Research Article

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Evaluation of Antibacterial Activity of Pineapple Fruit Bar Extract, treated with Sugar and Jaggery

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ABSTRACT

The infections/diseases are caused by many antibiotic-resistant bacteria, virus, fungi and protozoan parasites. The discovery of the plant origin of antibiotic drugs has inevitably fostered the development of resistance in microorganisms. The variety of natural candidates of plant origin, many leaves and fruits have potent antibacterial activity. This study is aimed at determining the antibacterial activity of pineapple *(Ananas comosus)* fruit bar extracts used for the antibacterial activity was carried out by agar well-diffusion technique and the activity was measured by the zone of inhibition in diameter. The results of the study revealed that the various extracts of pineapple (P1, PS2 and PJ3) have potential activity against both gram-positive bacteria (*Staphylococcus aureus*) and gram-negative bacteria (*Escherichia coli*).

Keywords: Antibacterial; Pineapple fruit bar extract; Agar well-diffusion; Zone of inhibition.

1. INTRODUCTION

Derivatives of plants are crucial sources of nutrients that promote health, including vitamins, minerals, antioxidants, proteins, carotenoids, fats and fibres. Consuming fruits and vegetables significantly help us with a diet that is well-balanced and healthful. Additionally, numerous non-communicable diseases associated with lifestyle choices such as obesity, bone disorders, diabetes, cardiovascular disease and stroke can be avoided (Elhadi, and Armando, 2019). Fruits and vegetables are especially perishable due to their high moisture content, which causes significant post-harvest losses. As a result, they must be stabilized, because preventing such food losses and waste should be the best plan of action for supplying the world's growing population with food (Charles and Tara, 2014). Sugars, acids, vitamins, and minerals are among the beneficial ingredients found in fruits and fruit products. Furthermore, regular consumption of fruits in sufficient amounts may help lower the risk of some chronic diseases like cancer, cardiovascular disease, stroke, Alzheimer's disease, and cataract, due to their high content of nutrients with therapeutic benefits like fibre and antioxidants. Numerous fruit varieties are seasonal in nature; due to their high moisture content, fresh fruits are perishable. As a result, it is necessary to research methods for canning fruits during the peak harvest season in order to extend their shelf life and reduce losses. Additionally, the desire for more leisure time, rising urbanization, rising female employment and other variables are all predicted to contribute to an increase in the demand for processed foods. As a result, numerous techniques for fruit processing and preservation have been developed. Fruits are used to make a variety of products, including fruit juices, canned fruit, frozen fruit slices and dehydrated goods. Fruit bars are a type of snack or confection made by drying fruit pulp and combining it with sugar and pectin in the proper proportions. Fruit bars are a wonderful nutritional supplement because they are largely composed of fruit and are a great source of vitamins and minerals. Because all the nutrients are concentrated in fruit bars, they are generally more nutrient-dense than raw fruits. People often consume market-available unhealthy food, especially children and young adults. Instead of supplying balanced nutrients, snack manufacturers concentrate on creating tasty snacks by adding artificial flavours and colours. Fruits can make up for the poor nutritional content of these snacks by giving consumers key nutrients including carbohydrates, vitamins, minerals and other essential elements. Protein, which is one of the most important nutrients, is not found in sufficient amounts in fruits and their products. Antimicrobial substances are essential for preserving health. Antimicrobial resistance poses a challenge to the treatment of illnesses like pneumonia, malaria, AIDS, wound healing and tuberculosis. Therefore, it is crucial to create antimicrobial resistance, which is accomplished by using diverse antimicrobial agents. An antibiotic is a substance that prevents the growth of microorganisms or kills them. Bromelain, a protein-digesting enzyme found in the fruit and stem of the pineapple plant (*Ananas comosus*), a member of the Bromeliaceae family, is one such antimicrobial agent (Bhattacharyya, 2008; Hale *et al.* 2005). People utilize it as medication as a result of its strong medicinal values, including decreasing swelling and inflammation, particularly in the nose and sinuses (Eric *et al.* 2005; Cohen, 1964). Nanomaterials, synthesized by different methods and produced with metallic nanoparticles, are very valuable products that can be used in many areas. Nanoparticles show biological, optical, magnetic and catalytic properties depending on their shape and size. Some features of nanoparticles (NPs) make them superior such as having a large surface area and being resistant to high temperatures; they can be used in many fields such as material science, pharmaceutics and electronics.

