

## Effect of saliva pH on *Candida albicans* activity in the oral cavity

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### Abstract

**Background:** Low saliva pH is supposed to increase *Candida sp* activity because low saliva pH can cause immunocompromising.

**Objective:** To determine the effect of saliva pH on the activity of *Candida albicans*.

**Methods:** Secondary data from literature studies were analyzed descriptively by presenting the results of research on the effect of saliva pH on the activity of *Candida albicans*.

**Results:** The results of the study reveal that decreasing salivary pH can increase the activity of *Candida albicans* in the oral cavity, which is characterized by the growth of hyphae and colonization of the microbiota itself as well as manifestations that can be seen clinically, such as oral candidiasis.

**Conclusion:** Salivary pH levels can influence the activity of *Candida albicans* in the oral cavity.

**Keywords:** Salivary pH; *Candida albicans*; Oral candidiasis; Immunocompromised.

### 1. Introduction

The primary determinant of intraoral pH depends on saliva pH, and varies throughout the day. The average pH of unstimulated saliva is approximately 6.8 and increases to 7.8 after stimulation. Salivary pH can be greatly influenced by external factors, such as food intake, smoking behavior, drugs, etc. Foods that have an acidic pH can cause a decrease in saliva pH. In addition, there are intrinsic factors that influence saliva pH, such as regurgitation, oral cavity microorganisms, as well as the flow rate and buffer capacity of saliva. The high quality of saliva buffers can maintain normal saliva pH over a long period of time [1].

*Candida albicans* is a healthy human microbiota, asymptotically colonizing several niches in the body, such as the gastrointestinal (GI) tract, female reproductive tract, oral cavity, and skin. For the majority of people with robust immune systems, *Candida albicans* is a benign commensal that coexists peacefully with other microbiota members. However, disruptions to this delicate balance can allow *Candida albicans* to grow quickly and cause infection. These disruptions can come from the use of antibiotics, changes in the local environment (such as pH shifts or nutritional changes), or changes in the immune system (due to infection or immunosuppressive therapy). These infections range from more serious hematogenously disseminated infections with a significant mortality rate (approaching 47% in some cases) to superficial mucosal and skin infections like thrush, diaper rash, and vaginal yeast infections (75% of women will experience a yeast infection at least once in their lifetime). *Candida albicans* is the primary cause of bloodstream infections in clinical settings and 15% of all cases of sepsis. It is also the leading source of hospital-acquired infections. Although *Candida albicans* can infect both immunocompetent and immunocompromised people, the infection is more

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dangerous in the latter group, which includes people with implanted medical devices, AIDS patients, and patients receiving immunosuppressive therapy or chemotherapy for cancer. [2].

Until a significant epidemiological study in the 1990s showed that yeasts of the genus *Candida* ranked first for death and fourth for nosocomial septicemia, the significance and seriousness of nosocomial candidiasis were widely underestimated [3]. Saliva is produced and secreted by the salivary glands. The basic secretarial unit of the salivary glands is the group of acinar cells. Saliva is a fluid that contains water, electrolytes, mucus and enzymes, all of which flow out of the acinus into the collecting duct, of course it is one of the most important and integral components for oral health. Protective roles and benefits including buffering, remineralization of healthy oral mucosa, immune defense, digestion, lubrication, diagnostic purposes, and proteome analysis are fulfilled by saliva. This buffering function is also related to the pH of each individual's saliva. An increase in pH is thought to be able to change the environmental conditions of the oral cavity, resulting in changes in the oral microbiota, one of which is *Candida albicans*. An increase in *Candida albicans* in the oral cavity can also be an indicator of an immunocompromised patient, so it is important to always monitor the condition of the oral microbiota [4]. Low saliva pH is also thought to increase *Candida sp* activity because low saliva pH can cause immunocompromising [5]. Therefore, this literature review was carried out with the aim of determining the effect of saliva pH on the activity of *Candida albicans* by identifying the mechanism from various references.

## 2. Methods

This literature review or literature study is reviewed from a number of research articles. The method used in this review is prism check. Prisma check is a method used to carry out internal assessments preparation of quality reviews. In preparing this literature review, articles were searched through Web of Science, Researchgate, Elsevier, PubMed, and several other sources using the keywords pH, Saliva, *Candida albicans*, oral candidiasis, and immunocompromised. The criteria for articles used are journals published from 2013 to 2024. These journals have titles and contents that are appropriate to the research objectives, full text, and related to the title. This aims to update research results and update database retrieval. Exclusion criteria: (1) Articles do not have a complete structure. (2) In the form of a review article (must use a research journal).

