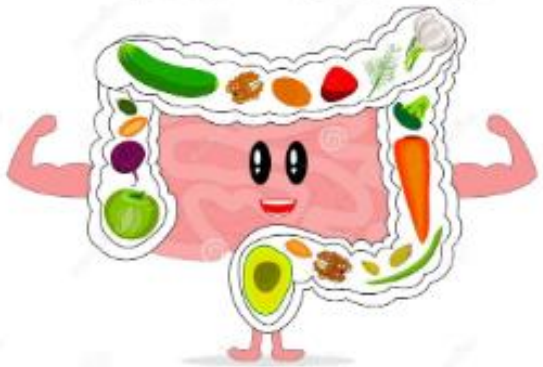
DSI's Gut health Clinical Trial

Build a Better Gut

Green Banana Powder



Pineapple Fiber Powder

CONFIDENTIAL

Prebiotics Market Overview

Global Prebiotics Market

Trends in prebiotic segment

Increasing
health awareness

Prebiotics & Awareness:

- People are keen on deep diving into healthcare and the health benefits of prebiotics
- Rise in prevalence of numerous GI conditions & aging geriatric population

Increasing in demand for
Natural products

Prebiotics & Natural Products:

- Increase in awareness of using natural products to live a healthy lifestyle
- With rising per capita incomes there is a high willingness to pay

Increasing awareness for
Better immunity

Prebiotics & Immunity:

- Prevent bacterial growth in gut
- Improve nutrient absorption
- Regular bowel movements
- Lower risk of type-2 diabetes

Global Prebiotics Market

Major Market Segments

Instant Formula or Baby Food

Dietary Supplements

Fortified Foods & Beverages

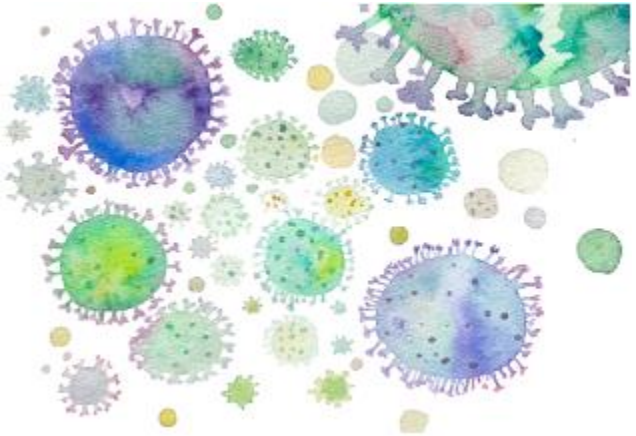
There has been an exponential **growth** in **Global prebiotics** market size from **US$ 66.17 billion** in **2023** to US$ 115.71 billion in 2029.

Gut Microbiome & it's Importance

What is gut microbiome?

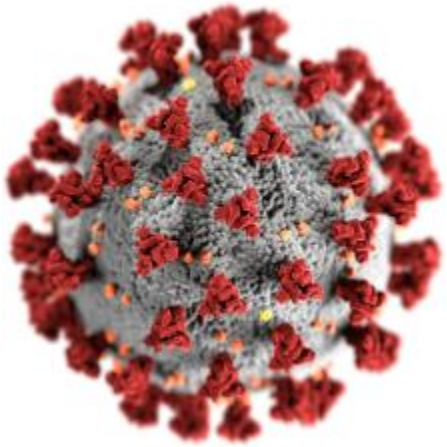
Gut microbiome consists of millions of bacteria, viruses and fungi that collectively reside in human digestive track

Bacteria



They create **critical compounds** including neurotransmitters, enzymes & vitamins

Viruses



Overall, play a **pivotal role** in maintaining good health

Fungi

Aid in **digestion, immune system regulation** & cognitive functions

Clinical Literature

Existing Clinical Literature on Fruit Powder

Studies have been conducted to understand the **intricate interplay between diet and gut microbiome**

This has resulted in literature that extensively explores the potential of incorporating **novel food ingredients to modulate the microbial community**

Among these, upcycled pineapple **and green banana** have emerged as potential candidates due to their unique **nutritional profiles and bioactive compounds**

Pineapple & Banana are among the **top produced tropical fruits in the world**

Literature on Green Banana Powder (GBP) & Gut Health

1

GBP accelerated the recovery of gut microbiota by enriching the abundance of beneficial bacteria

