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# HALITOSIS: CAUSES, DIAGNOSIS, AND TREATMENT

## HALITOZA: PRZYCZYNY, DIAGNOSTYKA, LECZENIE

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**A –** przygotowanie projektu badania | study design, **B –** zbieranie danych | data collection, **C –** analiza statystyczna | statistical analysis, **D –** interpretacja danych | interpretation of data, **E –** przygotowanie maszynopisu | manuscript preparation, **F –** opracowanie piśmiennictwa | literature review, **G –** pozyskanie funduszy | sourcing of funding

**SUMMARY**

Nowadays halitosis is a common disorder, with a wide range of causes, mostly dental, laryngological, and gastrological. There are many ways to diagnose halitosis, but it is not always possible to determine its cause. There are also many ways of managing it, therefore patients should be encouraged to seek diagnosis and treatment for this troublesome ailment.

Halitosis (*halitus*: smell; *osis*: chronic dysfunction) refers to the presence of a persistent unpleasant mouth odor, which can last for years. Halitosis can also be referred to as fetor oris, bad breath, oral malodor, ozostomia, and stomatodysodia. Apart from actual halitosis, there are also pseudohalitosis and halitophobia, when the people around the patient detect no unpleasant mouth odor, but the patient believes it is present. Fetor oris is quite a common problem, with studies confirming about 15–30% incidence among the population. Bad breath may be a symptom of other diseases, such as gastrointestinal and respiratory tract disorders or metabolic disorders. Dietary and hygienic habits are of great significance in causing halitosis. The easiest and most common diagnostic method of establishing halitosis is for the doctor to smell the patient's exhaled air (the organoleptic method). Another easy test is the BANA test, which detects one of the proteolytic enzymes generated by the bacteria that colonise the plaque and the back of the tongue. There is also a test to objectively measure the severity of halitosis using the halimeter, a device that measures the amount of volatile sulfides in the exhaled air. Furthermore, there is gas chromatography, a very sensitive and accurate method of separately measuring the amount of each of the volatile sulfides in the exhaled air; unfortunately the test is very expensive. Halitosis management consists primarily of treating the underlying disease, and maintaining strict oral hygiene, using appropriate oral mouthwashes and chewing gums.

**KEYWORDS:** halitosis, halimeter, organoleptic measurement, volatile sulfides

**STRESZCZENIE**

W dzisiejszych czasach halitoza jest często występującym schorzeniem o różnych podłożach, na ogół stomatologicznym, laryngologicznym i gastrologicznym. Halitozę można diagnozować na wiele sposobów, lecz nie zawsze daje się ustalić jej przyczynę. Istnieje wiele dostępnych możliwości leczenia tej dolegliwości, dlatego należy zachęcać pacjentów, by zgłaszali się do lekarza i rozpoczynali kurację.

Halitoza (*halitus*: zapach; *osis*: przewlekłe zaburzenie) to uporczywy, nierzadko utrzymujący się przez lata, nieprzyjemny zapach z jamy ustnej. Inne nazewnictwo halitozy, które spotykamy w literaturze to: fetor oris, przykry

zapach z ust, nieświeży oddech, ozostomia i stomatodysodia. Oprócz halitozy prawdziwej rozpoznajemy również pseudohalitozę i halitofobię, kiedy to nieprzyjemny zapach z ust nie jest wyczuwalny przez otoczenie, ale pacjent uparcie skarży się na jego występowanie. Fetor ex ore jest obecnie dość powszechnym problemem, zgodnie z wynikami badań stwierdzonym u około 15–30% populacji. Dolegliwość ta może być objawem chorób nie tylko jamy ustnej, ale również przewodu pokarmowego, układu oddechowego, a także chorób metabolicznych. Bardzo istotnymi czynnikami w wywoływaniu halitozy są nasze przyzwyczajenia dietetyczne i higieniczne. Najprostszą i najpowszechniej stosowaną metodą określenia halitozy jest ocena zapachu powietrza wydychanego przez pacjenta za pomocą własnego węchu (badanie organoleptyczne). Praktycznym i łatwym w użyciu jest test BANA, wykrywający jeden z enzymów proteolitycznych wytwarzanych przez bakterie kolonizujące płytkę poddziąsłową i grzbiet języka. Do metod obiektywizujących zjawisko halitozy zaliczamy badanie za pomocą halimetru, urządzenia mierzącego zawartość lotnych związków siarki w powietrzu wydychanym przez pacjenta. Do bardzo dokładnych i czułych, ale zarazem i bardzo kosztownych metod diagnostycznych zalicza się chromatografię gazową, mierzącą pojedynczo związki siarki w wydychanym powietrzu. Leczenie halitozy polega przede wszystkim na leczeniu choroby podstawowej, poza tym na utrzymywaniu bardzo dobrej higieny jamy ustnej, stosowaniu odpowiednich płukanek i gum do żucia.

