INVESTIGATION OF TASTE SENSATION IN HUMAN SUBJECTS DURING PROLONGED INHALATION OF OXYGEN

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Various workers have shown that the sensation of taste is influenced by the taking of food, by temperature, light, and noise [1, 2, 3], and also by a deficiency of oxygen in the inspired air [4, 5]. The investigations of N. V. Timofeeva, conducted at an altitude of 2800, 3200, and 4250 m, showed that taste sensitivity is depressed as altitude increases. According to O. V. Solovei, very little change occurs in the taste sensitivity as a result of a lowering of the barometric pressure (in a pressure chamber) to that corresponding to an altitude of 5000-7000 m. These studies were important for the organization of feeding of persons whose activity is associated with oxygen deficiency.

However, with the development of aviation techniques, the factor of oxygen deficiency has lost much of its importance. Meanwhile, in connection with prolonged high-altitude flights, a new factor affecting the issue has appeared, viz. the prolonged inhalation of a gas mixture with an increased oxygen concentration.

We have studied the effect of prolonged inhalation of oxygen on the changes in taste sensation in human subjects receiving an appropriate diet. Changes in the level of taste sensation are known to be affected by the functional state of the alimentary tract [2]. Reflex influences from the interoceptors of the stomach on the taste receptors largely determine these changes. Investigations conducted at different intervals after taking food provide material from which the dynamics of the changes in the taste analyzer can be assessed, and reveal the time intervals at which regular meals must be taken.

EXPERIMENTAL METHOD

Observations were made on two men aged 21 years, comprising 48 experimental and 32 control determinations. The method of "functional mobility" was used, demonstrating not only the changes in the level of sensation, but also the powers of adaptation of the sense organs investigated. Investigations of the sensitivity of the individual taste papillae of the tongue (4 fungiform papillae), situated in the anterior third of the tongue, were made. Solutions of substances with a strong taste were applied in a concentration above the threshold level to the papillae under investigation, by means of glass capillary tubes. Each test of the same solution in the same concentration was applied at intervals of 2 or 3 min 12 times in the course of the investigation (since there were 4 papillae, in each experiment 48 determinations of the sensitivity were made). After each test, the subject rinsed his mouth with warm water, and before the test he dried his tongue with filter paper. Solutions of sugar (concentration 44.5%), common salt (26%) citric acid (4%) were used.

Only the experimenter and the subject were present in the pressure chamber during the experiment. After each experiment the subjects completed special questionnaires, giving their assessment of the taste qualities of the food they had eaten, whether it was sufficient in amount, describing their appetite and stating whether or not they were satisfied with the diet. Throughout the investigation the subjects remained under observation by the physician. The period of oxygen inhalation lasted up to 8 h and the experiments up to 10 h. Strict uniformity was enforced as regards the diet and the times of determination of the taste sensitivity during the experiments, in which the subject was "raised to an altitude of 5500 m" in the pressure chamber and inhaled a gas mixture with an increased concentration of oxygen, supplied from an oxygen apparatus, and during control tests in which he was kept at a normal pressure and inhaled ordinary atmospheric air.

TABLE 1. Dynamics of Changes in the Level of Mobilization of the Taste Papillae in Relation to the Functional State of the Alimentary Tract

Functional state of alimentary tract	Level of mobilization of taste papillae	
	normal	experiment
Fasting	+46 –2	+43 –5
5 min after eating	+23 –25	+19 –29
1.5 min after eating	+31 –17	+27 –21
4 h after eating	+40 –8	+40 –8

TABLE 2. Comparison between Changes in Taste Sensitivity at Ground Level Inhaling Atmospheric Air and at a "High Altitude" Inhaling a Gas Mixture with an Increased Oxygen Concentration

Functional state of alimentary tract	Level of mobilization of taste papillae during inhalation of		Duration of oxygen inhalation (in hours)
	atmospheric air	a gas mixture with an increased O_2 concentration	
4 h after 1st meal	+39–9	+41–7	2.5
1.5 after 2nd meal	+36–12	+36–12	4
4 h after second meal	+38–10	+38–10	6
45 min after third meal	+29–19	+30–18	8

EXPERIMENTAL RESULTS

Initially it was necessary to determine the level of taste sensitivity of the subjects in ordinary conditions, so that it could be compared with existing data for the state of taste sensation in the normal human subject [2]. For this purpose the pattern of the changes in taste sensitivity in relation to the taking of food was studied in 8 experiments: fasting, and 5 min, 1.5 h and 4 h after taking food. The results of the investigations are given in Table 1 (mean experimental data are given: the figures denote the number of positive and negative determinations of sensitivity).

It follows from Table 1 that the level of mobilization of the taste papillae of these subjects differed hardly at all from the normal values as a result of taking food. In the experiments in which a gas mixture with an increased oxygen concentration was inhaled, besides breakfast the subjects ate food every 4.5 h. In both control and experimental subjects the level of mobilization of the taste papillae was determined 4 h after the first meal, 1.5 and 4 h after the second meal, and 45 min after the third meal.

The results given in Table 2 show that inhalation of the gas mixture with a high oxygen concentration at a "high altitude" for 2.5-8 h did not alter the taste sensitivity of the subjects. In these conditions, the general principles governing the activity of the taste analyzer during the taking of food remained undisturbed. The indices of the level of mobilization of the taste papillae before taking food also show that intervals of 4.5 h between meals are normal, and this was also observed subjectively (by the development of appetite).

No changes therefore took place in taste sensitivity of subjects kept in a pressure chamber at a barometric pressure equivalent to an altitude of 5500 m and inhaling for a period of between 2.5 and 8 h a gas mixture with an increased oxygen concentration. This, in turn, was evidence of the normal functioning of the alimentary tract. It seems that other factors, namely emotional stress, vibration, etc. during flight may affect the sense of taste, and this is a matter for special investigation.

Another series of experiments was conducted, in which the subjects were kept for long periods (about 23 days) on a diet of liquids or food in paste form, with a limited quantity of bread. These investigations showed that the change from a normal to the experimental diet did not affect the level of taste sensitivity or the normal functioning of the alimentary tract in the subjects, although some of them occasionally developed an aversion towards the new diet.

The technique of determining the functional mobility of the taste receptor apparatus may be used in the study of feeding during long, high-altitude flights.

SUMMARY

The paper describes the effect produced by prolonged oxygen inhalation on the changes occurring in taste sensitivity of subjects on a strictly planned diet. No changes occur in the taste sensitivity of humans placed in a barochamber with an atmospheric pressure corresponding to an altitude of 5500 m and gas mixture with an increased oxygen content for 2.5-8 hours; this points to normal function of the digestive tract.

This method of determining the functional mobility of the taste receptor apparatus may be used to study nutritional problems in prolonged high-altitude flights.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