As a result, the findings of this study showed that the different pineapple extracts (P1, PS2 and PJ3) are active against gram-positive bacteria like *Staphylococcus aureus* and gram-negative bacteria like *Escherichia coli*. This study could aid in the creation of an antibacterial protein using pineapple extract as a component.

2. MATERIALS AND METHODS

2.1 Preparation of Pulp Mixture

Pineapple fruit bars were washed under running water, manually peeled with a knife and cut into small pieces; then, the pulp was extracted from the fruit by using a pulper (Philips HL 7756/00, 750 W, YC1A2227444047). A blend of pineapple pulp was taken in (250 g) and thermally processed; sugar (100 g) and jaggery (100 g) were added to the boiled pulp and were labelled as P1, PS2 and PJ3, respectively. Pectin (3.5%), maltodextrin (1.5%) and citric acid (1.5%) were added and it was thermally processed. Heated enough to form a homogeneous mixture till 78° Brix TSS; then the mixture was poured in a plastic moulder smeared with butter (2-3 cm) and then taken out from the moulder after setting the fruit bar and dried at 55 °C ± 2 °C for 24 h in a tray drier. Afterwards, the cooled fruit bars wrapped in silver paper were diluted with double distilled water for antimicrobial studies. The preparation of the pulp mixture is shown in Fig. 1.

2.2 Growth and Maintenance of Test Bacteria for Antibacterial Studies

The bacterial cultures were maintained on nutrient broth (NB) at 37 °C.

Table 1. Composition of Nutrient agar medium

S. No.	Ingredients	g/1000 ml
1	Peptone	5.0 g
2	Beef extract	3.0 g
3	Agar	15.0 g
4	Distilled water	1000 ml
5	pH	7.0

2.3 Preparation of Inoculum

The gram-positive bacteria, *Staphylococcus aureus* and gram-negative bacteria *E. coli*, were pre-cultured in nutrient broth overnight in a rotary shaker at 37 °C and centrifuged at 10,000 rpm for 5 min. The pellets were suspended in double distilled water and the cell density was standardized spectrophotometrically (A_{610} nm).

