

## Potential Bromelain Pineapple Extract to Breaker Tempe Protein As Organic MSG

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### ABSTRACT

New alternatives are needed to change flavorings from chemicals to organic so that they do not have a bad impact on health. The study's results proved that giving MSG at a dose of 9 g / day to red blood cells caused the appearance of a micronucleus so that it indicated a mutagenic MSG. The potential of bromelin enzyme contained in pineapple fruit is able to break down proteins from tempe so that it can give rise to a savory taste that is generally found from other flavorings. The purpose of this study was to determine the potential of bromelin extract pineapple, which is a tempe protein breaker as an organic flavoring sourced from various literatures. The research was conducted using a literature review method of reference sources such as google scholar and research gate. A total of 40 articles were found and then selected based on predetermined parameters resulting in 25 selected articles. From the results of the literature search obtained a percentage of 80% for the sampling method on the extraction method, 16% centrifuged and the method using extraction and centrifugation 4%. Meanwhile, judging from the variables studied, 52% were obtained regarding the activity of hydrolyzing proteins, 12% for the characterization of the enzyme bromelin, 8% for the mechanism of action of bromelin as an anti-bacterial and 4% in the stacking of meat, catalyzing peptide bonds, mobilization of bromelin enzymes, meat quality, decreased glucose levels, healing of lukan and physical quality of cheese curd. And when viewed from the part of the pineapple plant that is utilized 44% of the flesh of the pineapple fruit, 12% of the pineapple weevil, 8% each of the flesh of the fruit and the fruit weevil of the fruit, the skin of the pineapple fruit and the flesh of the young pineapple fruit and 4% each of the ripe pineapple weevil, the flesh of the ripe fruit, the stem and the final leaf of the pineapple plant. And when viewed from the use of the benefits of bromelin, a score of 36% was obtained to increase protein levels in the product, 20% to speed up the hydrolysis process, 12% to stack meat, 8% to inhibit streptococcus bacteria, and 4% each was used to hydrolyze collagen. Helps the fermentation process, anti-browning agents fund therapeutic genes.

### KEYWORDS

Bromelin; Pineapple Fruit Extract; Hydrolysis; Protein; Organic Flavoring

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## Introduction

Bromelain or proteolytic enzymes in pineapples are able to break down proteins, so they are included in the group of protein-digesting enzymes that attack the peptide bonds of a protein chain. In addition, it can also be called a proteolytic enzyme that can accelerate the hydrolysis reaction of the main protein or protease enzymes found in pineapple plants (Wiyati & Tjitraresmi, 2018). If excess bromelain enzyme concentration is added, the hydrolysis will not run efficiently because the enzyme will turn out to be saturated. Saturated enzymes will have an impact on the substrate so that they cannot function faster in the hydrolysis process (Alfiyanti, *et al.*, 2020).

According to Ketnawa (2011), a relatively large amount of bromelain is found in the stems and fruits of pineapples. Stem bromelain and fruit bromelain are both single-chain glycosylation enzymes. The bromelain present in pineapple has the EC number EC 3.4.22.33 and is considered fruit bromelain (FBM). Likewise, the bromelain found in pineapple stems is called stem bromelain (SBM) and its EC number is EC 3.4.22.32. Stem bromelain has different properties and biochemical composition compared to fruit bromelain (Manzoor, *et al.*, 2016). Bromelain has been widely used in the medical food, pharmaceutical and cosmetic industries and other industries as well. In the food industry, it is used for meat tenderization, grain protein dissolution, beer clarification, pastries and protein hydrolyzate production (Triastuti, *et al.*, 2021).

The addition of pineapple extract helps increase the tenderness of duck meat. Starting from reducing the tensile strength of the meat, collagen and myofibrils are hydrolyzed by proteases, causing the bond structure of the meat to become shorter fragments and making the meat more tender. Furthermore, the addition of enzymes and the right time can affect the attractiveness of the meat, because protein hydrolysis occurs at a concentration of 15% which

reduces the attractiveness of the meat at 30 and 60 minutes (Utami, *et al.*, 2011) . One of the primary functions of bromelain is to break down proteins and also as a strong antibacterial and anti-inflammatory agent. Ripe pineapple contains bromelian enzymes which are more active than unripe pineapple leaves and fruit (Nurnaningsih & Laela, 2022).

The protein content of coconut pulp flour increased because the addition of pineapple peel extract was higher than the protein content of coconut flour without the addition of bromelain enzymes. This is because bromelain acts as a catalyst. Bromelain enzyme activity from pineapple peel extract (*Ananas comosus* Merr L.) on increasing amino acid levels of coconut pulp flour (*Cocos nucifera* L.) with concentrations of 10%, 15%, 20%, 25%, significantly affected the increase in protein content of pulp flour. coconut (Nur, *et al.*, 2017) .

