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Utilization of Pineapple (*Ananas comasus*) Plant Stem as Starch and Lignocellulose Feedstock for Biobased Products

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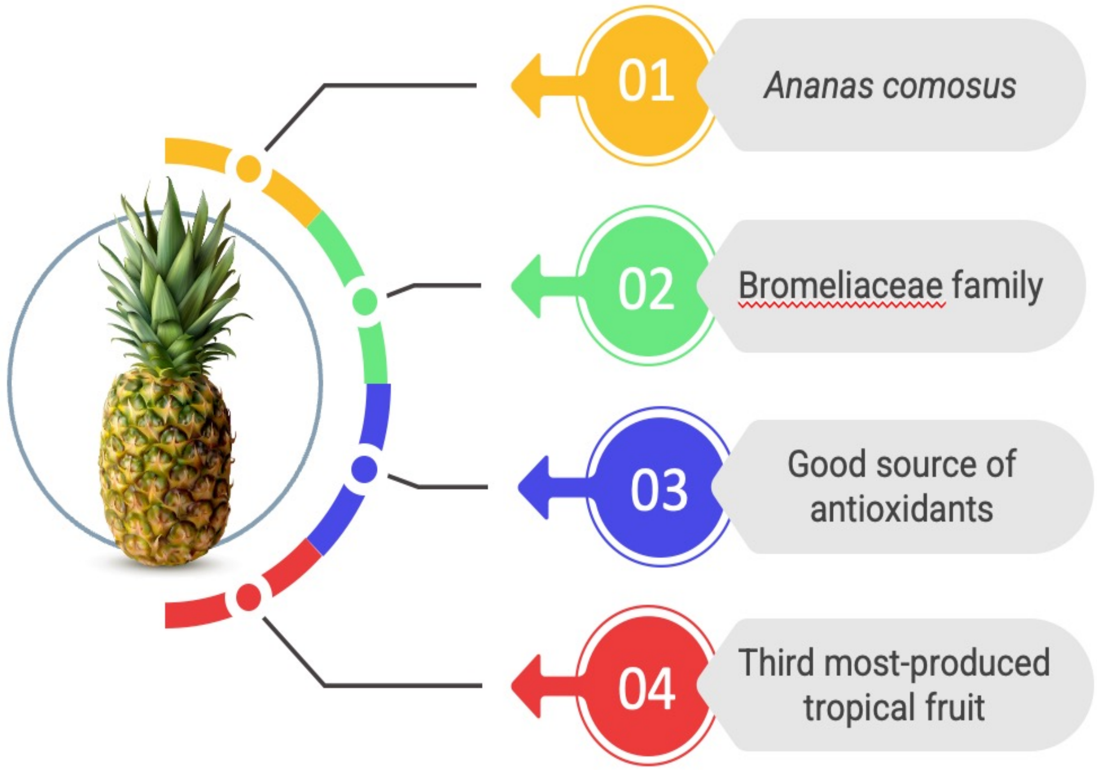
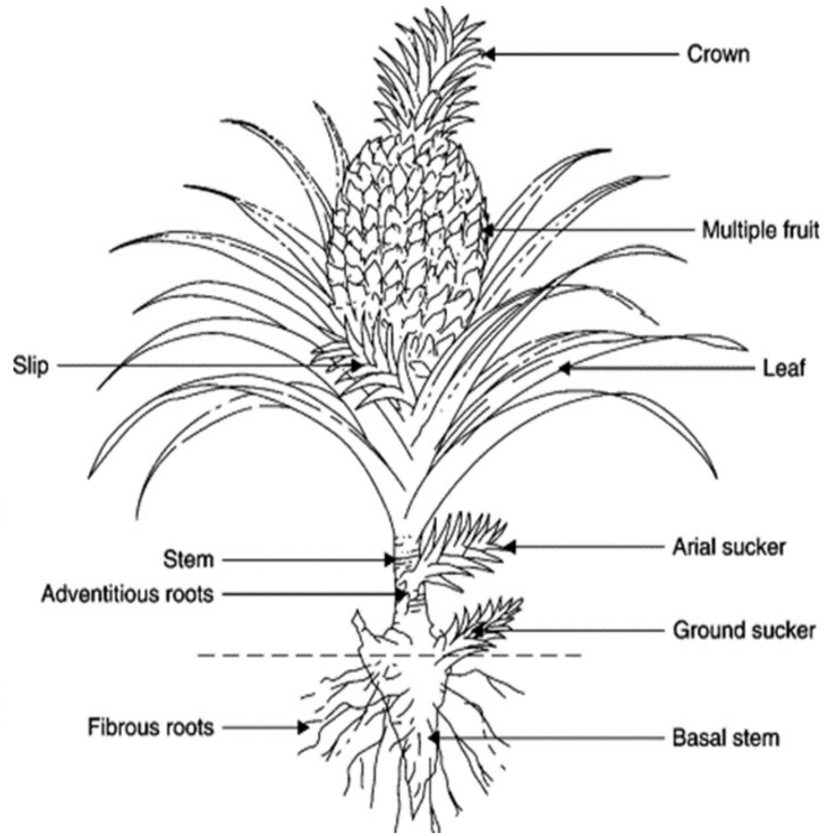
INTRODUCTION