## 3. Results and Discussion

This study is a systematic review to examine the effect of saliva pH on *Candida albicans* activity in the oral cavity. This study was conducted by conducting a review of 13 journals obtained through the database. The results obtained from this study are pH levels can influence the activity of *Candida albicans* in the oral cavity. Inhibition of *Candida albicans* colonies can be done by increasing saliva pH and preventing xerostomia.

**Table 1** Randomized controlled trial effect of saliva pH on *Candida albicans* activity in the oral cavity

Author	Year	Result
Maghfirah, F., Saputri, D. [6]	2017	The results of this study show that probiotic drinks that have a low pH can kill pathogenic bacteria, but cannot but reduce the growth of <i>Candida albicans</i> in the oral cavity.
Gani, B.A., Nasution, A.I., Andayani, R., Zayanti, V. and Fitri, R.A. [7]	2016	<i>Candida albicans</i> was discovered to have hyphae production activity at pH 4 in a study utilizing artificial saliva pH.
Chairani, S. [8]	2022	The research results show that chlorhexidine and garlic extract can inhibit the growth of <i>Candida albicans</i> by increasing the pH and making saliva in a more alkaline condition.
Ludy, N.C. [9]	2023	Propolis extract was reported to effectively suppress the growth of <i>Candida albicans</i> by avoiding xerostomia and raising saliva pH in experiments utilizing artificial saliva pH.
Bokor-Bratic, M., Cankovic, M., Dragnic, N. [10]	2013	According to univariate analysis, patients with oral lichen planus (OLP) had a significantly higher risk of oral candidiasis infection when their salivary pH was less than 6.5.

Müller, V. J., Belibasakis, G. N., Bosshard, P. P., Wiedemeier, D. B., Bichsel, D., Rücker, M., and Stadlinger, B. [11]	2019	The results of the study showed an increase in <i>Candida albicans</i> in head and neck cancer patients during and after intensity-modulated radiotherapy (IMRT) due to a decrease in saliva flow rate and saliva pH.
Lam-ubol Aroonwan, Matangkasombut, O., Trachootham, D., Tarapan, S., Sattabanasuk, V., Talungchit, S., Mungkung, O. [12]	2020	The results showed that decreasing saliva pH can increase <i>Candida</i> species, including <i>Candida albicans</i> , <i>Candida tropicalis</i> , and <i>Candida krusei</i> .
Negi, M., Sepolia, N., Panwar, S. S., Kumar, M., Singla, J., and Aggarwal, R. K. [13]	2019	In research, it was found that there was an increase in the prevalence of <i>Candida albicans</i> in sufferers of leukoplakia and tobacco pouch keratosis due to low oral pH and buffer capacity.
Tarapan S., Matangkasombut, O., Trachootham, D., Sattabanasuk, V., Talungchit, S., Paemuang, W., Phonyiam, T., Chokchaitam, O., Mungkung, O. O., and Lam-Ubol, A. [14]	2019	In the study, it was found that there was an increase in <i>Candida albicans</i> colonization in post-radiotherapy xerostomic patients due to a decrease in the pH of oral saliva.
Pereira-Lopes, O., Simões-Silva, L., Araujo, R., Correia-Sousa, J., Braga, A. C., Soares-Silva, I., and Sampaio-Maia, B. [15]	2019	The results of the study showed an increase in <i>Candida albicans</i> colonies in patients undergoing hemodialysis therapy and peritoneal dialysis therapy due to a decrease in saliva pH.
Paoletti, I., Fusco, A., Grimaldi, E., Perillo, L., Coretti, L., Di Domenico, M., Cozza, V., Contaldo, M., Serpico, R., Guida, A., and Donnarumma, G. [16]	2013	Studies have revealed that low salivary pH is the origin of <i>Candida albicans</i> , an opportunistic pathogen that can infect immunocompromised hosts.
Queiroz, P. A., Godoy, J. S. R., Mendonça, P. S. B., Pedroso, R. B., Svidzinski, T. I. E., and Negri, M., [17]	2015	In research using artificial saliva, it was found that the adhesion capacity of <i>Candida albicans</i> produced was very dependent on the environmental conditions of the oral cavity which included the amount of medium (saliva), pH and oxygen.
Barbosa, A., Araújo, D., Ribeiro, E., Henriques, M., and Silva, S. [18]	2020	In research comparing pH 5.8 and 7 as a variable, planktonic growth of <i>Candida albicans</i> was obtained slightly higher at pH 5.8 (tends to be sour).