One of the local processed products that contain a lot of protein is tempe. There are changes in some of the nutritional content of soybeans before and after being processed into tempe. Soybean is the basic ingredient for making tempe, 100 grams contains 446 calories and 20 grams of fat. While 100 grams of tempe contains 193 calories and 11 grams of fat. In addition to calories and fat, there is also a change in cyanocobalamin content. Soybeans do not contain cyanocobalamin but after being processed into tempe, the cyanocobalamin content becomes 0.1 micrograms. This is because the fermentation process increases the absorption of nutrients from soybeans and also causes the formation of cyanocobalamin in tempe (Jayanti, 2019).

The addition of pineapple stem extract on the hydrolysis of soybeans can have an effect on increasing the concentration of protein contained in tempe. One of the methods used to increase protein levels in foodstuffs is the hydrolysis of tempe. In the bromelain enzyme hydrolysis process, all kinds of amino acids from protein constituents will be broken down into peptide fragments (Khanifah, 2018).

The use of synthetic flavorings that are widely used by the community in general has a negative impact on health. MSG given in male and female mice with doses of 3 g/day, 6 g/day and 9 g/day lead to the formation of micronuclei on bone marrow red blood cells mouse femur. The formation of micronuclei after administration of MSG indicates that MSG is mutagenic (Rangkuti, *et al.*, 2013) .

According to (Asngad, 2021; Bhattacharya) the high sodium salt of glutamic acid contained in the chemical flavoring can cause carcinogenic in the body and the concentration of salt in the blood will increase. MSG is composed of 12% sodium, 78% free glutamate, and 10% water (Saraswati & Hardinsyah, 2012) and also the maximum limit consumption is 2400 mg sodium per day (Kuniasari & Andriani, 2018). So, other alternatives are needed to replace the use of flavorings that are safe and good for health, one of which is by making natural flavorings from plant and animal extracts. However, most of the organic and chemical flavorings are in powder form so that they are more easily decomposed in free air due to contact with air and are also difficult to dissolve (Asngad, 2021). Pineapple extract is rich in the bromelain enzyme which can break down the molecular structure of proteins into amino acids. The high protein content of tempeh is broken down into peptides by the bromelain enzyme, which includes a protease enzyme, giving rise to a savory taste that can be used as organic MSG.

Therefore, it is necessary to find a new alternative to replace chemical flavoring from chemicals to organic ones. Thus, it is not harmful to the body when consumed on a long scale. With so much potential that pineapple has as a tempe protein breaker which will be able to bring out a savory taste and also the abundant availability of these two ingredients so that they can be used for new alternatives as organic flavorings. This research aims to find out the potential of bromelain pineapple extract to break down tempe protein as an organic flavoring sourced from various literatures.

## Method

The method used is the selection and analysis of relevant articles, namely by collecting analyzing 40 related research. The articles studied are in the form of national journals, international journals, indexed journals, proceedings, scientific articles and from popular books. Research articles obtained from the last 6 years. Literature sources were identified from Google scholar articles, and ResearchGate articles. The articles obtained are analyzed based on variations in sampling method, the variables studied, the part of the pineapple plant used and the benefits of the bromelain taken. After selecting the articles, the remaining 25 articles according to the parameters based on the research method can be seen in Figure 1.

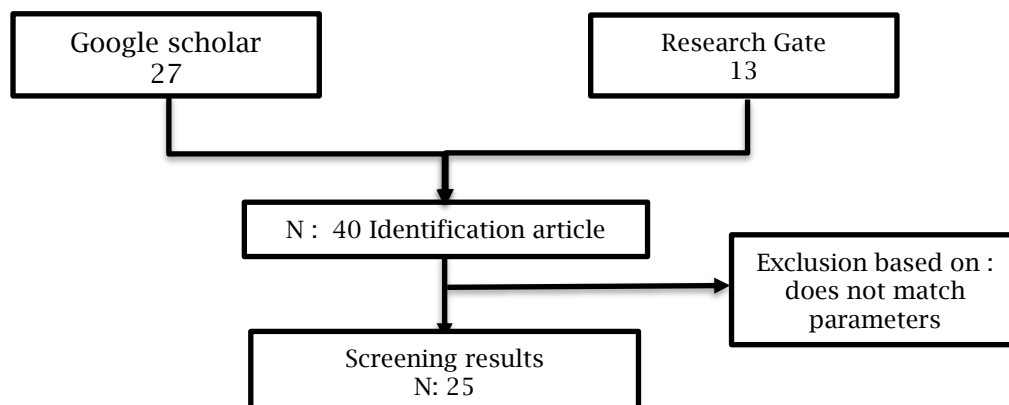


Figure 1. Flowchart Identification of research articles

## Results

Liquid organic MSG is made from tempe hydroxylate and pineapple extract bromelain as the main ingredients whereas tempeh has a high protein content and pineapple which has high bromelain enzymes in the flesh. The high protein content of tempeh is broken down into peptides by the bromelain enzyme, which includes a protease enzyme, giving rise to a savory taste that can be used as organic MSG. Based on search results by entering keywords from Google Scholar as many as 27 articles and ResearchGate 13 articles. So the total articles are 40 articles, after sorting with inclusion criteria, 25 articles are obtained. The parameters taken were 4 types, namely related to the sampling method, the variables studied, the part of the pineapple plant used and the benefits of the bromelain taken, it can be seen in table 1.