PINEAPPLE





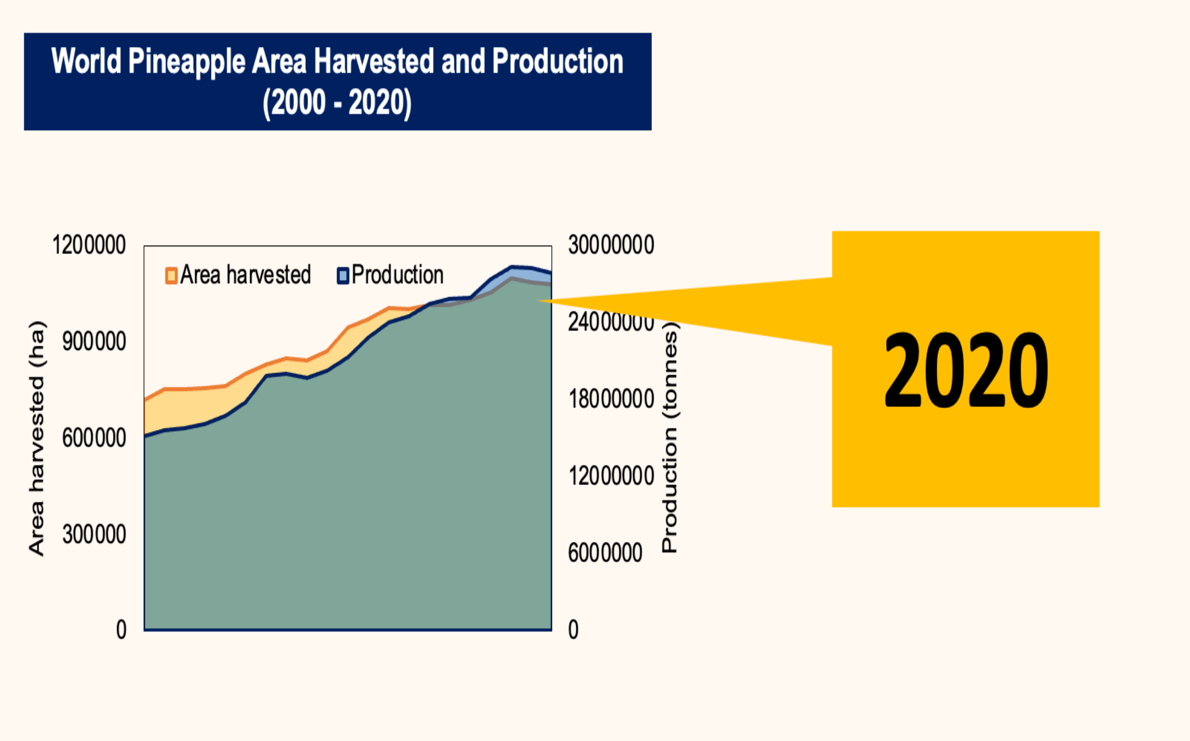
Pineapple is the third most-produced tropical fruit after banana and mango.

Source: Hassan et al. (2011); Hamzah et al., (2021)

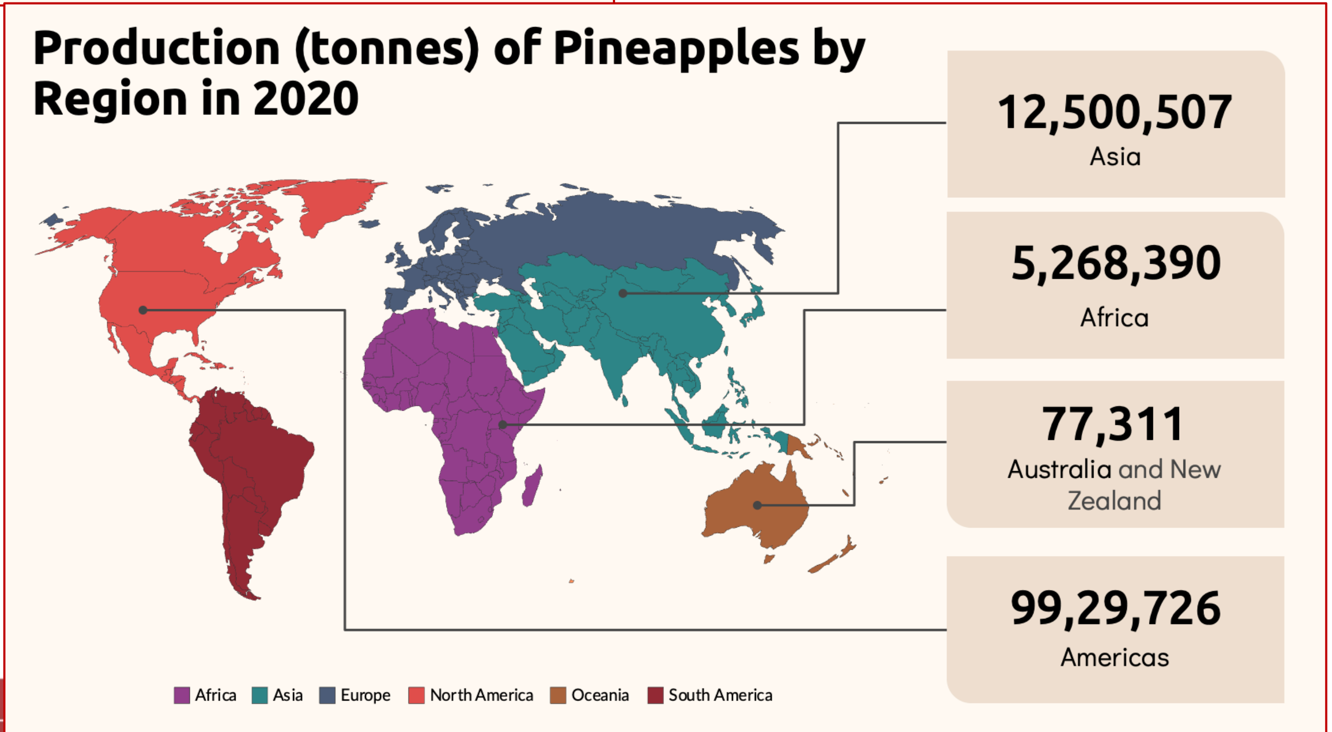
- About 80% of pineapple parts, including the crown, peels, leaves, core and stems, are discarded during pineapple processing, transportations and storage and ends as waste.