2

It also resulted in an increase of SCFA producing microbes such as *lachnospiraceae*, *Bacteroidaceae*

3

Reduced the abundance of *Firmicutes* but increased that of *Bacteroidetes* as compared to the control diet

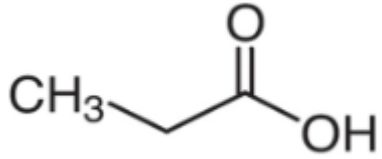
Literature on Pineapple Fiber Powder (GBP) & Gut Health

1

In-vitro studies revealed enrichment of beneficial *Lactobacillus spp.* and *Bifidobacterium spp.*

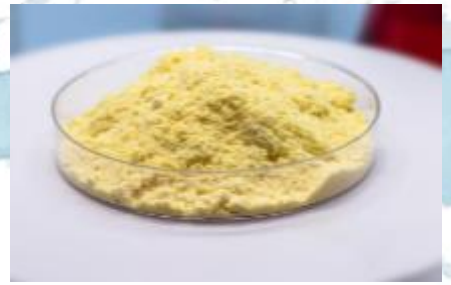
2

PFP also supports the growth of Probiotics *L. acidophilus*, *L. casei*, and *L. paracasei spp. Paracasei* when cultured with pineapple powder in respective medias



3

Increase in the production of SCFAs, Such as propionic acid and acetic acid in the human fecal microbiome



Clinical Trial Conducted by DSI

Goal of Clinical Trials conducted by DSI

In light of the existing literature, DSI conducted studies to evaluate the changes to gut microbiome composition and functional pathways through short-term dietary changes from GBP and PFP consumption

*We hope to **identify** changes in gut **microbiome** due to consumption of either Dole Specialty Ingredient (DSI) GBP or PFP*

*Additionally, we wanted to **investigate changes** in metabolic functional capabilities of **gut microbiota** due to **consumption** of either **GBP** or **PFP** (for two weeks)*

*Monitor **changes in GI symptoms** such as bloating and bowel frequency, as a potential **indicator** of **improved gut health***

*Confirm **safety** for usage in **functional foods** and dietary supplements that incorporate GBP and PFP*

Study Design & Methodology

Experiment Design

We divided the participants into three cohorts – **control, GBP & PFP** (explained in more details on the next slide)

Each intervention cohort had **20** participants between the ages of **21 – 65** years inclusive

All participants had a healthy BMI in the range of **18 – 29** and had agreed to provide consent for the following study protocols

The participants **added GBP and PFP** to prebiotics, probiotics or postbiotics. Smoker and pregnant/lactating females were excluded

Study Methodology

Length of Study was **2 weeks (14 consecutive days)**

Participants Consumed

10.75 of **GBP** or **7.41** or **PFP,** achieving a total fiber consumption of 5g. The control group consumed **10.75g of Maltodextrin**

The fruit powders were consumed with water, juice or milk in the morning with breakfast. Participants followed their regular diets with the exemption of **prebiotic or probiotic supplements**.

Study Methodology

Sample Collection

Stool **samples were collected** in Zymo DNA/RNA shield collection tube from participants at Day (0), Day 7 (T1) and Day 142 (T2) of the study.

Results

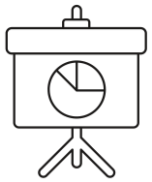
Data was manipulated in Rstudio for downstream analysis. The relative abundances and log2-transafromed relative abundances of selected bacterial taxa taxa and functional pathways was visualized

Statistical Analysis

The consumption of GBP & PFP led to an increase in **beneficial bacteria** while **prohibiting** the growth of **harmful bacteria** in the gut

Benefits of GBP Consumption

Green Banana Powder (GBP) Results



Growth in Beneficial Bacteria & Prohibition of Negative Bacteria

1

Green Banana Powder (GBP) promoted growth of ***Bifidobacterium genera*** across timepoints. There was also a noticeable consistency in the relative abundance of various bacteria

2

Alongside the significant increase in ***Bifidobacterium, there*** was a decrease in ***Phocaeicola*** and ***Alistipes*** was also observed across all cohorts at all time points. In the Jap

3

Interestingly in the Japanese cohort of participants, there was an increase (in a time dependent manner), of ***Prevotella and Collinsella.***

