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(REVIEW ARTICLE)

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Effect of bromelain enzyme in pineapple (*Ananas comosus L.*) on the Acidity Degree of Saliva

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Abstract

Background: Dental and oral health is part of overall body health. Many oral problems can be prevented with self-care such as consuming fruits that are rich in fiber and water such as pineapple. Pineapple (*Ananas comosus L.*) has benefits that are very good for health because pineapple contains 90% water and is rich in Potassium, Calcium, Iodine, Sulfur, and Chlorine.

Purpose: To determine the effect of the enzyme Bromelain in pineapple on the acidity level of saliva.

Method: By using the method of collecting and searching various journals related to the discussion to be analyzed.

Results: Based on the search results, it shows that the effect of the Bromelain enzyme contained in pineapple has an effect on saliva pH.

Conclusion: The enzyme bromelain in pineapple can affect changes in saliva pH.

Keywords: Pineapple; Saliva; pH; Bromelain

1. Introduction

Oral diseases in Indonesia are still one of the problems that are still concern until now. Oral diseases can be influenced by negligent habits, or lack of knowledge in how to care for teeth and mouth. These problems may be experienced by anyone regardless of age, ethnicity, or economic conditions[1]. Dental and oral health problems can be prevented. One way to prevent dental and oral diseases is through self-care. Examples of self-care include brushing your teeth, using dental floss, gargling, and consuming fruits that are rich in fiber and water, one example of which is pineapple[2]

Pineapple (*Ananas comosus L.*) has many health benefits. Pineapple contains 90% water and is rich in calcium, sodium, phosphorus, pectin, iron, carotene, magnesium, carbohydrates, thiamine, protein, potassium, sucrose, chlorine, iodine, and phenol. In addition, pineapple (*Ananas comosus L.*) also contains large amounts of Biotin, Vitamin B12, Vitamin E, vitamin A, vitamin C, vitamin B1, vitamin B6, minerals, and antioxidants[3].

Pineapples also contain several active components such as Bromelain Enzyme which can suppress the growth of plaque bacteria and increase saliva secretion. An increase in saliva pH is directly proportional to an increase in saliva flow rate[4]. The bromelain enzyme works by reducing glycoproteins which are mediators for bacteria to adhere to the tooth surface. The bromelain enzyme also plays a role in acid metabolism. The high water and fiber content in pineapple can help the

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role of saliva in cleaning the oral cavity, thereby inhibiting plaque formation. Plaque formation cannot be avoided and is influenced by several factors, such as tooth anatomy, tooth position, food consumed and saliva[5].

Based on these results, it can be concluded that consuming pineapple can stimulate saliva flow so that it can affect the acidity of saliva. Pineapple is easily found in the community and can increase the acidity of saliva. On this basis, the author is interested in knowing the effect of the bromelain enzyme in pineapple extract (*Ananas Comosus L.*) on saliva pH.

2. Methods

In this article review, the data collection method is carried out by reviewing the literature (literature review). The search for research journals and scientific articles was conducted in July 2025 through electronic journal databases, namely *Google Scholar, Science Direct, Pubmed, Elsevier*, and others. The search was carried out using the keywords, "Bromelain Enzyme Activity on Pineapple". The inclusion criteria for the literature are scientific articles that related to bromelain enzyme activity on pineapple peel, and articles that discuss the effect of temperature and pH on bromelain enzyme activity on pineapple peel.

3. Result

3.1. Bromelain

Bromelain is an enzyme that comes from the plant family *Bromeliaceae*, and several studies state that the highest bromelain content is found in pineapple plants. Bromelain is an enzyme whose main composition is protein so that the protein concentration indicates the amount of bromelain contained in each part of each pineapple variety[6].

Bromelain enzyme belongs to the group of sulfhydryl protease enzymes that can hydrolyze proteins to produce simple amino acids that are soluble in water. The active side of the bromelain enzyme contains cysteine and histidine groups which are important for the activity of the enzyme, so that the bromelain enzyme specifically cuts peptide bonds in carbonyl groups such as those found in arginine or aromatic amino acids, namely phenylalanine and tyrosine. The bromelain enzyme also hydrolyzes peptide bonds in the middle of the peptide chain, so it is classified as an endopeptidase[7].

3.2. Characterization of Bromelain

The work of bromelain as an enzyme is certainly influenced by several factors such as pH, temperature. Thus, to determine the characteristics of the bromelain enzyme, it is also necessary to determine the optimum conditions for the bromelain enzyme in carrying out its activity. Visual confirmation of the optimal temperature and pH of bromelain activity as a protease or protein digestion at different temperatures and pH values. Based on the research that has been done, the activity of the crude bromelain enzyme increases with increasing temperature up to 50 °C and will decrease rapidly,for pure bromelain, the activity will increase up to a temperature of 60 °C, and will begin to decrease thereafter[6].Bromelain enzyme is generally found in bromelain extracted from pineapple stems (80%), fruit (10%) and ananain (5%). On the other hand, bromelain enzyme can also be found in lower concentrations, for example in pineapple waste, namely skin, core, leaves, and crown[8].

3.3. Uses of Bromelain

Bromelain enzyme can be used in several industrial fields, such as bromelain enzyme is used as a meat tenderizer, beer making material, developer, and protein hydrolysate. Then in the textile industry, bromelain enzyme is used as a tanner, hair remover, wool and leather softener, and as a detergent formulation[7].

Then, in the health sector, bromelain can inhibit platelet aggregation, sinusitis, post-operative trauma, thrombophlebitis, pyelonephritis, angina pectoris, bronchitis, and increase drug absorption, such as antibiotics. In addition, the bromelain enzyme can also be an anti-tumor, immune modulator, help the digestive process, improve wound healing, and improve cardiovascular circulation[9].