**SŁOWA KLUCZOWE:** halitoza, halimter, ocena organoleptyczna, lotne siarczki

## Background

With the increase in interest in healthy lifestyles and hygiene, there has also been increased awareness of bad breath, leading individuals to consult with dentists, otorhinolaryngologists, and general practitioners.

The name "halitosis" (*halitus*: smell; *osis*: chronic disorder) was created in the 1920s and remains in common use in the medical literature and everyday speech. Synonyms include fetor oris, oral malodor, and bad breath [1–2].

The classification of halitosis distinguishes genuine halitosis (of oral or extraoral origin), from pseudohalitosis and halitophobia. Genuine halitosis is defined as a bad smell of unacceptable intensity from the oral cavity. In pseudohalitosis, patients believe that they are suffering from bad breath, but this is not sufficiently intense to be noticed by others. Pseudohalitosis can be managed through consultation (explaining of the results of laboratory tests, recommending literature, and training) and simple oral hygiene. A diagnosis of halitophobia should be made if the patient, following successful treatment for genuine halitosis or pseudohalitosis, continues to complain of bad breath, despite of absence of any symptoms in physical examination [1, 3–4].

The Vorher test allows patients with pseudohalitosis to be distinguished before applying specific tests for halitosis. It consists of a five-question test created by Christoph Benz of Ludwig Maximilian University, Munich. The test includes questions about the intensity of the bad breath according to the patient and other people [5].

## Epidemiology of halitosis

Halitosis is a common problem: according to population studies, it affects 15–30% of the population. It is most common in seniors, patients with mental disorders, and those with ineffective oral hygiene [3].

## Causes of halitosis

The most common causes of halitosis are stomatological diseases (over 80%), such as calculus, chronic gingivitis, periodontitis, caries, poor oral hygiene (mostly of the base of the tongue, which is very broad, segmented, and has many papillae, encouraging the deposition of food, epithelial cells, and saliva constituents), bacterial and fungal stomatitis, inflammatory alterations in mucus membrane and bones, tumors, developmental changes in mucosa and tongue, and piercing [1–2, 4, 6–8].

The second most common class of causes is laryngological origins (about 5–10% of cases), such as acute and chronic inflammation, tonsillolithiasis, tonsil pockets, acute and chronic rhinosinusitis, nasal polyps, obturation of the nasal duct (such as nasal septum deviation), foreign bodies in the nasal duct (mostly in children), diseases of the salivary glands, and tumors of the nasopharynx, sinus, upper respiratory tract and digestive tract [1, 3–4, 7–9].

Gastroenterological causes are also significant (5% of cases), and include gastroesophageal reflux disease (GERD), Crohn's disease, and ulcerative colitis. GERD is the most common gastroenterological cause of halitosis as acidic reflux can produce lesions of the oral cavity, esophagus, and oral epithelium [1–2, 4, 7–8].

Systemic diseases can also contribute to halitosis. These include diabetes (which can produce an acetone odor from the mouth), chronic renal diseases (fishy odor), hepatic failure, Sjogren syndrome, or ketosis, as in starvation [1, 7–8].