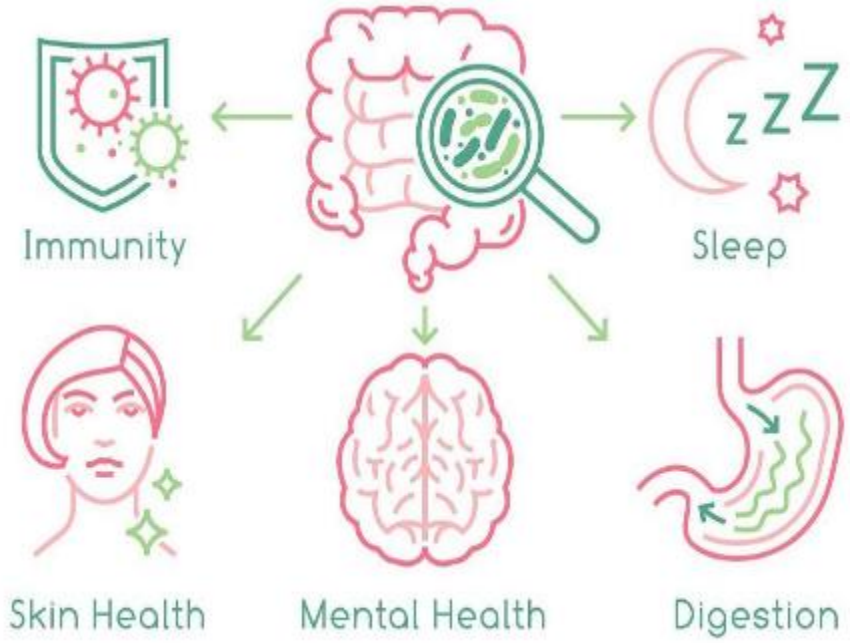
4

GBP also promoted additional beneficial bacteria taxa including ***Faecalibacterium praunsnitzii and Roseburia inulinivorans***

Benefits of GBP Consumption

Production of histidine & antioxidants. ***BCAA, Acetic acid and Butyric acid***

GBP consumption aids in the production of upregulated ***metabolites*** *and* ***SCFA***



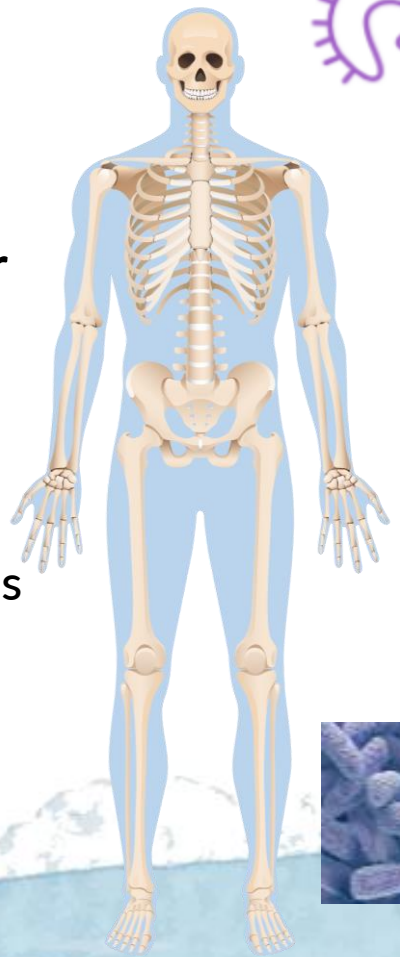
No disruption of ***sleep quality*** *or sleep habits from fiber intake throughout the day*

Improved regularity and stool quality due to the high resistant starch content. ***Reduce bloating***

Green Banana Powder (GBP) Result

Increase in Roseburia Inulinivorans

- Plays a role in regulating **barrier homeostasis**
- **Prevents** intestinal **inflammation**
- Maintain energy homeostasis by **Producing metabolites** such as butyrate



Increase in Faecalbacterium Prausnitzii

- Biomarker for **development** of different **gut related conditions**
- Produces **anti-inflammatory metabolites**
- **Low levels** can cause inflammatory Bowel disease, obesity and diabetes

Inhibition of Klebsiella pneumoniae

- It is a common cause of **antimicrobial resistant** opportunistic **infections** in hospitalized patients

Two-fold positive impact of GBP consumption

A)

