Figure 3)

Taste recognition threshold for bitter taste (Figure 4):

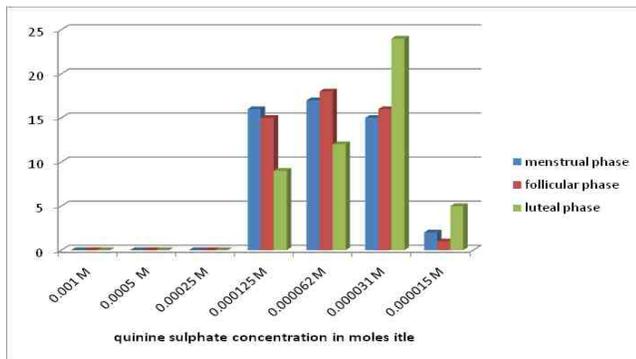


Figure 4: Bitter taste response in different phases of menstrual cycle

It was observed that at 0.000031 molar and lower concentrations, in luteal phase twenty nine subjects were able to recognize bitter taste properly while menstrual phase and follicular phase seventeen subjects were able to recognize bitter taste properly. For higher concentration that is 0.000062 molar and above, luteal phase twenty one subjects were able to recognize bitter taste properly while menstrual phase and follicular phase thirty three subjects were able to recognize bitter taste properly. In general luteal phase subjects shows statistically significant decrease taste threshold than menstrual and follicular phase subjects ($p < 0.05$). (Figure 4)

Discussion:

It is well known that taste threshold alters in different phases of menstrual cycle (5,6), however, the result of previous studies often presented with varying conclusion (16). The result of the present study revealed statistically significant variations for four basic taste modalities during different phases of menstrual cycle. In general follicular phase shows raised salt threshold, luteal phase shows raised salt and sweet threshold, but decreased bitter taste threshold.

In agreement with previous studies (7,17), the increased sweet taste threshold may be one of the reasons for increased sweet (carbohydrate) consumption during luteal phase. Dalvit-McPhillips (18) have found significant and consistent variation during the menstrual cycle only in carbohydrate consumption, not in fat or protein. The data showed that women consumed more carbohydrate per day in the luteal phase than in the follicular phase. It was postulated that this increased carbohydrate intake may be an attempt to compensate for the change in basal metabolic rate. She also

noted the well described anorectic effect of oestrogen levels in other mammalian species. Thus the decrease in taste threshold for sweet taste during follicular phase may be related to high level of oestrogen and that increase taste threshold for sweet taste during luteal phase may be due to interaction between oestrogen and increased progesterone.

The present study shows taste recognition threshold for salt is increased during follicular and luteal phase as compared to menstrual phase. This is similar to the findings of with Verma et al (8) and Frye et al (19). Females in their follicular and luteal phase of their menstrual cycle have high levels of circulating oestrogen and progesterone and these hormones appear to be related to salt intake. Thus the female salt preference increases when levels of endogenous hormones are high and decline when level of these hormones are lower. This view is supported by the studies which reported that salt appetite or intake increase when animal's oestrogen and progesterone levels are exogenously or endogenously increased (20-21). Besides the direct effect of hormones on salt appetite there could be indirect effects of oestrogen on salt appetite through opioid receptor (22) while that of progesterone is by affecting the membrane fluidity and flux of ions (23) that may cause increased sodium requirement and its appetite.

Our data also revealed that during luteal phase bitter taste recognition threshold decreased, these findings are consistent with the observations made by Alberti-Fidanza et al (5) and reason for this may be increased progesterone level in luteal phase.

Present study does not reveal significant alteration for sour taste recognition. Alberti et al (5) and Sueda K et al (16) have come out with the similar observation. However, mild rise in sour taste threshold is seen in our study during luteal phase. This may indicate reduction in unpleasantness for sour taste, which may further continue for more preference for sour food in first trimester of pregnancy (10).

In present study cyclical changes in taste recognition threshold are seen predominantly for sweet and salt taste during different phases of menstrual cycle. However, the causes of these variations are still unclear and it may be attributed to cyclical physiological variation of oestrogen and progesterone. Decrease threshold for bitter taste during luteal phase as seen from our study may explain the aversion for bitter taste, and which may secondarily lead to preference for salt and sweet.

Further, the highest preference for sweet and salt during luteal phase might be associated particularly with raised progesterone level and could be correlated to increased weight gain and other premenstrual symptoms. We conclude that taste threshold changes during menstrual cycle. This Altered taste threshold can modify food preference and diet of individual. A cyclical hormonal change during menstrual cycle is one of the factors responsible for it. However, further studies involving hormonal assays along with taste recognition threshold during different phases of menstrual cycle are needed.