3.4. Role of Saliva

Saliva is a complex oral fluid. Saliva consists of a mixture of secretions from the salivary glands in the oral mucosa. Saliva is a fluid in the oral cavity that is composed of 98-99% water, while around 2% is composed of organic and inorganic components, electrolytes, mucus, antimicrobial substances, and various enzymes. The functions of saliva include lubricating the tissues in the oral cavity, protecting against dehydration and as a buffer system to protect the oral cavity

in preventing colonization of pathogenic bacteria and neutralizing the oral cavity from acidic conditions so as to avoid enamel demineralization[10]. Saliva has several functions, namely protecting the tissue in the oral cavity by mechanically cleaning to reduce plaque accumulation on the tooth surface, as a buffer to maintain optimal pH, helping the taste and digestion functions, and helping tissue repair. The protective function of saliva is greatly influenced by changes related to the composition and viscosity, the composition of saliva ions and proteins, and saliva pH [11] .

3.5. pH Saliva

Power of Hydrogen (pH) is the degree of acidity of saliva which in normal conditions ranges from 5.6-7.0 with an average pH of 6.7. Several factors that cause changes in salivary pH include the average speed of saliva flow, microorganisms in the oral cavity, salivary buffer capacity, and food and drinks that are often consumed[12]. Bacteria will break down carbohydrates into lactic acid, butyric acid, and aspartic acid, which causes a decrease in the pH value of saliva. Fats consumed will also be broken down by bacteria into fatty acids which can also reduce the pH value of saliva. The decrease in pH causes a decrease in supersaturation of calcium and phosphate which will increase demineralization of tooth enamel and dentin[13].

The acidity level (pH) of saliva is an important factor that plays a role in the oral cavity, so that saliva can function properly, the composition and properties of saliva must be maintained in optimal balance, especially the acidity level. Because pH is closely related to several chewing activities that occur in the oral cavity. A decrease in salivary pH can cause rapid demineralization of tooth elements, while an increase in pH can form bacterial colonization that stores and increases the formation of calculus[14].

The acidity level (pH) of saliva under normal conditions is in the range of 6.8–7.0 (neutral). The buffer capacity of saliva is the ability of saliva to return to its normal pH. Saliva has three main buffers, namely bicarbonate (HCO3-), phosphate (PO4+), and protein, however, the most important of the three is bicarbonate (HCO3-)[15]. Saliva is a complex fluid produced by the salivary glands and has a very important role in maintaining the balance of the ecosystem in the oral cavity. Saliva is the result of secretions from several salivary glands, where 93% of the total volume of saliva is secreted by the major salivary glands which include the parotid, submandibular, and sublingual glands, while the remaining 7% is secreted by the minor salivary glands which consist of the buccal, labial, palatine, glossopalatine, and lingual glands[15].

4. Discussion

The bromelain enzyme is related to changes in saliva pH. This bromelain enzyme comes from pineapple fruit which is generally found in pineapple stems (80%), fruit (10%), and several other parts[16]. The bromelain enzyme plays a role in reducing glycoproteins which are mediators for bacteria to adhere to the tooth surface. The bromelain enzyme plays a role in inhibiting the growth of normal acid- producing flora bacteria[17, 18]. The work of bromelain is certainly influenced by pH. The acidity level (pH) of saliva is in the range of 6.8–7.0 (neutral). When the pH of saliva drops (less than 6.8), it will cause rapid tooth demineralization[15]. Meanwhile, when the pH of saliva rises (more than 7) it can form bacterial colonization and increase calculus formation. Several factors that cause changes in saliva pH, such as the average speed of saliva flow, microorganisms in the oral cavity, or the buffer capacity of saliva. Saliva has a buffer capacity produced by carbohydrate fermentation by various types of bacteria in the oral cavity. The buffer system works to protect the oral cavity in preventing colonization of pathogenic bacteria and neutralizing the oral cavity from acidic conditions. The acid formed will experience balance with saliva and can affect the acidity of saliva. If the bromelain enzyme process can run well, then the pH of saliva will be able to return to normal faster. Thus, the bromelain enzyme can regulate the pH of saliva[19].

On the other hand, pineapple (*Ananas comosus L.*) can increase salivary pH through simultaneous chewing and tasting stimulation when consuming pineapple which results in an increase in salivary flow rate[20]. The acidity level of saliva changes with the presence of mechanical stimuli, namely the process of chewing fibrous foods which can stimulate saliva secretion so that saliva secretion increases and affects salivary pH. Citric acid contained in pineapple can increase salivary secretion[21]. This can prove that acid stimuli are strong stimulators in stimulating salivary secretion compared to mechanical stimulation. Taste stimuli such as sour taste stimuli can stimulate saliva secretion in very large amounts, generally 8-20 times the basal secretion rate. Therefore, the increase in salivary flow rate is directly proportional to the increase in salivary pH, so that if there is an increase in salivary flow rate, the salivary pH will also increase [22] .

However, there are also insignificant results, namely those that occurred in one study which stated that there was no significant difference between gargling with a 6.25% pineapple stem extract solution and gargling with distilled water on saliva pH. This could be caused by mechanical factors resulting from the movement of gargling distilled water so that it can release many debris particles. Meanwhile, the concentration factor of 6.25% pineapple stem extract is likely to

have no significant effect on the pH of saliva in the oral cavity. Thus, these results contradict the statement that pineapple can affect the acidity level (pH) of saliva[19].

5. Conclusion

The bromelain enzyme found in pineapple can lower saliva pH. The bromelain enzyme plays a role in regulating bacterial mediators in the salivary flow that can increase saliva pH so that the presence of the bromelain enzyme can help saliva pH to return to its normal pH condition.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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