**Table 1.** Results of studies on various references

No	Name of researcher & year of research	Research title	Parameter			
			Sampling method	Variable under study	The part of the pineapple plant that is used	Pineapple Bromelain Benefits
1	Syabhana, Rifqi. (2017)	Utilization of Bromelain Enzyme Isolated from Pineapple Weevil ( <i>Ananas Comosus</i> L) as Beef Tenderizer	Centrifuged at 10000 rpm for 30 minutes	The effect of soaking beef in crude bromelain enzyme extract on the tenderness value of beef	Ripe pineapple hump	Can be used as an alternative method that can be used in the meat tenderization process with the best tenderness value obtained from the 90-minute soaking period, which is 0.2311 g/mm.
2	Alfiyanti, RD, Prihatiningrum, B., & Budirahardjo, R. (2020)	The Effect of Bromelain Enzyme in Pineapple ( <i>Ananas comosus</i> (L.) Merr) Gel-Based Preparations on Dentin Intertubule Width	Centrifuged at 3000 rpm for 15 minutes at 15°C	Cleaning caries tissue can use Chemo-mechanical Caries Removal (CMCR) Based on proteolytic enzymes that catalyze peptide bonds into simpler compounds.	Ripe Flesh	Hydrolyzes collagen in the intertubular dentin to break hydrogen bonds in the trop reshaped collagen triple helix changed into polypeptide chains.
3	Mulidasari, W., & Rahmayani, RFI (2019)	Utilization of crude bromelain enzyme from pineapple extract ( <i>Ananas comosus</i> L.) for the manufacture of soy sauce on the cob ( <i>Euthynnus affinis</i> )	Bromelain enzyme isolation was carried out by extraction method, while enzyme purification bromelain is done by precipitation technique using 60% ammonium sulfate	Bromelain enzyme from the flesh and tubers of pineapple ( <i>Ananas comosus</i> (L.) Merry,) has the potential as a safe enzyme-based <i>chemo-mechanical caries removal</i> (CMCR) material and is economical.	Flesh and fruit hump	It is used for the fermentation of tuna fish sauce with the best protein content in the manufacture of tuna ( <i>Euthynnus affinis</i> ) soy sauce in the addition of 20% crude bromelain and 3 days of fermentation.
4	Purwaningsih, Beautiful. (2017)	The Potential of the Bromelain Enzyme in Pineapple Juice ( <i>Ananas comosus</i> L) in Increasing Protein Levels in Tofu	Extracted by mashing grating and filtering with gauze	The protein content in tofu can be increased by the enzymatic method. One type of protease enzyme that is often used in the food industry is -the enzyme bromelain. Bromelain enzymes are abundant in pineapples.	Flesh of fruit	To increase the protein content of tofu with the higher bromelain enzyme concentration and incubation time with bromelain enzyme, the higher the protein content. The best tofu protein content was obtained from the manufacture of tofu with the addition of bromelain enzyme from pineapple juice at a concentration of 50% with an incubation period of 12 hours, which was 16.6195%.
5	Hardi, J., Syaiful, B., & Buheli, RAP (2021)	Making VCO uses pineapple weevil as a source of bromelain in Bale Village, Donggala Regency, Central Sulawesi Province	Making VCO by extraction	Get more VOCs by utilizing coconut milk cream into VCO and also a mixture of pineapple bromelain enzymes.	Pineapple hump	The use of pineapple hump juice was chosen to be the best source of bromelain enzyme compared to pineapple hump pulp because it produced a higher volume of VCO.
6	Sarkar, S., Ahmed, M., Mozumder, NHMR, & Saeid, A. (2017)	Isolation and characterization of bromelain enzyme from pineapple and its utilization as an anti-browning agent	Extraction with sodium citrate buffer	Characterization of pulp and stem bromelain enzymes and comparing the effectiveness of these enzymes as	Ripe stems and pulp	Bromelain showed maximum activity at pH 8.5 and 50°C for 30 minutes. Bromelain rods with a concentration of 1% had better anti-browning activity than ascorbic acid and citric acid.