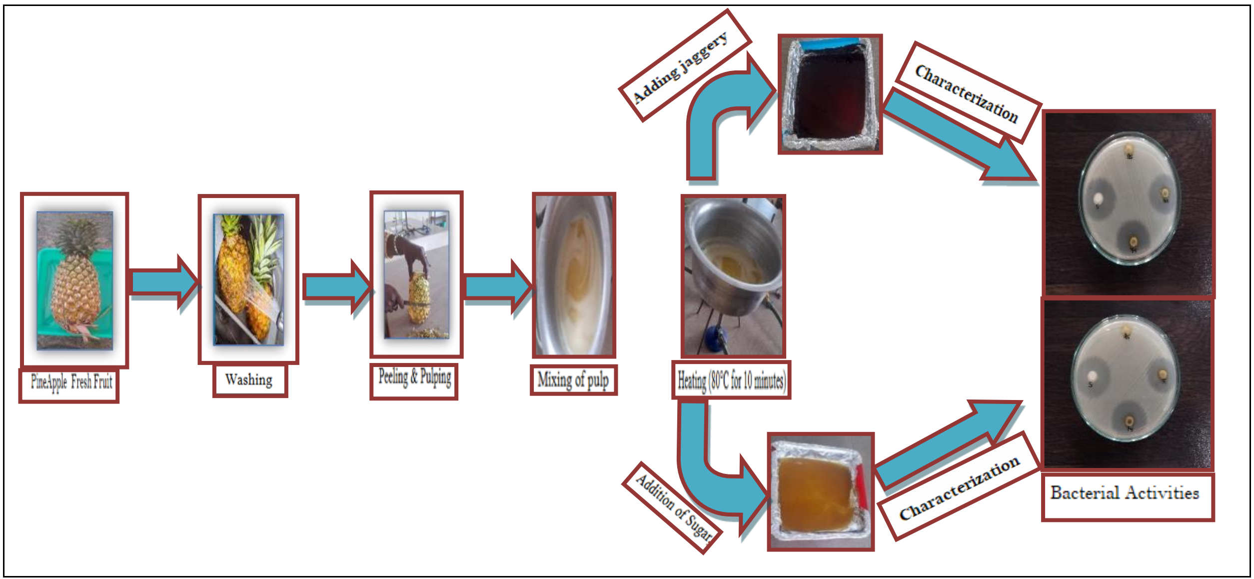

Fig. 1: Flow chart of the present study

2.4 Antibacterial Studies

The test organisms used were clinical isolates *(Staphylococcus aureus* and *E. coli)*, which were obtained from Department of Microbiology, Bharathiyar University, Coimbatore, India. The samples of different extracts (P1, PS2 and PJ3) were tested by Well diffusion method. The different concentrations of the extracts (100 µg/ml) was prepared by reconstituting them with methanol. The test microorganisms were seeded into the respective medium by spread plate method (10 µl; 10 cells/ml) with the 24 h cultures of bacteria growth in nutrient broth. After solidification, the filter paper wells (5 mm in diameter) impregnated with the extracts were placed on test organism-seeded plates. Ciproflaxin (10 µg) was used as a standard for the antibacterial test. The antibacterial assay plates were incubated at 37 °C for 24 h. The diameters of the inhibition zones were measured in mm.

3. RESULT

The antibacterial effects of the pineapple fruit bar of crude extract (P1), crude extract with sugar (PS2) and crude extract with jaggery (PJ3) of different concentrations were tested against human pathogenic bacteria *Staphylococcus aureus* and *Escherichia coli*. The pineapple fruit extracts have an appreciable antibacterial activity on selected disease-causing pathogens.

3.1 Antibacterial Effect of P1

The pineapple fruit bar crude extract was tested against gram-positive bacteria *Staphylococcus aureus* and gram-negative bacteria *E. coli*. The highest zone of inhibition was found at 19 mm at 75 ml of test sample and lowest zone of inhibition was shown at 5 mm at 25 ml of the test sample. Similarly, the highest zone of inhibition against *Staphylococcus aureus* was found at 16 mm at 75 ml concentration and the least inhibitory effect at 5 mm at 25 ml test sample.

3.2 Antibacterial effect of PS2

The pineapple extract with sugar (PS2) actively inhibits *E. coli* and *Staphylococcus aureus*. The highest zone of inhibition was measured in *E. coli* at 18 mm at 75 ml concentration and the least value was measured at 5 mm on both *E. coli* and *Staphylococcus aureus* at 25 ml concentration of test sample.

3.3 Antibacterial effect of PJ3

The pineapple extract with sugar (PJ3) actively inhibits *E. coli* and *Staphylococcus aureus*. The highest zone of inhibition was measured in *Staphylococcus aureus* at 18 mm at 75 ml concentration and the least value was measured at 5 mm on both *E. coli* and *Staphylococcus aureus* at 25 ml concentration of test sample.