Xerostomy also affects oral odor, and all sources of dryness can also cause halitosis: these include psychosis, depression, stress, hyperthyroidism, GvHD reactions on transplantation, avitaminosis (deficiency of vitamin $B_1$ and $B_6$), AIDS, anemia, iron deficiency, hormonal disorders, sarcoidosis, amyloidosis, radiotherapy of head and neck tumors, and chronic treatment with diuretics, TLPD, antihistamines, hypotensive, neuroleptic, inhalation steroid, B-adrenomimetic, cholinolithical, chemotherapeutic, antibiotic, anxiolytic, cytostatics,

opioid painkillers and interferon drugs; in total, about 400 drugs decrease saliva production [10–11].

Dietary and hygienic habits contribute to halitosis: ineffective or rare brushing of the teeth, nonuse of oral rinses, and nonuse of dental floss can favor halitosis. Inappropriate oral hygiene promotes dental plaque on the surfaces of the teeth, gingiva, and dentures. Shortly after brushing, a pellicle forms, which thickens because of organic and nonorganic substance wasting. The plaque becomes covered by stains, made of a mixture of microorganisms (including those responsible for halitosis), excoriated epithelium cells, leucocytes, and remains of food [12].

Diet and addictions can also cause unpleasant mouth odors. For example, overconsumption of highly salted dishes, onions, and coffee can dries the mucus of the oral cavity, leading to halitosis. Eating garlic produces allyl methyl sulfide, which can leave a smell for 72 hours. Weight loss diets that cause the release of energy supplies (fats and proteins) may also cause halitosis as the metabolized products of the fats are released by the lungs. Meat consumption, which delivers proteins (which are made of peptides and amino acids) can be a cause of halitosis, too.

Smoking contributes significantly to halitosis development, as it favors xerostomy (32%), periodontal diseases, and molecules derived from cigarette smoke return with the blood to the lungs, causing so-called smoker's breath. Alcohol consumption can cause halitosis too, on account of its drying properties. Additionally, bacteria that live in the oral cavity (*Streptococcus salivarius, S. intermedius, S. mitis*) can transform ethanol to acetaldehyde using alcohol dehydrogenase.

Addiction to drugs such as amphetamines and methamphetamine influences saliva production. Other important factors in the etiology of mouth odor include breathing through the mouth, the flow of dry air during sleep, and a neutral or alkaline pH in the oral cavity–as well as other unknown factors [12].

There are thousands of bacterial species present in the oral cavity. The conditions that help these grow include an anaerobic environment and appropriate pH range; they consume food remains, excoriated epithelium, and blood serum components [4].

The bacteria responsible for halitosis are mainly anaerobic and produce strong smelling substances, such as hydrogen sulfide from cysteine (*Peptostreptococcus anaerobius*, *Eubacterium limosum*, and *Bacteroides* spp.), methyl mercaptate from methionine (*Fusobacterium nucleatum*, *Fusobacterium periodonticum*, *Eubacterium* spp., and *Bacteroides* spp.), hydrogen sulfide from blood serum (*Prevotella intermedia, Porphyromonas gingivalis, Treponema denticola*), mercaptate from blood serum (*Treponema denticola, Porphyromonas gingivalis, Porphyromonas endodontalis*), and dimethyl sulfide (*Eubacterium, Fusobacterium*); other substances are produced by *Campylobacter rectus*, *Prevotella oralis*, *Leptotrichia buccalis*, *Enterobacter cloacae, Fusobacterium periodonticum* [4, 7–8, 13].

## Assessment of halitosis

The assessment of patients with an initial diagnosis of halitosis begin with the collection of a full medical history, encompassing also current treatment, oral hygiene, working conditions, and stressful situations at work and at home. It is necessary to perform a full physical examination, paying special attention to any white covering of the tongue, periodontium, dentition, and mucous membranes, examination of the patency of the salivary glands ducts, and oral hygiene. The evaluation should include a pantomogram evaluation, which is usually performed by a dentist. Full otorhinolaryngological and gastrological examinations are often necessary as well.