No.	Beneficial bacteria promoted by GBP intake	
1	*Bacteroides ovatus*	▲
2	*Bacteroides cellulosilyticus*	▲
3	*Akermansia muciniphila*	▲
4	*Faecalibaterium praunitzii*	▲▲
5	*Bifidobacterium longum*	▲
6	*Bifidobacterium bifidum*	▲
7	*Bifidobacteroum adoloscentis*	▲▲
8	*Bifodobacterium pseudocatenulatum*	▲▲
9	*Bifodobacterium catenulatum*	▲▲
10	*Bacteroides intestinalis*	▲
11	*Blautia obeum*	▲
12	*Roseburia inulinivorans*	▲▲
13	*Alistipes onderdonkii*	▲
14	*Eubacterium siraeum*	▲
15	*Eubacterium rectale*	▲▲

B)

No.	Pathogenic bacteria inhibited by GBP intake	
1	*Klebsiella pneumoniae*	▼▼

Key Findings:

1.Table A depicts a wide range of beneficial bacteria that were **found** in the test samples after the consumption of **Green Banana powder (GBP).**

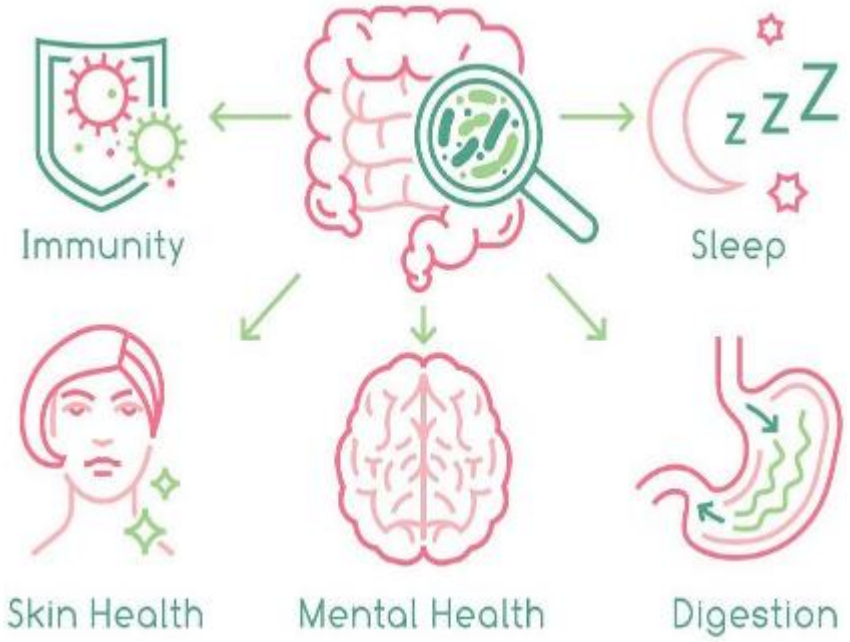
2.Table B depicts the **inhibition of bacterial growth** after the consumption of GBP. These include bacteria such as Klebsiella Pneumoniae

Benefits of PFP Consumption

Benefits of PFP Consumption

Production of histidine & antioxidants. ***BCAAs, Acetic acid and Butyric acid***

GBP consumption aids in the production of upregulated ***metabolites*** *and* ***SCFA****.*



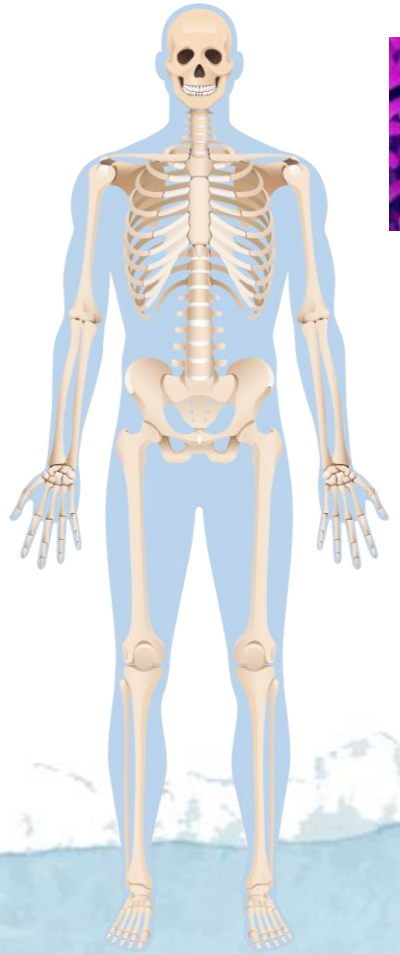
The benefits of PFP consumption range from those for ***gut to improved and sleep/social quality***