Table 2: Antibacterial activity of P1

S. No.	Pathogenic bacteria	Zone of inhibition (mm)			Standard (Ciproflaxin)
		25	50	75	
1.	*E. coli*	05	12	19	20
2.	*Staphylococcus aureus*	05	11	16	20

Table 3: Antibacterial activity of PS2

S. No.	Pathogenic bacteria	Zone of inhibition (mm)			Standard (Ciproflaxin)
		25	50	75	
1.	*E. coli*	05	12	19	20
2.	*Staphylococcus aureus*	05	11	16	20

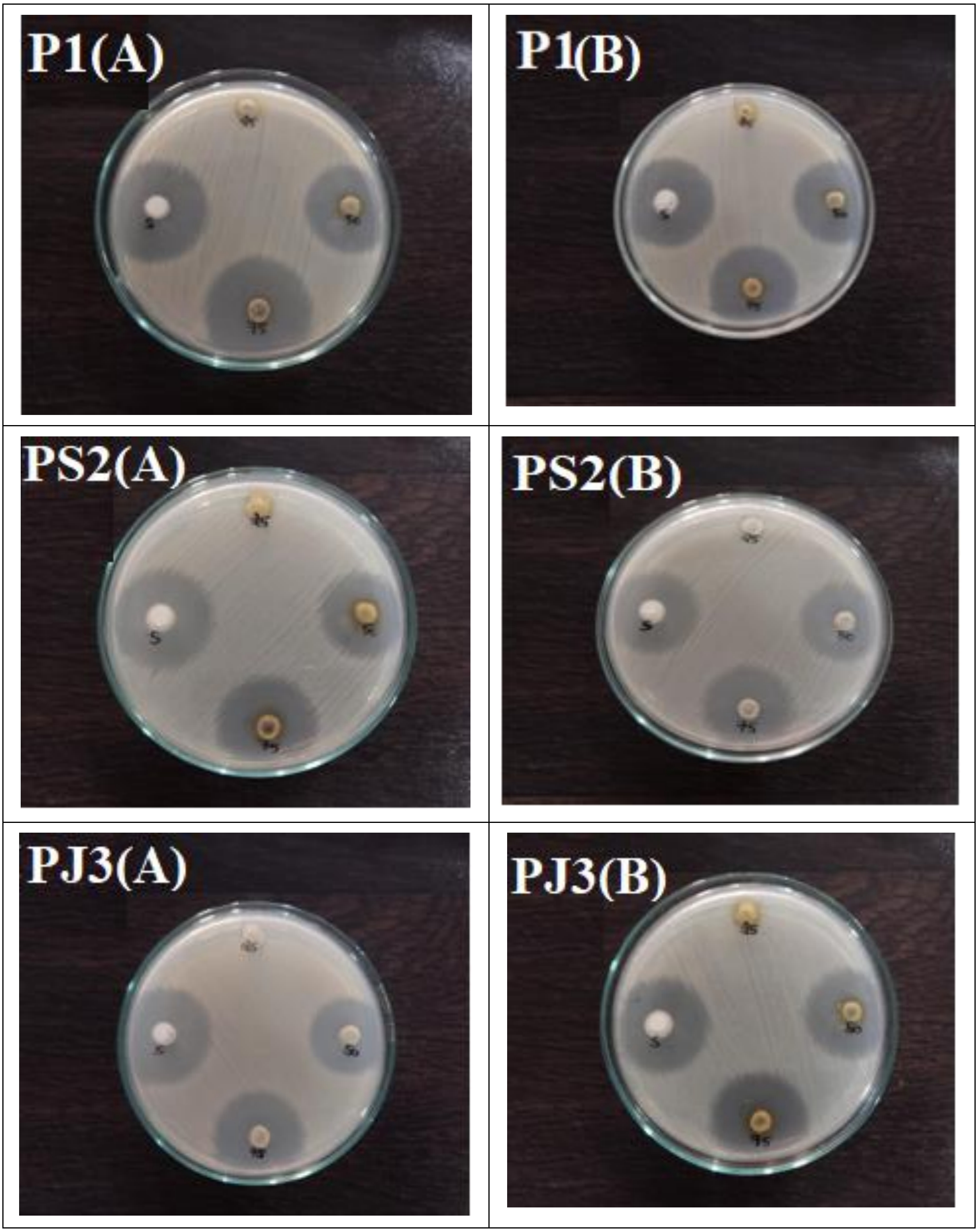

Fig. 2: Antibacterial activity of different Pine apple fruit bars extracts

P1 (A) - Crude extracts against *E. coli*
PS2 (A) - Crude extracts with sugar against *E. coli*
PJ3-(A) - Crude extracts with Jaggery against *E. coli*
P1 (B) - Crude extracts against *S. aureus*
PS2 (B) - Crude extracts with sugar against *S. aureus*
PJ3 (B) - Crude extracts with Jaggery against *S. aureus*