- As one of the leading agricultural commodity producers in the Southeast Asian region, Malaysia produces 335,488 tons of pineapple in addition to 67,098 and 137,550 tons of leaf and peel wastes (Hamzah et al., 2021)

STATISTICS

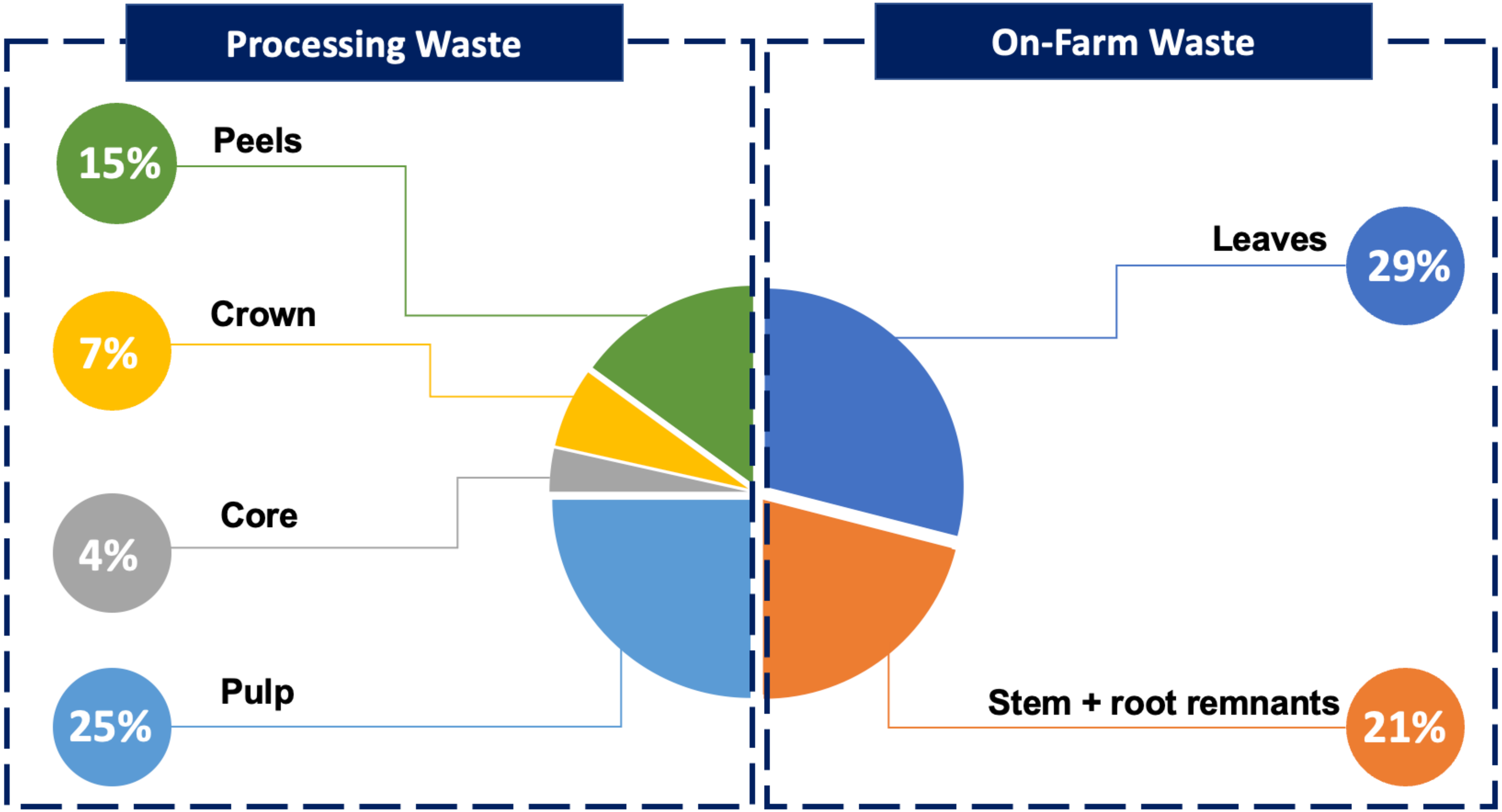


Source: Hamzah et al. (2021)