According to the literature reviewed in the aforementioned studies, there is a positive correlation between saliva pH and *Candida albicans* activity. Specifically, an acidic saliva pH causes *Candida albicans* to become more active, as evidenced by the growth of both the hyphae and the *Candida albicans* itself. Although, there are other factors that can increase the activity of *Candida albicans*, namely age, denture use, saliva flow rate, diabetes mellitus, and alcohol as explained in the research of Bokor-Bratic, et al., 2013 [10]. This is in line with Tarapan's research, et al., 2019 which stated that there was an increase in *Candida albicans* colonization influenced by factors such as age, gender and denture use [14].

Tarapan, et al., 2019 stated that there was a substantial inverse relationship between the pH and flow rate of saliva and the amount of *Candida*. The most likely cause of this association is decreased salivary flow, which promotes *Candida* adherence to the oral mucosa. Furthermore, it has been demonstrated that acidic environments decrease salivary IgA reactivity with *Candida albicans*, which may compromise immunological function and raise the risk of oral *Candida* colonization and candidiasis. This shows that despite treating the symptoms of dry mouth, measures to improve salivary flow and quantity may help lower the risk of candidiasis and *Candida* colonization [14].

*Candida albicans* itself can also produce manifestations in the oral cavity, such as oral candidiasis. In research by Bokor-Bratic, et al., 2013, it was explained that a decrease in salivary pH was associated with oral cavity infections by *Candida* species in OLP (Oral Lichen Planus) patients [10]. Meanwhile, research conducted by Paoletti, et al., 2013 explains that *Candida albicans* is an opportunistic pathogen that can cause disease in immunocompromised hosts based on local or systemic pathological processes. Adhesion of *Candida* to the oral epithelium is the first step in the infection process and allows yeast to inhibit the body's secretory mechanisms. During infection with *Candida* species, epithelial cells actively participate in host defense by producing antimicrobial peptides and proinflammatory cytokines. Both compounds can damage the adhesion and growth of *Candida* in the oropharyngeal cavity [16].

*Candida albicans* can also appear as a post-therapy side effect, as explained in research by Pereira-Lopes, et al., 2019 where an increase in *Candida albicans* colonies was found in patients undergoing hemodialysis therapy and peritoneal dialysis therapy. Higher *Candida albicans* colonies in patients indicate more severe periodontal disease and may be exacerbated by smoking [14]. According to research by Negi et al., 2019, there is a correlation between smoking habit and an increase in *Candida albicans* colonies. Because of their low oral pH and buffer capacity, persons with tobacco pouch keratosis and leukoplakia had a higher frequency of *Candida albicans* [13]. In patients undergoing intensity-modulated radiotherapy (IMRT), *Candida albicans* colonies not only appear after therapy but can also appear during therapy. According to Müller, et al., 2019 this is the case caused by 2 factors, namely decline saliva flow rate and saliva pH [11].

According to research by Gani, et al., 2016, the appearance of hyphae which indicates the start of the growth of *Candida albicans* can be observed when the pH in the oral cavity reaches [7]. This research is in line with research by Lam-ubol, et al., 2020 which shows that an increase in *Candida albicans* colonies can occur due to a decrease in salivary pH [12]. According to Queiroz, et al., 2015, apart from decreasing the pH of saliva which becomes low, the environmental conditions of the oral cavity which include the amount of medium (saliva) and oxygen also affect the adhesion of *Candida albicans* [17]. From research by Barbosa, et al., 2020, it was found that the growth of *Candida albicans* colonies was greater at pH 5.8 than at pH 7 [18]. This makes it clearer that an acidic atmosphere will make it easier for colonies to grow. However, low pH in the oral cavity also has benefits for killing pathogenic bacteria [6]. Inhibition of *Candida albicans* colonies can be done by increasing saliva pH and preventing xerostomia using propolis extract [9]. In Chairani's research, 2022, it was also explained that chlorhexidine and garlic extract were used to increase salivary pH level [8].

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#### 4. Conclusion

From this literature review, it was concluded that pH levels can influence the activity of *Candida albicans* in the oral cavity.

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#### Compliance with ethical standards

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All the authors affirm that there isn't any conflict of interest with this document's release.

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