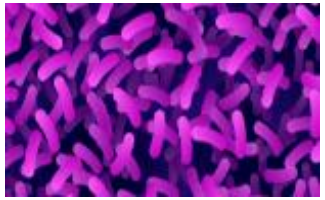
Improved regularity and ***stool quality****. Production of Vitamin B7 (Biotin) and Vitamin B2*

Pineapple Fiber Powder (PFP) Results

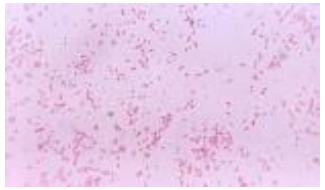
Increase in *Bacteroides and Phocaeicola*

Increase in *Bifidobacterium*





Increase in *Akermanisa Muciniphila*



Increase in *Bacteroides ovatus and Bacteroides cellulosilyticus*

Decrease in *Prevotella*

Benefits of GBP and PFP Consumption

PFP, GBP & Overall Health

Dole Specialty Ingredients (DSI) conducted numerous clinical studies with Contract Research Organization (CRO) for determining the impact of GBP and PFP consumption on several aspects of human health

1. **Social Impact** such as that on sleep
2. Impact on gut **genome**
3. Impact on **Bowel**
4. And other **Physiological elements**

Green Banana Powder is a **nutrient powerhouse.** It is **high in resistant starch.** Aids **bloods sugar regulation** and **improves digestive health**

Pineapple pomace is high in dietary fiber – **cellulose, hemicellulose, lignin and pectin**

Benefits of GBP & PFP Consumption

Compounds found in GBP & PFP

BCAAs

BCAAs are essential for muscle health and overall protein synthesis, making them valuable for those interested in **fitness & muscle maintenance**

Increased antioxidant capacity

Increased antioxidant capacity is essential for countering oxidative stress and ageing which can be emphasized for **health conscious consumers**

Elevated Vitamin B7 Levels

Elevated vitamin B7 levels participate in normal **immune function** to maintain the integrity of intestinal mucosa. It also plays an important role in maintaining skin, hair and nail health, making it an appealing feature for personal care and beauty products.

SCFAs

SCFAs play a vital role in **promoting human health,** through the maintenance of a proper gut barrier function and integrity, influencing the reduction in **cholesterol** and **triglyceride levels** in the blood, and **providing energy for colonocytes** among others, attracting those concerned with gut health.

Benefits of GBP & PFP Consumption

Specific Bacteria in GBP & PFP

There were varius beneficial bacteria the abundance of which increase wit the intake of GPB and PFP

- Akkermansia munichiphila
- B. Longum
- B. Ovatus
- F. Prausnitzii
- Badolescentis
- Bacteroides
- B. Longum
- Bifidobacterium bifidum

With ***GBP*** there's an increase in the BCAA's Histidine, SCFAs, and Antioxidant capacity

The above was cause due to an increase in the following:

- Bifidobacterium spp.
- F. Prausnitzii
- Akkermansia spp
- Bacteroides spp.

With ***PFP*** there's an increase in the BCAA's Histidine, SCFAs, and Antioxidant capacity

The above was cause due to an increase in the following:

- Vitamin B7
- Bacteroides spp.

Summary

- The consumption of GBP and PFP play a positive role in promoting human health with the production of BCCAs, Histidine, SCFAs, enhanced anti-oxidant capacity and elevated B7 Levels.

Similar yet distinct benefits of GBP & PFP

Both powders are **high in dietary fiber and rich sources of prebiotics**

GBP promoted the growth of Bifidobacterium spp. Such as B. adoloscentis & B. Longum

Green Banana Powder

Support a healthy immune system!

Pineapple Fiber Powder

Both ***GBP and PFP*** promoted the growth of Beneficial bacteria such as A. muciniphila, Bacteroides spp., Bifidobacterium spp., F. Prausnitzii

PFP promoted the growth of Bacteroides spp. Such as B. ovatus and B. cellulosityicus

Applications of GBP and PFP

Positioning of GBP & PFP

Applications for F & B Companies

Convenient Snack made with Green Banana Powder

Pineapple Smoothies

Prebiotic enhanced Yogurts

Positioning of GBP & PFP

Applications for
Dietary Supplement & Prebiotic Companies

Gut Health Enhancement	Medication Support	Digestive Harmony

Thank You!