Table 4: Antibacterial activity of PJ3

S. No.	Pathogenic bacteria	Zone of inhibition (mm)			Standard (Ciproflaxin)
		25	50	75	
1.	*E. coli*	05	10	16	20
2.	*Staphylococcus aureus*	05	12	18	20

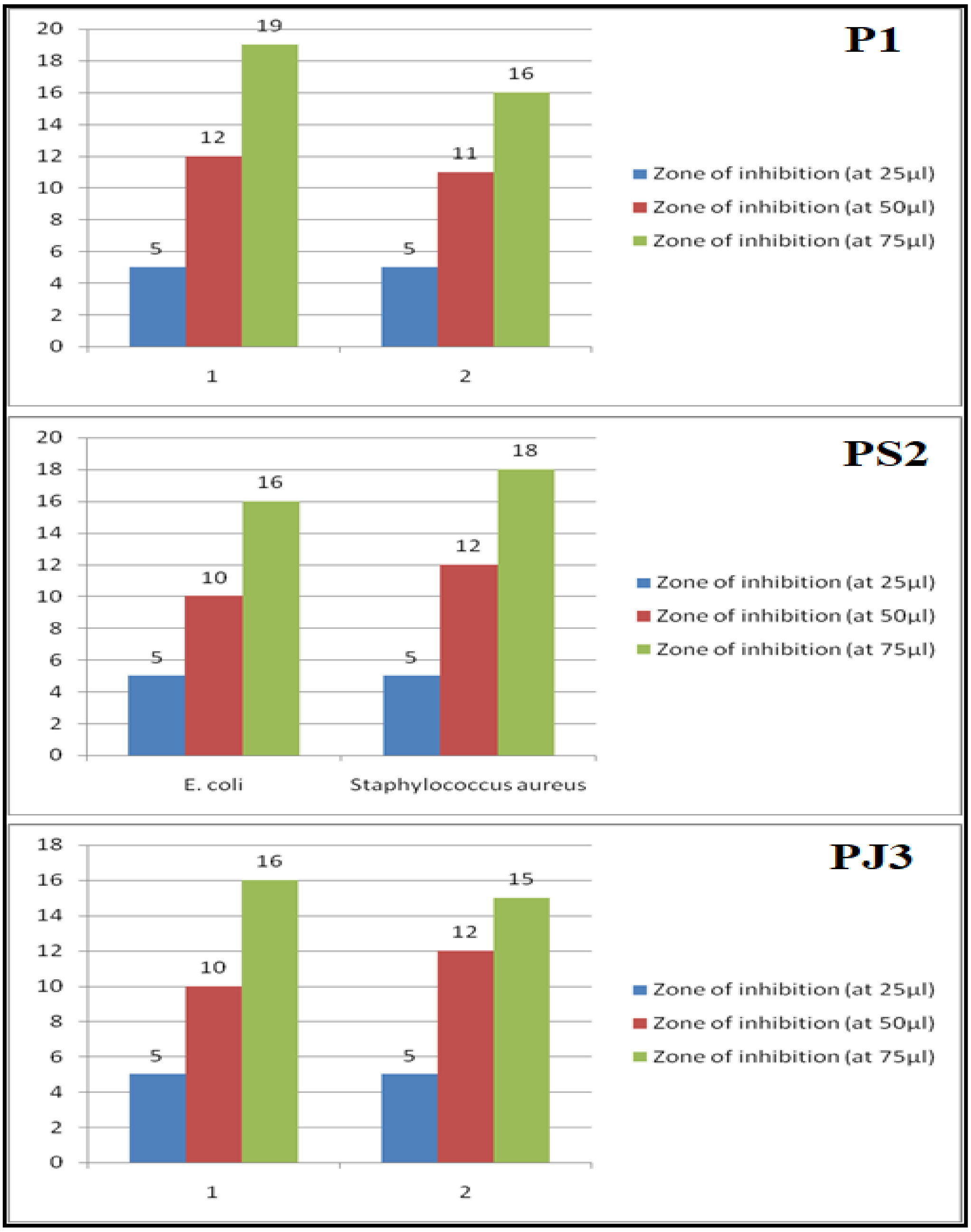

Fig. 3: Antibacterial activity of different Pineapple fruit bar extracts (P1, PS2 and PJ3) against *E. coli* and *S. aureus*

4. DISCUSSION

Pineapple (*Ananas comosus*) is an incredibly delicious, healthy tropical fruit. Pineapple contains plenty of nutrients and beneficial compounds such as vitamins, manganese and enzymes to help the digestion process in the human digestive system. Eating fresh or roasted ripe pineapple may help to boost immunity and lower cancer risk. Pineapples become a rich source of amino acids when mixed with sugar and jaggery and has the potential to resist the microorganisms. The present study reveals that the three different extracts from the pineapple at different concentrations tested against both gram-positive and gram-negative bacterial strains show significant effects. Ashik *et al.* 2016 reported significant antibacterial activity in the pineapple extract against *E. coli, P aeruginosa, K. pneumoniae and S. aureus.* Similarly, the present study shows antibacterial activity of the pineapple fruit bar extracts - P1, PS2 and PJ3, screened by Agar well diffusion technique. The results are presented in Tables 2, 3 and 4.

The Pineapple extract was more effective against *E. coli* with a zone of inhibition of 19 mm diameter. In this research, the pineapple fruit bar (P1) extract sample (P1) and pineapple sugar extract sample (PS2) show the highest inhibitory effect on *E. coli* bacteria than on *Staphylococcus aureus* bacteria. The