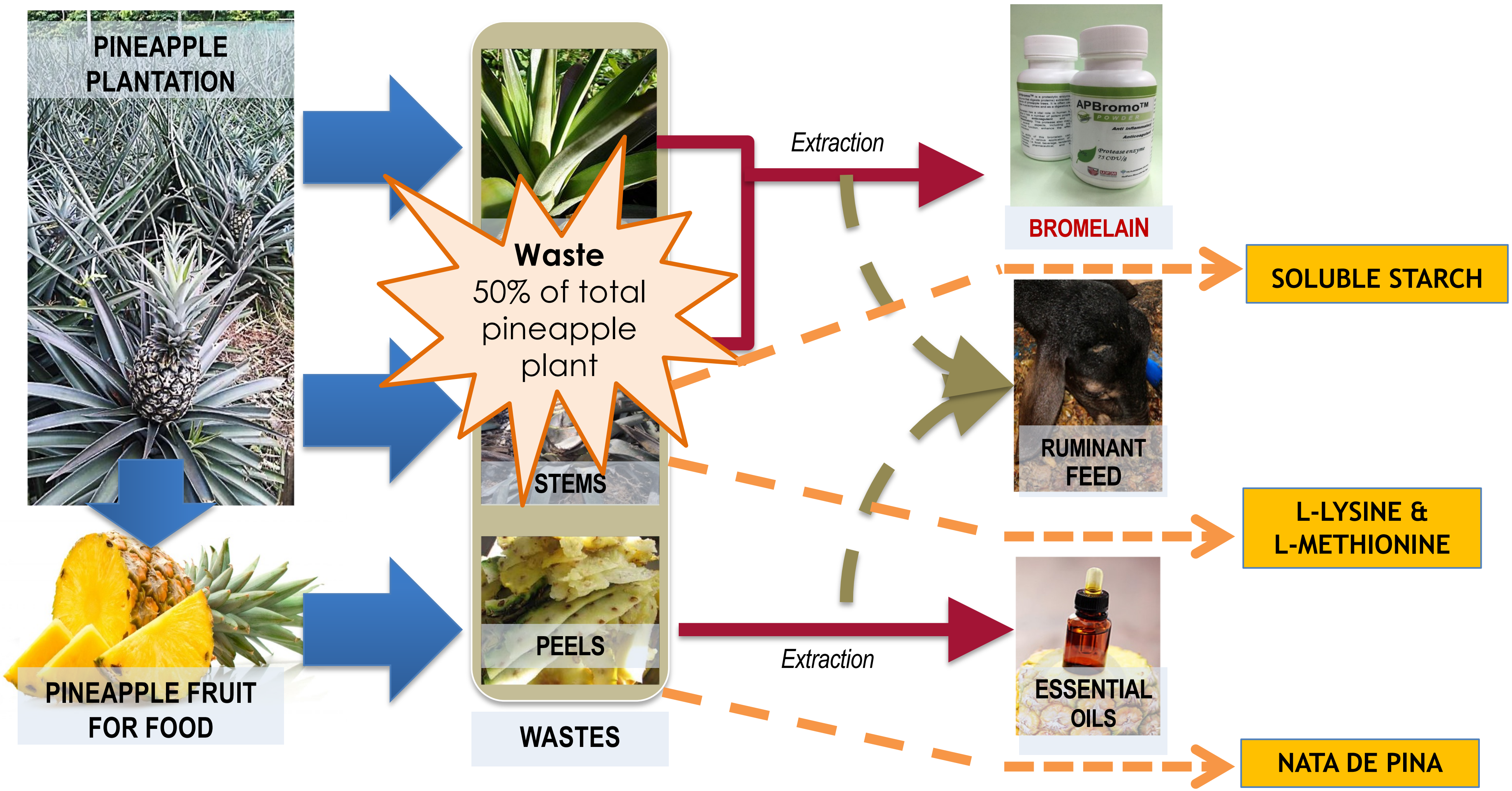
Source: FAO (2022)

COMPOSITION OF PINEAPPLE WASTES



OBJECTIVES

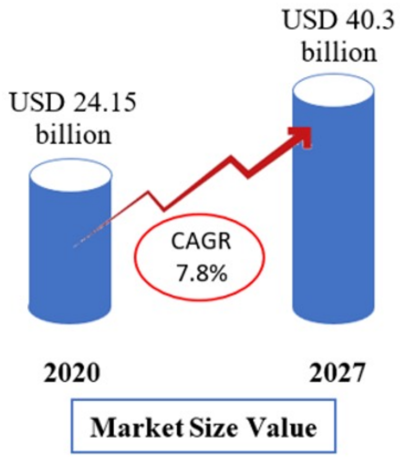
PINEAPPLE BIOREFINERY (Zero Wastes)