				anti-browning agents with commercial anti-browning agents.		
7	Nurnaningsih, H., & Laela, DS (2022)	The antibacterial effect of various concentrations of bromelain enzymes from pineapple extract <i>Ananas comosus</i> (L.) Merr. against <i>Streptococcus mutans</i> in-vitro The antibacterial activity effectiveness of various concentrations of bromelain enzymes from pineapple ( <i>Ananas comosus</i> (L.) Merr.) extract on <i>Streptococcus mutans</i> in-vitro	Extraction	The mechanism of action of bromelain as an antibacterial is by inhibiting the reverse transcriptase and DNA topoisomerase enzymes	Flesh of fruit	The bromelain enzyme can inhibit <i>Streptococcus mutans</i> bacteria starting from a concentration of 1%, the diameter of the inhibition zone is 11 mm. There was a significant increase in the concentration of 10%, and the diameter of the inhibition zone was 20 mm. Liquid ciprofloxacin 20mg as positive control showed inhibition with an inhibition zone of 24 mm
8	Dzulqaidah, I., Zanuba, RB, Alwi, ASF, Salsabila, ARP, Mursidi, S., & Muliastari, H. (2021)	Extraction and Activity Test of Crude Bromelain Enzyme from Pineapple Fruit.	Isolating and extracting	Isolating the bromelain enzyme from pineapple plants, testing the activity of the enzyme, and determining the optimum temperature of the enzyme	Hump and fruit	The bromelain enzyme activity of pineapple showed that room temperature was the best temperature for the enzyme to tenderize meat compared to hot and cold temperatures.
9	Warochmah, M. (2017)	Bromelain Enzyme Immobilization from Pineapple ( <i>Ananas Comosus</i> L. Merr.) Using Chitosan Matrix for Reducing Protein Content in Tofu Factory Wastewater	Centrifugation	Content reduction protein in tofu factory wastewater is carried out by optimization of immobilized enzyme mass with incubation time, as well as Determination of protein content was carried out by test Colorimetry	Flesh of fruit	immobilized bromelain enzyme with chitosan able to degrade protein in wastewater optimum tofu factory using 2 mg of bromelain enzyme immobilized for 10 hours of incubation can degrade protein 89.506% (7.91377 mg).
10	Nurhayati, D., Sundara, Y., & Merdekawati, F. (2020)	Bromelain Isolation from Pineapple ( <i>Ananas comosus</i> L. Merr) With Kitchen Salt	Extracted by blending, squeezing and filtered to obtain a clear liquid (bromelain crude extract).	Pineapple contains bromelain which is a sulfhydryl (-SH) protease. which can hydrolyze peptide bonds in protein molecules which will produce amino acids. The process used to get bromelain from pineapple by isolation by inorganic salts	Flesh of fruit	Meat tenderizers, in medicine and in industrial fields such as dissolving wheat protein.
11	Defri, I., Jariyah., & Anin, N. (2021)	Study of Addition of Crude Bromelain and Soaking Time in Making Afki Laying Chicken Nuggets	Extraction	The effect of adding crude bromelain enzyme concentration and immersion time on the quality of rejected laying hens and determining the best treatment between the addition of bromelain enzyme concentration and soaking time so that the nuggets produced can be	Flesh of fruit	The best nugget product was obtained based on the panelists' preferences through sensory testing, namely 1% crude bromelain treatment and 30 minutes of soaking time with the highest sensory ranking value, namely texture 118, taste 117, aroma 121, and color 119, nugget product texture measured 0.270 mm/ g. dt, and 84.49% yield. The best nugget product was supported by the results of initial testing of meat that had been soaked in crude bromelain, namely water content 72.36%, fat content 1.39%, protein content 0.58%,