Original Article**References:**

- 1) Danker HH, Roczen K, Lowenstein WU. Regulation of food intake during menstrual cycle. *Anthropol Anz* 1995; 53: 231–238.
- 2) Ganong WF. Smell and taste. In *Review of Medical Physiology*, 21st Ed Asia: McGraw-Hills Companies 2003: 188-194.
- 3) Zverev Yurii P. Effects of caloric deprivation and satiety on sensitivity of the gustatory system. *BMC Neuroscience* 2004; 5:1471: 2202-5.
- 4) Kaur Sandeep, Manchanda KC, Garg A, Maheshwari A. Effect of female sex hormones on central auditory conductivity in young rural females in Bhatinda district of Punjab. *National J of Physiol, Pharmacy and Pharmacology* 2013; 3(2): 124-128.
- 5) Alberti-Fidanza A, Fruttini D, Servili M. Gustatory and food habit changes during the menstrual cycle. *Int J Vitam Nutr Res* 1998; 68(2): 149-153.
- 6) Kuga M, Ikeda M, Suzuki K. Gustatory changes associated with the menstrual cycle. *Physiol Behav* 1999; 66(2): 317-322.
- 7) Than TT, Delay ER, Maier ME. Sucrose threshold variation during the menstrual cycle. *Physiol Behav* 1994 Aug; 56(2):237-239.
- 8) Verma P, Mahajan KK, Mittal S, Ghildival A. Salt preference across different phases of menstrual cycle. *Indian J Physiol Pharmacol* 2005 Jan; 49(1):99-102.
- 9) Masayo M, Kazuyuki S, Toshiya F, Fukuko K. Positive relationship between menstrual synchrony and ability to smell 5 androst-16-en-3-ol. *Chem Senses* 2000; 25: 407-411.
- 10) Nicole Ochsenbein-Kolble, Ruth Von Mering, Roland Zimmermann, Thomas Hummel. Changes in gustatory function during the course of pregnancy and postpartum. *BJOG* 2005; 112: 1636–1640.
- 11) Mojet J, Heidema J, Elly C. Taste perception with age; generic or specific losses in suprathreshold intensity of five basic taste qualities? *Chem Senses* 2003; 28: 397-413.
- 12) Loretta MM, Nielsen Cr. Sucrose taste threshold: age related differences. *J of Gerontology* 1982; 37(1): 64-69.
- 13) Bhatia S, Sircar SS, Ghorai BK. Taste disorder in hypo and hyperthyroidism. *Ind J Physiol Pharmacol* 1991; 35(3): 152-158.
- 14) Harris H, Kalmus H, Trotter WR. Taste sensitivity to phenylthiourea in goitre and diabetes. *Lancet* 1949; 2(6588): 1038-1039.
- 15) Schroeder JA, Schroeder E. Use of the herb gymnema sylvestre to illustrate the principles of gustatory sensation: An undergraduate neuroscience laboratory exercise. *The J of Undergraduate Neurosci Edu* 2005; 3(2): A59-A62.
- 16) Sueda K, Atsumi K, Inayoshi T, Okad E. Gustatory changes associated with menstrual cycle-threshold for sweet, sour and bitter taste. *Natural Science* 2004; 50: 29-34.
- 17) Pliner P, Fleming A. Food intake, body weight and sweetness preferences over menstrual cycle in humans. *Physiol Behav* 1983; 30: 663–666.
- 18) Davit-McPhillips SP. The effect of the human menstrual cycle on nutrient intake. *Physiol and Behav* 1983; 31: 209-212.
- 19) Frye CA, Demolar GL. Menstrual cycle and sex differences influence salt preference. *Physiol and Behav* 1994; 55: 193-197.
- 20) Denton DA, Nelson JF. The control of salt appetite in wild rabbits during lactation. *Endocrinology* 1978; 103: 1880–1887.
- 21) Fregly MJ, Newsome DG. Spontaneous NaCl appetite by administration of an oral contraceptive and its components to rats. In: Kare M, Fregly MJ, Bernard RA, eds. *Biological and behavioural aspects of salt intake*. New York: Academic Press: 1980: 248–272.
- 22) Gosnell BA, Majchrzak MJ, Krahn DD. Effect of preferential delta and kappa opioid receptor agonists on the intake of hypotonic saline. *Physiol Behav* 1990; 47: 601–603.
- 23) Carlson JC, Gurber MY, Thompson JE. A study of the interaction between progesterone and membrane lipids. *Endocrinology* 1983; 117: 190–194.