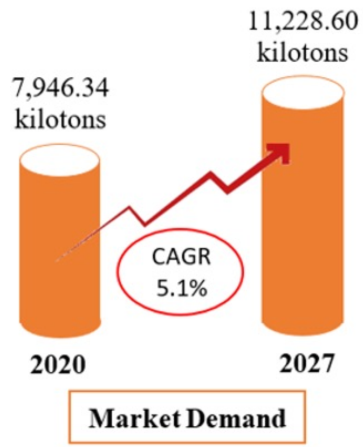


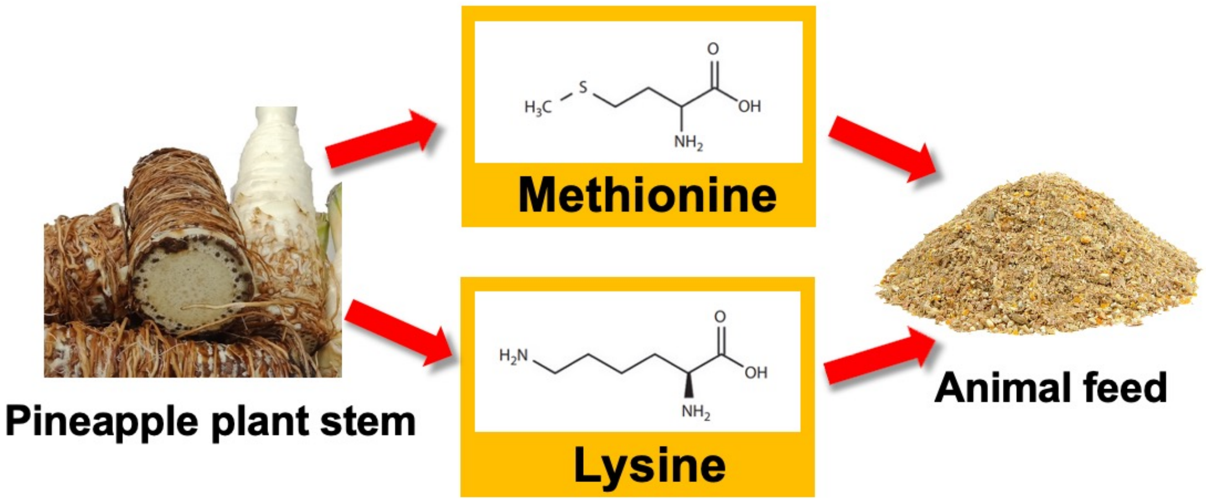
Biorefinery represents an innovative approach in the environmental management, where products at the end of their service life or waste materials are seen as valuable resources for the production of high added value bioproducts or biofuels and are produced from renewable sources.