				liked by consumers.		tenderness 2.533 mm/ g.dt, water holding capacity (WHC) 22.186.
12	Angela, GC, Hens, O., Feny, M., Roike, M., Deiske, S., & Alfrets, L. (2021)	Amino Acid Profile of Tuna Fish Sauce (Euthynnus affinis) Fermented with Pineapple Addition	Extraction .	Amino acid, protein content, carbohydrate content, fat content, nitrogen content, ash content, water content, and pH of the effect of pineapple concentration on fermentation time and amino acid profile.	Flesh of fruit	Fish sauce with 15% pineapple juice concentration with 10% salt can accelerate the hydrolysis process on the 10th day.
13	Widawati, L., & Ki Ageng, S. (2019)	Quality Characteristics of Shrimp Head Soy Sauce with Variation of Pineapple Extract Volume and Incubation Time	Extraction	Characterizing the quality of shrimp head sauce through protein, viscosity, and organoleptic analysis	Flesh of fruit	The highest protein content of shrimp head soy sauce was in the treatment with 15% pineapple extract volume and 24 hours incubation time, which was 5.893%.
14	Triastuti, WE, Putra, AFP, Pudjiastuti, L., Suprpto, S., Sari, ON, Provito, WTA, & mKholifatur, AE (2021, April)	Extraction and purification of bromelain enzyme from queen pineapple	Extracted by enzyme isolation method then purified with ammonium sulfate salt, ethanol, and ultrafiltration membrane.	The removal of hemicellulose also increases the movement of the reinforcing molecular fibers, this causes a decrease in the flexible strength of PALF to some extent.	Leaf Meat	The best results are bromelain enzyme powder from pineapple precipitated with 15% ammonium sulfate, and 5% ethanol using a membrane with an enzyme activity of 0.658 U/gr and a protein content of 2.03%
15	Putri, AB, & Anita, A. (2017)	Anti-Inflammatory Effect of Pineapple Bromelain Enzyme Against Osteoarthritis	Extraction	There are four different proteases in pineapple, the two main enzymes in pineapple are defined as stem bromelain and fruit bromelain	Flesh of fruit	Bromelain enzyme has been recognized as a type of safe therapeutic agent, has a good therapeutic effect, and has been used by individuals all over the world for several diseases, such as bronchitis, sinusitis, arthritis, and inflammation due to inflammation.
16	Rochmawati, A., & Syahrul Ardiansyah. (2018)	Test of Antidiabetic Activity of Pineapple Weevil Extract (Ananas comosus L.) in Alloxan-Induced Rats	Pineapple hump extraction and evaporation are carried out using a rotary evaporator at a temperature of 45-50 °C	Decreased glucose levels in alloxan-induced rats by administration of pineapple weevil extract	Pineapple hump	Bromelain enzyme is used to lower glucose levels in the blood.
17	Wiyono, AW, & Dian Mustofani. (2019)	The Effectiveness of Pineapple Skin Bromelain Extract Gel (Ananas comosus L. Merr) Formula Optimization Results in Rats with Bruised Wounds	In pineapple peel extraction, fine preparations are filtered to get the juice for further storage in the refrigerator for 24 hours. The precipitate that appeared was centrifuged at 3,500 rpm for 15 minutes. The colloid layer that appears is added with 0.2% sodium metabisulfite three times the weight of the colloid and then	Crude extract of pineapple peel bromelain to be formulated into a gel and to determine the effect of crude extract of pineapple peel bromelain gel on the healing of rat skin bruises	Pineapple skin	Bromelain enzyme is used to reduce bruising.

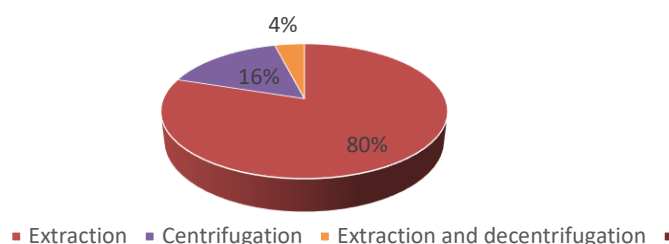
			dried at 55°C for 7 hours.			
18	Bahraini, F., Razak, AR, Bahri, S., & Ys, H. (2021)	Protein Hydrolysis of Black Sea Cucumber ( <i>Holothuria edulis</i> ) Using Crude Bromelain from Pineapple Stems ( <i>Ananas com focus</i> L)	Centrifuged at a speed of 314.16 rad/s for 15 minutes at 15°C	Effect of concentration and hydrolysis time of sea cucumber protein using crude enzyme bromelain from pineapple stems.	Stem	The highest degree of hydrolysis produced in the process of hydrolysis of black sea cucumber protein was at a concentration of 12% bromelain enzyme extract with a hydrolyzate level of 11.43%,
19	Nur, S., Surati, S., & Rehalat, R. (2017)	Bromelain enzyme activity on increasing coconut pulp flour protein	Extract	Bromelain enzyme activity from pineapple peel extract on increasing amino acid levels of coconut pulp flour in	Skin	The addition of pineapple peel extract at a concentration of 25% gave the highest soluble protein content and at 0% concentration, it gave the lowest soluble protein content.
20	Ranty, C. (2019).	Different Incubation Periods on Physical Quality of Cheese Curd	Extraction	The percentage of crude extract of bromelain enzyme from pineapple juice with the best incubation period in the manufacture of cheese curd made with lactic acid bacteria starter <i>Streptococcus thermophilus</i> in terms of yield, moisture content, organoleptic quality, and microstructure.	Flesh of fruit	Making cheese curd with the addition of crude extract of bromelain enzyme from pineapple juice with different incubation periods can significantly affect the water content of the curd produced and have a very significant effect on the organoleptic quality of the color of the curd.
21	Wijana, S. (2019)	Hydrolysis of Blondo Protein Concentrate Waste from Virgin Coconut Oil (VCO) Products as Food Flavoring Raw Material	Extraction	Hydrolyzing Blondo Protein, As well as The Number Of Enzyme Concentrations And The Optimum Length Of Hydrolysis Time So That The Best Blondo Protein Hydrolyzate Products Can Be Produced As Food Flavoring Raw Materials	Young Pineapple Flesh	Increasing the Protein Content of Materials Needs Hydrolysis Using Bromelain Enzyme There is a 5% Concentration Treatment and 11 Hours With a Value of 5.03% Water Content, 21.33% Fat Content, 19.68% Protein Content, And 19.52% Total Yield
22	Diana, F., Aluras, HJ, & Zulfadhli, Z. (2017)	Addition of Bromelain Enzyme to Increase Feed Protein Utilization and Growth of Tawes Fish Seed ( <i>Barbonymus gonionotus</i> )	Extraction	The addition of bromelain enzymes into artificial feeds can help the protein hydrolysis process, and can also break down collagen contained in artificial feeds so that the protein can be utilized properly by the fish body.	Hump	The addition of bromelain enzymes in Tawes fish feed gave a significant effect on PER (2.26%), SGR (2.64%), and LPB (0.117g), and the best protein utilization from the addition of bromelain was found in P3 treatment (2.26%).
23	Yolanda, TO (2021)	Bromelain Fractionation of Honey Pineapple Fruit ( <i>Ananas Comosus</i> L.) and Hydrolysis Test on Etawa Crossbreed Goat Milk Protein	Extraction	Antioxidant activity of hydrolyzate produced from protein hydrolysis process of Etawa Peranakan goat milk using fractionated honey pineapple bromelain	Mida pineapple meat	Hydrolysis of goat's milk protein was carried out using the bromelain fraction which had the highest specific activity, namely F60 at a temperature of 55 C and pH 7 with various incubation times of 10, 20, 30, 40, 50, and 60 minutes. The highest degree of hydrolysis for casein hydrolyzate was 77.77% and the highest whey hydrolyzate was 47.49%
24	Lestari, P. (2020)	Antioxidant Activity of Hydrolyzed Protein	Extraction	Each protein hydrolyzate fraction of casein	Leaf	Hydrolysis of casein from milk protein Etawa goat with bromelain from