lowest concentration of P1, PS2 and PJ3 extracts have a minimum zone of inhibition on both gram-positive and gram-negative bacteria - Staphylococcus aureus and E. coli. The pineapple jaggery extract exhibits the highest zone of inhibition on Staphylococcus aureus.

5. CONCLUSION

The different pineapple fruit bar extract samples have significant effects on gram-positive bacteria *S. aureus* and gram-negative bacteria *E. coli*. The pineapple fruits have antioxidants, vitamins, proteins, carotinoids, fibers and fat molecules which might inhibit the growth of tested microorganism.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCE

Bhattacharyya, B. K., Bromelain: An Overview, Natural Product Radiance, 7(4), 359-363 (2008).

Charles, H. J. G. and Tara G., Food security and sustainable intensification, *R. Soc.*, 369(1639), 1-10 (2014). https://doi.org/10.1098/rstb.2012.0273

Cohen, A. and Goldman, J., Bromelain therapy in rheumatoidarthritis, *Pennsylvania Medical Journal*, vol. 67, 27–30 (1964).

Elhadi, Y., and Armando, C. L., Postharvest Physiology and Biochemistry of Fruits and Vegetables, *Woodhead Publishing*, 1st Ed, 19-45 (2019). https://doi.org/10.1016/C2016-0-04653-3

Eric, R. S. J., William, F. C., Michelle, M. C., Linda, A. G., Craig, M. S., Carol, A. W., Roger, S. T., Bromelain exerts anti-inflammatory effects in an ovalbumin-induced murine model of allergic airway disease, 237(1), 68-75 (2005). https://doi.org/10.1016/j.cellimm.2005.10.002

Hale, L. P., Greer, P. K., Trinh, C. T., and James, C. L., Proteinase activity and stability of natural bromelain preparations, *Int. Immunopharmacol*., 5(4), 783-793 (2005). http://dx.doi.org/10.1016/j.intimp.2004.12.007