Biorefinery Systems as an Element of Sustainable Development

Market size value and market demand of amino acids



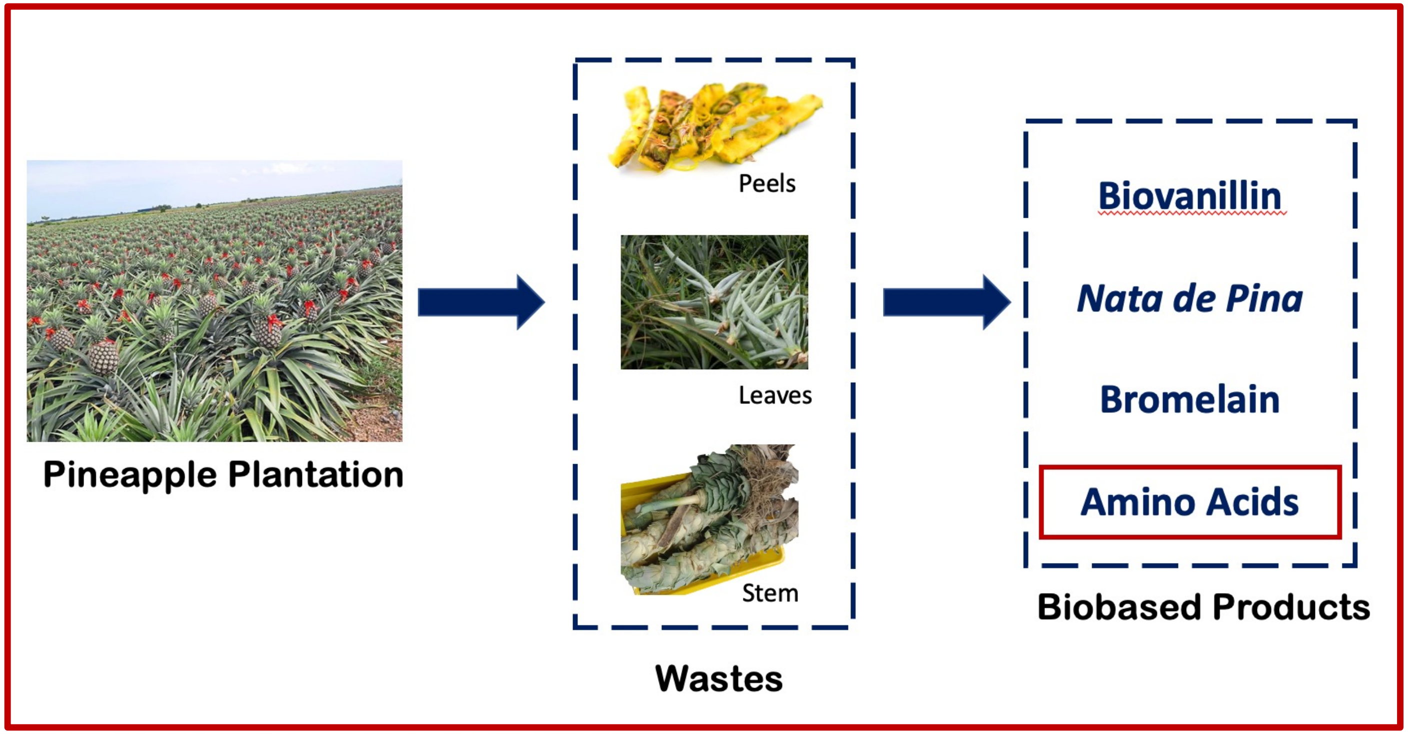




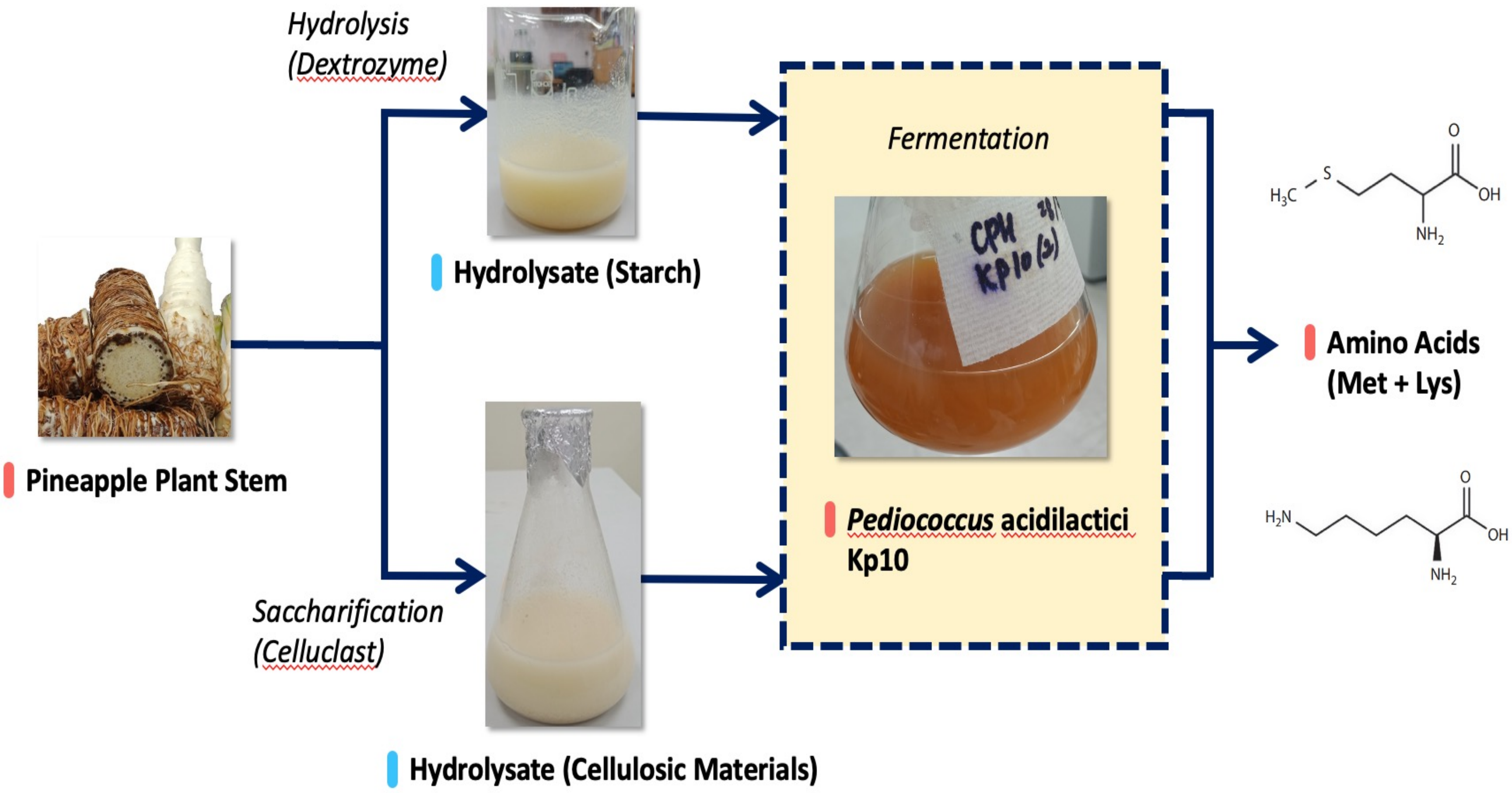
- ✓ Enhance growth performance
- ✓ Improve quality & quantity of meat

1. To produce the fermentable sugars from starch and cellulosic materials from pineapple stem via enzymatic hydrolysis

2. To utilize the fermentable sugars obtained from pineapple stem in the production of amino acids by *Pediococcus acidilactici* Kp10



METHODOLOGY


Hydrolysis
(Dextrozyme)
Hydrolysate (Starch)
Pineapple Plant Stem
Saccharification
(Celluclast)
Hydrolysate (Cellulosic Materials)
Fermentation
CPH
Kp10 (2)
Pediococcus acidilactici
Kp10
Amino Acids
(Met + Lys)
H3C
S
O
OH
NH2
H2N
O
OH
NH2

FINDINGS

Chemical composition of Pineapple stem

Pineapple stem

*dry basis

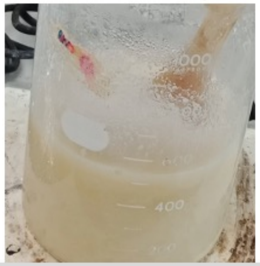
78% Starch

Lignocellulosic Materials

- 32% Cellulose
- 46% Hemicellulose
- 18% lignin

Hydrolysis of Pineapple Stem

1) Starch part



Hydrolysis
(5.56 U/mL Dextrozyme)

Starch — 77.78%

Reducing sugar — 57.57 g/L

Hydrolysis yield — 100%

2) Cellulosic part

Saccharification
(10 FPU Celluclast 1.5 L)