		From Etawa Goat Milk Casein Hydrolyzed Bromelain From Honey Pineapple Leaves		determined the degree of hydrolysis, tested antioxidant activity by the method e PDF, and hemolysis test on cells Red blood		honey pineapple leaves on condition the optimum yield of casein fraction hydrolyzate with antioxidant activity highest at the hydrolysis time of 30 minutes.
25	Giordan, E. (2020)	Goat's Milk Casein Bioactive Peptides as Antibacterial Agent against Staphylococcus aureus	Extraction was continued by centrifugation at 14,000 rpm, 15 minutes	Antimicrobial potential of bioactive goat's milk casein peptide hydrolyzed by bromelain	Flesh of fruit	Casein and hydrolyzate from the hydrolysis of goat milk casein with bromelain can inhibit Staphylococcus aureus.

After analyzing research articles from the last six years, for the research method, there are three types of sampling methods used by researchers who reviewed from 25 articles. For details, see Table 2 and Figure 2.

**Table 2. Sampling Method**

No	Type of Sampling method	Amount
1	Extraction	$20/25 \times 100\% = 80\%$
2	Centrifugation	$4/25 \times 100\% = 16\%$
3	Extraction and decentrifugation	$1/25 \times 100\% = 4\%$



**Figure 2. Sampling Method Diagram**

The parameters taken for further analysis are the studied variables used by the researchers whose articles were analyzed. There are ten types of variables studied. The details can be seen in table 3 and figure 3.

**Table 3. Variable Under Study**

No	Variable under study	Amount
1	Tenderize the meat	$1/25 \times 100\% = 4\%$
2	catalyze peptide bond	$1/25 \times 100\% = 4\%$
3	Bromelain enzyme characterization	$3/25 \times 100\% = 12\%$
4	Mechanism of action of bromelain as an antibacterial	$2/25 \times 100\% = 8\%$
5	Bromelain Enzyme Immobilization	$1/25 \times 100\% = 4\%$
6	Meat quality	$1/25 \times 100\% = 4\%$
7	Hydrolyzes protein	$13/25 \times 100\% = 52\%$
8	Decreased glucose levels	$1/25 \times 100\% = 4\%$
9	Healing wound	$1/25 \times 100\% = 4\%$
10	Cheese Curd Physical Quality	$1/25 \times 100\% = 4\%$