The examination of a patient with halitosis is based on a subjective organoleptic measurement of the oral odor. This can be performed by several methods.

In the first method, the patient gives a long exhalation into a tube 10 cm long and 24 mm in diameter. As the patient exhales, the doctor smells the other end of the tube for odor and rates the bad odor on a 0–4 or 0–5 scale [1, 3].

In the second method, the patient breathes through the nose only for three minutes. After this, the patient exhales through the mouth into a tube connected to a syringe with. The exhaled air is retained in the syringe by a valve. Later, a cup and straw are attached to the syringe and the smell of the sample is examined by a doctor [14].

Several scales are used in evaluating the intensity of bad breath. The first is the Rosenberg scale:

0: no smell,
1: the smell is hardly perceptible, questionable,
2: the smell is hardly perceptible, but not questionable,
3: obviously perceptible smell,
4: intense smell,
5: very intense smell [4, 6, 8].

The second scale used in the evaluation of the bad breath is the De Boever and Loeshe 0–5 scale and is similar to the Rosenberg scale. The third scale, the Filippi scale, is most commonly used by practitioners:

0: the smell is absent,
1: the smell is perceptible from 10 cm,
2: the smell is perceptible from 30 cm,
3: the smell is perceptible from 100 cm [12, 15].

In the organoleptic evaluation of halitosis, it is not possible to localize the exact origin of the smell (oral or nasal cavity, pharynx, or digestive system).

If there is suspicion of a laryngological disorder of the tonsils, bad breath is assessed by the Finkelstein test, which involves applying a massage and some pressure to both tonsils. The obtained excretion is evaluated for its smell separately for the left and the right tonsil.

0: the smell is absent,
1: the smell is perceptible from 1 cm,
2: the smell is perceptible from 10 cm [16].

The objective methods of evaluating halitosis are the halimeter and gas chromatography. Using a halimeter, the concentration of volatile sulfides is measured at the probe, which is inserted into the oral cavity (rather than measuring exhaled air). This method has limited accuracy, because not all microorganisms responsible for a bad breath produce volatile sulfides.

The halimeter test is performed in the morning and in the evening of the test day. The patient should restrain from drinking (except for mineral water), eating, smoking, chewing gum, and brushing teeth for three hours prior the test. On the day of the test, the patient should not use mouth fresheners, perfume, aftershave, lipstick, or other oral cosmetics. Two days before the test, the patient should restrain from drinking alcohol and eating onions or garlics. The test can be performed once three weeks have elapsed after the end of antibiotic therapy [6, 17–19].

During the test, the air in the oral and the nasal cavity is evaluated separately. Before the assessment the patient breathes through the nose for one minute; the probe is then placed on the back of the tongue while the patient continues to breathe through the nose. The results are obtained as parts per billion (ppb) of volatile sulfides. The results of the test are evaluated on a 0–4 Filippi scale:

0: < 100 ppb (lack of halitosis),
1: 100–179 ppb (benign halitosis),
2: 180–250 ppb (medium halitosis),
3: > 250 ppb (severe halitosis) [4, 8, 12].

Gas chromatography is the second objective method for evaluating bad breath. In this method, hydrogen sulfide, methyl mercaptane, and dimethyl sulfide are measured. Air from the oral cavity is collected using a syringe. Afterwards, the probe is introduced to a chromatograph using a cannula. After eight minutes of evaluation, a result is obtained as ng/10 ml. Gas chromatography is a very sensitive, accurate, and repeatable test, but is rarely used in practice because of its high cost [3, 7–8].

The practical and easy-to-perform BANA test is also used in the assessment of halitosis; it involves detecting the enzymatic decomposition of the reagent benzoyl-dL-arginine-L-naphthylamide. The enzyme that performs this is one of the proteolytic enzymes produced by gram-negative bacteria localized in the plaque and on the top of the tongue.

The test results correlate well with organoleptic measurement, but not with the halimeter or gas chromatography tests. It is impossible to determine the type of bacteria responsible for halitosis [3, 7].