Cellulosic materials — 78.01%

Reducing sugars — 24.67 g/L

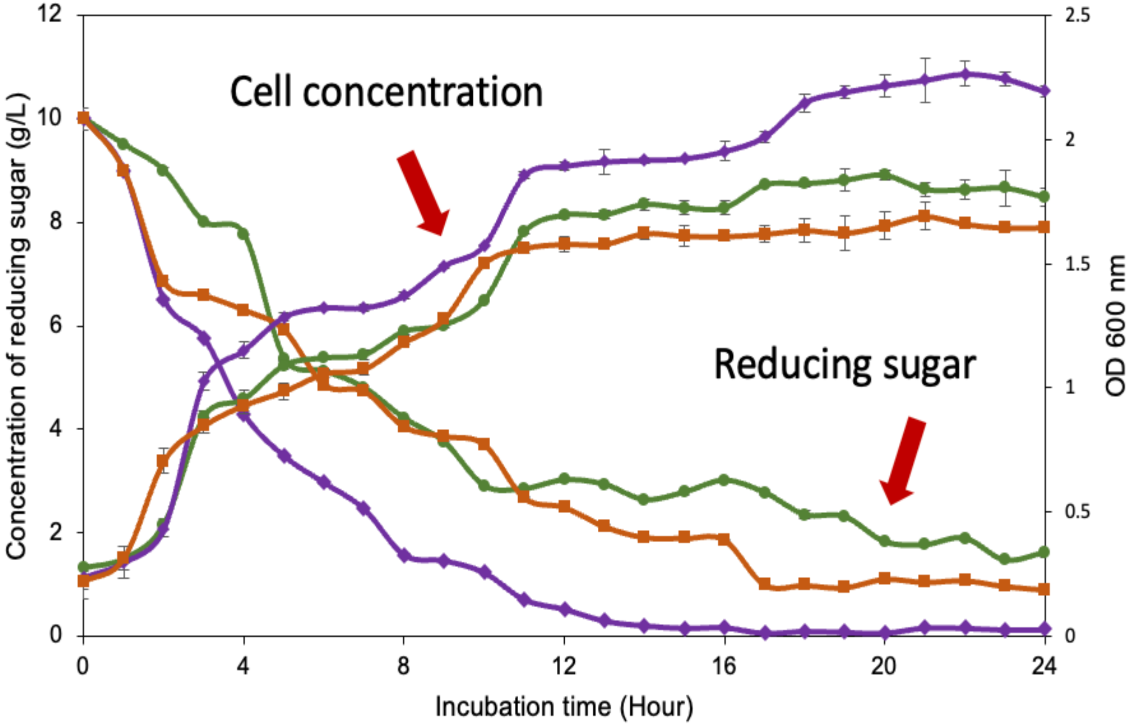
Hydrolysis yield — 56.93%

Amino Acid Production

Commercial **glucose**

Starch hydrolysate

Cellulosic hydrolysate



Profiling of amino acid production by *Pediococcus acidilactici* Kp10

Methionine production by *P. acidilactici* Kp10

Glucose	Starch hydrolysate	Cellulosic hydrolysate
Concentration 75.50 mg/L	Concentration 40.25 mg/L	Concentration 37.31 mg/L
Yield 14.66 mg/g	Yield 7.04 mg/g	Yield 10.08 mg/g
Productivity 37.75 mg/L/h	Productivity 10.06 mg/L/h	Productivity 9.33 mg/L/h

Lysine production by *P. acidilactici* Kp10

	Glucose	Starch hydrolysate	Cellulosic hydrolysate
Concentration	1.61 g/L	0.97 g/L	0.84 g/L
Yield	0.23 g/g	0.11 g/g	0.23 g/g
Productivity	0.134 g/L/h	0.097 g/L/h	0.21 g/L/h

Comparison Study

Carbon source	Initial glucose (g/L)	Concentration	Yield	Productivity	References
Methionine					
Glucose	15	64.7 mg/L	4.31 mg/g	8.09 mg/L/h	Lee et al. (2014)
Starch hydrolysate	10	40.25 mg/L	7.04 mg/g	10.06 mg/L/h	This study
Cellulosic hydrolysate	10	37.31 mg/L	10.08 mg/g	9.33 mg/L/h	
Lysine					
Glucose	15	219 mg/L	14.6 mg/g	27.38 mg/L/h	Lee et al. (2014)
Starch hydrolysate	10	0.97 g/L	0.11 g/g	0.10 g/L/h	This study
Cellulosic hydrolysate	10	0.84 g/L	0.23 g/g	0.21 g/L/h	

CONCLUSIONS

Reducing sugars

1

Starch : 77.78 % › 57.57 g/L reducing sugars
Cellulosic materials : 78.01 % › 24.67 g/L reducing sugars

Amino acids concentration

2

Starch hydrolysate : 40.25 mg/L methionine & 0.97 g/L lysine
Cellulosic hydrolysate : 37.31 mg/L methionine & 0.84 g/L lysine

PUBLISHED WORKS

Chu et al. Chem. Biol. Technol. Agric. (2021) 8:29
https://doi.org/10.1186/s40538-021-00227-6

Chemical and Biological Technologies in Agriculture

RESEARCH Open Access

Starch extracted from pineapple (*Ananas comosus*) plant stem as a source for amino acids production

Pei Hsia Chu[1], Mohd Azwan Jenol[1], Lai Yee Phang[1], Mohamad Faizal Ibrahim[1], Sehanat Prasongsuk[2], Wichanee Bankeeree[2], Hunsa Punnapayak[2], Pongtharin Lotrakul[2] and Suraini Abd-Aziz[1*]

Abstract

Background: Pineapple plant (*Ananas comosus*) is one of the largest productions in Asia and its increasing production has generated a huge amount of pineapple wastes. Pineapple plant stem is made up of high concentration of starch which can potentially be converted into value-added products, including amino acids. Due to the increasing demand in animal feed grade amino acids, especially for methionine and lysine, the utilisation of cheap and renewable source is deemed to be an essential approach. This study aimed to produce amino acids from pineapple plant stem hydrolysates through microbial fermentation by *Pediococcus acidilactici* Kp10. Dextrozyme was used for hydrolysis of starch and Celluclast 1.5 L for saccharification of cellulosic materials in pineapple plant stem.