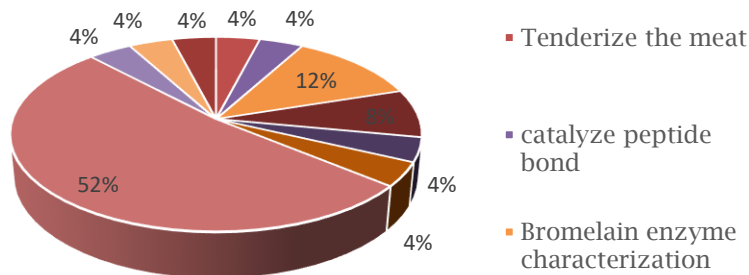


Figure 3. Researched Variables

Furthermore, the third parameter taken for analysis is the plant part of the pineapple that is used by researchers whose articles have been analyzed. There are ten types of pineapple plant parts that are used in the extraction of bromelain. The details can be seen in Table 4 and Figure 4.

**Table 4. Pineapple Plant Parts Used**

No	The part of the pineapple plant that is used	Amount
1	Ripe pineapple hump	$1/25 \times 100\% = 4\%$
2	Ripe Flesh	$1/25 \times 100\% = 4\%$
3	Flesh and fruit hump	$2/25 \times 100\% = 8\%$
4	Flesh of fruit	$11/25 \times 100\% = 44\%$
5	Pineapple hump	$3/25 \times 100\% = 12\%$
6	Ripe stems and pulp	$1/25 \times 100\% = 4\%$
7	Pineapple skin	$2/25 \times 100\% = 8\%$
8	stem	$1/25 \times 100\% = 4\%$
9	Young Pineapple Flesh	$2/25 \times 100\% = 8\%$
10	Leaf	$1/25 \times 100\% = 4\%$

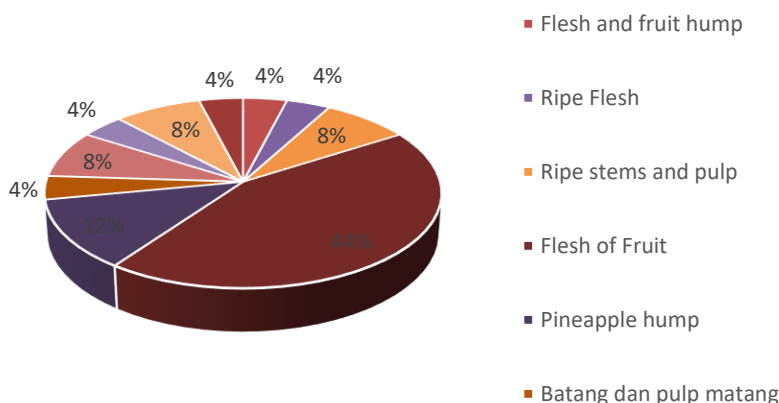


Figure 4. Diagram of Pineapple Plant Parts Used

Finally, the fourth parameter taken for analysis is the benefits of bromelain from the pineapple plant that is used by researchers whose articles have been analyzed. There are ten kinds of benefits derived from the analysis of articles. The details can be seen in Table 4 and Figure 4.

**Table 5. Pineapple Bromelain Benefits**

No	Pineapple Bromelain Benefits	Amount
1	Tenderize the meat	$3/25 \times 100\% = 12\%$
2	Hydrolyzes collagen in the intertubular dentin	$1/25 \times 100\% = 4\%$
3	Helping the fermentation process of making tuna fish sauce	$1/25 \times 100\% = 4\%$
4	Increase the protein content of the product	$9/25 \times 100\% = 36\%$



5	As an anti-browning agent	$1/25 \times 100\% = 4\%$
6	Inhibits Streptococcus bacteria	$2/25 \times 100\% = 8\%$
7	Accelerate the hydrolysis process	$5/25 \times 100\% = 20\%$
8	Therapeutic agent	$1/25 \times 100\% = 4\%$
9	Lowering glucose levels in the blood	$1/25 \times 100\% = 4\%$
10	Reduces bruising.	$1/25 \times 100\% = 4\%$

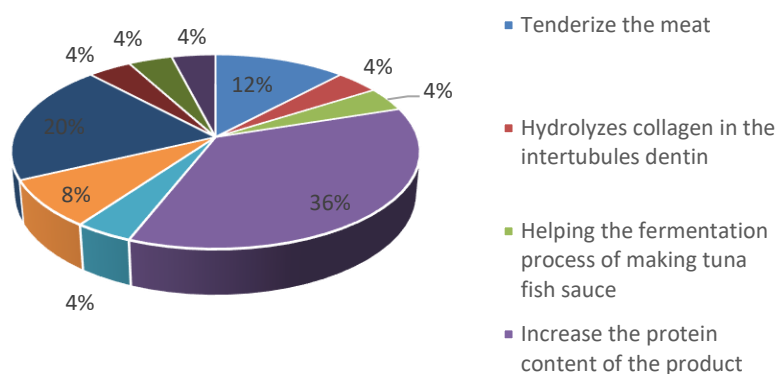


Figure 5. Pineapple Bromelain Benefits Chart

## Discussion

Of the total literature, which is 25 articles, thirteen articles or as much as 52% discuss the protein hydrolyzing bromelain variable. This indicates the potential for bromelain in pineapple to hydrolyze the protein contained in Tempe so that it can produce a savory taste due to the reaction and has the potential to be a flavor enhancer. The high concentration of bromelain and also the incubation time carried out, the results of enzyme hydrolysis are more and more amino acids and the glutamic acid produced can give a savory taste effect on tempe embus (El Kiyat, *et al.*, 2019).