Measuring the amount of saliva in basic secretion and following stimulation is an important element of bad breath diagnosis. During this test, the patient is asked to chew paraffin chewing gum for two minutes and to spit 5 minutes later. The saliva is collected in a calibrated cup.

Another test of saliva secretion is the Saliva-Check Buffer test. With this test, it is possible to also evaluate the viscosity, consistency, pH, amount of acid, and buffering ability of the saliva [12].

During the evaluation of halitosis, the covering of the tongue should be assessed. There are several scales used for this:

The Winkel index divides the surface of the tongue into six sections and sums the following assessment for each section:

0: no covering,
1: small amount of covering; the underlying color of the tongue is visible,
2: large amount of covering; the underlying color of the tongue is not visible [12];

Miyazaki index:

0: no covering,
1: covering visible on less than one third of the surface of the tongue,
2: covering visible on less than two thirds of the surface of the tongue,
3: covering visible on more than two thirds of the surface of the tongue [6, 12];

Shimizu index:

0: lack of covering,
1: thin covering, papillae are visible,
2: thick covering, papillae are not visible [12].

## Management of halitosis

The most important part of halitosis management is the treatment of the underlying disorders through dental, otorhinolaryngological, gastroenterological, or general therapy. Apart from that symptomatic relief is of great important for the patient.

Different natural products have been used in different countries to reduce bad breath, including clove oil, parsley leaves, aniseed, cinnamon, guava peel, and egg shells [4].

The importance of the oral hygiene in halitosis management has long been proved. Such hygiene can be achieved through local antisepsis and mechanical cleaning, such as:

– brushing teeth and gums three times a day;
– removing the covering from the upper surface of the tongue using a special cleaner at least once a day at for 30–40 seconds (longer periods of mechanical cleaning are not recommended, as they may destroy the natural bacterial flora and cause candidiasis);
– rinsing the oral cavity and throat with antiseptic and antiodor mouthwash;
– using dental floss or interdental brush to clean the spaces between the teeth;
– using an oral irrigator.

Antiodor mouthwashes contain different substances, such as Meridol and the following:

– a complex of amine fluoride and tin fluoride that inactivates bacteria on the surface of the tongue and in the oral cavity;
– zinc lactate, which neutralizes volatile sulfides, creating sulfatide;

– other substances that neutralize unpleasant odors by inhibiting the transformation of amino acids to volatile sulfur compounds and CB12 – e.g., 0.3% zinc acetate, 0.025% chlorhexidine, and 0.05% sodium fluoride.

Antiseptic mouthwashes are based on:

– 0.12–0.2% chlorhexidine (Eludril, Corsodyl, Curasept), which reduces adhesion of bacteria by destroying their cell membranes;

– Essential oils (Listerine) such as thymol, menthol, eucalyptus, which destroy bacterial cell membranes and inhibit bacterial enzymes;

– Cetylopiridine chloride; mouthwashes with cetylopiridine chloride have 70% effectiveness and cause fewer side effects than those with chlorhexidine;

– Triclosan, which reduces volatile sulfur compounds.

The use of antiseptic mouthwashes is, however, limited by the amount of alcohol they contain, which causes drying of the oral mucosa [4, 7–8, 13, 17].

The most commonly used antiodor specific is chewing gum. It is important to use a chewing gum containing zinc or zinc, xylitol, and sodium fluoride.

Other methods of halitosis management include:

– zinc supplementation in form of tablets – for example, Halitomin and Hali-Z (which also contains xylitol);

– taking oxidizing tablets containing dehydroascorbic acid, which neutralizes volatile sulfides;

– chlorophyll tablets;

– active carbon tablets [20–22].

Probiotic treatment with *Streptococcus salivarius* K12 or *Lactobacillus salivarius* WB21 is a new approach to halitosis management. While using probiotics, the secretion of volatile sulfur compounds decreases, but after the treatment, the bacteria responsible for bad breath quickly recolonize. It is possible that the future of halitosis treatment will depends on the development of an appropriate vaccination [12, 23].

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