Results: The hydrolysates obtained were used in the fermentation to produce methionine and lysine. Pineapple plant stem showed high starch content of 77.78%. Lignocellulosic composition of pineapple plant stem consisted of 46.15% hemicellulose, 31.86% cellulose, and 18.60% lignin. Saccharification of alkaline-treated pineapple plant stem gave lower reducing sugars of 13.28 g/L as compared to untreated, where 18.56 g/L reducing sugars obtained. Therefore, the untreated pineapple plant stem was selected for further process. Starch hydrolysis produced 57.57 g/L reducing sugar (100% hydrolysis yield) and saccharification of cellulosic materials produced 24.67 g/L reducing sugars (56.93% hydrolysis yield). The starch-based and cellulosic-based of pineapple plant stem were subjected as carbon source in methionine and lysine production by *P. acidilactici* Kp10.

Conclusions: In conclusion, higher methionine and lysine production were produced from starch-based hydrolysis (40.25 mg/L and 0.97 g/L, respectively) as compared to cellulosic-based saccharification (37.31 mg/L and 0.84 g/L, respectively) of pineapple plant stem.

Keyword: Pineapple plant, Stem, Starch, Amino acids, Methionine, Lysine

Chemical and Biological Technologies in Agriculture (CBTA)

Quartile : 1
Impact factor: 2.929

Take Biomass into any Direction You Want

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BOOK PRE-LAUNCH

PINEAPPLE AND ITS WASTES UTILISATION

Towards Circular Bioeconomy and Sustainability

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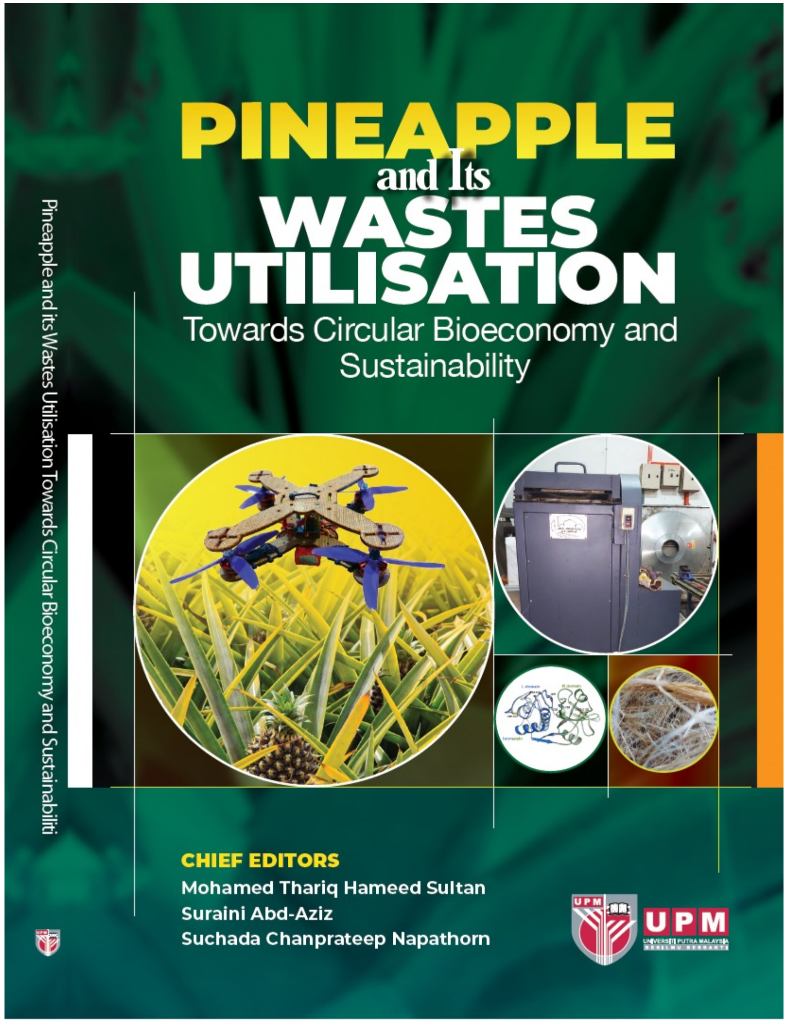

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BOOK HIGHLIGHTS

In this book, an insight into pineapple and its wastes utilisation towards circular bioeconomy and sustainability is discussed.

PART 1: Availability of pineapple plants in Malaysia and the World.
PART 2: Pineapple wastes bring your attention to the wastes generated from the pineapple plantation after harvesting, follow by wastes from the pineapple factory/processing industries.
PART 3: Conversion of pineapple wastes from pineapple plantations.
PART 4: Conversion of pineapple wastes from pineapple processing industries.
PART 5: Circular bioeconomy in pineapple industry


THANK YOU