Getting the extract from pineapple bromelain is very easy, it does not need to require any special tools. There are 80 % or 20 other articles getting bromelain samples by the extraction method, how to use a blender, then squeezing, and filtering so that a clear liquid is obtained. (crude extract of bromelain). Thus, getting a savory taste from the hydrolysis reaction of bromelain to tempe protein is very easy.

To get a good quality flavoring, pineapple is needed which has a high bromelain content. As in the eleventh or as many as 44% of the articles that have been studied, the meat from pineapples is taken for bromelain. However, from the eleventh, there is no information on ripe or young pineapples. Young pineapples contain more bromelain enzymes than ripe pineapples (Hairi, 2010). According to Tochi (2012), yang fruit Cooking shows a pH of 3.0 -3.5 and in an acidic environment, the bromelain enzyme is denatured and undergoes a structural conformational change so that its activity is reduced. The part of the pineapple plant that has the highest bromelain enzyme activity value is the pineapple flesh compared to the stem and also the quantity and quality of DNA obtained has a greater total activity (Maryam, 2009).

A total of 36% of the total articles or as many as 9 articles studied utilized bromelain extracted and used to increase protein concentration levels. The higher the bromelain enzyme concentration and the incubation time with the bromelain enzyme, the higher the protein content contained in tofu (Purwaningsih, 2017). In addition, in Nur's research (2017) coconut pulp flour products also apply the addition of pineapple peel extract at a concentration of 25% giving the highest dissolved protein content. Furthermore, 20% of all articles or 5 articles studied used bromelain to speed up the hydrolysis process. The concentration of the bromelain enzyme extract added to the tofu pulp substrate for the hydrolysis process to produce the hydrolyzate greatly affects the degree of hydrolysis. As it is known that one of the factors that affect the activity of enzymes is the concentration of enzymes. The total protein content (total N) before the hydrolysis process was 38.26703 %. In this case, the bromelain enzyme acts as a biocatalyst that accelerates the breakdown of proteins into amino acids. Therefore, the higher the concentration of added enzymes, the higher the reaction rate will be (Bahri, *et al.*, 2021).

From some literature obtained bromelain from pineapple extract will start the breakdown process through the hydrolysis technique, protein tempe can be converted into acidic compounds amino acids, nucleotides, and various peptides. This variety of hydrolysis results plays a role in the formation of a delicious taste generated. This enzyme can break down proteins, therefore it can increase protein levels. This enzyme has an important meaning like the papain enzyme from papaya (Machin, 2012).

## Conclusion

Through this literature review, it was Pineapple extract which has a high bromelain content has the potential to be one of the compositions of organic MSG because of its ability to break down protein bonds into small peptides into amino acids by the hydrolysis process. Thus, a savory taste is produced from the hydrolysis process so that it can be used as an alternative to organic MSG. The highest sampling method is the extraction method by 80%, centrifugation at 16%, and the method using extraction and centrifugation at 4%. There is great potential for bromelain to be used as a protein breaker in time so that it produces a savory taste that becomes a flavor enhancer. Judging from the variables studied, it was found that 52% of protein hydrolyzing activity, 12% of bromelain enzyme characterization, 8% of bromelain's anti-bacterial mechanism of action, and 4% of meat tenderization, catalyzing peptide bonds, bromelain enzyme immobilization, meat quality, lowering glucose levels, wound healing and physical quality of cheese curd. And if we look at the part of the pineapple plant that is used, 44% of the pineapple flesh is used, 12% of the pineapple weevil, 8% each of the fruit flesh and fruit hump, pineapple skin and young pineapple flesh and 4% each from the weevil. ripe pineapple, ripe fruit flesh, ripe pineapple stem and pulp, stem, and lastly the leaves of the pineapple plant. And when viewed from the use of the benefits of bromelain, a score of 36% was obtained for increasing the protein content of the product, 20% for accelerating the hydrolysis process, 12% for tenderizing meat, 8% for inhibiting *streptococcus bacteria*, and 4% each used to hydrolyze collagen, helps the fermentation process, anti-browning agent and therapeutic agent.

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