21st Century Natural, Zero Calorie & Low GI Sugars

Presented to:

INVEST INDIA
NATIONAL INVESTMENT PROMOTION & FACILITATION AGENCY
ABOUT PETIVA

Petiva is a **next generation industrial biotechnology company** having aspirations to be a global leader by developing, producing and marketing **advanced, sustainable and affordable** bulk food ingredients to meet the demands of the 21st century.

**Technology Development**
Developing **industrial biotechnology platforms** for sustainable and economical production of next Generation ingredients to address the issues of consumables like sugars, oils, fibers, carbohydrates etc.

**Forging Global Alliance**
Developing global alliance for undertaking production of its products and sourcing of supplies - with existing/new ingredient (sugars etc.) producers.

**Unlocking Additional Value**
Realizing untapped value potential through backward integration and developing value added products using its ingredients.

Petiva’s Focus Areas

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**Petiva** is founded with a single purpose of **Bringing Back the Joy in Eating** - Good Health without compromising on Taste, Choice or Convenience.

Petiva believes addressing major ingredient classes that make up our diet such as **Sugar** with novel, affordable and sustainable ingredients can to a large extent promote an enjoyable, healthy diet and lifestyle.

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**Research & Development Team**
- Over a 100 highly qualified & experienced associates 65% of whom are associated since inception.
- Qualifications - PhD and M. Tech Degree

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**Areas of Expertise**
- Genetics, Biochemistry, Protein Engineering, Computational Biology, Microbiology, Chemistry, Chemical and Biochemical Engineering, Mechanical Engineering etc.

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**Infrastructure Created**
- Laboratory - Experimental, Quality, Microbiology, Molecular biology
- Pilot plant - Fermentors, Protein Purification, SMB, Crystallizer etc.
- Process & scalability engineering facility

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**Current Status**
(Refer pages 17-19 for More Details)

**Seed Marketing**
(Refer pages 20-22 for More Details)

**Commercial Plans**
(Refer page 23 for More Details)
Health Impact of Sugar Economy - Global

Global economic burden of diabetes will increase from U.S. $1.3 trillion in 2015 to $2.2 trillion by 2030.

The health effects of excessive sugar consumption, such as obesity and the risk of developing conditions such as heart disease and diabetes, places a heavy burden on healthcare systems around the world.

~7% of national health spending in EU member states as a whole is due to obesity in adults; and this is aside from indirect costs to societies such as sickness and early death, or the impacts on carers.

Increased consumption of sugary beverages has resulted in substantial amount of period (>36 Years) to be spent with health problems in total lifespan.

EU spent US$ 156 billion in 2015 as healthcare expenditure due to diabetes. It is projected to increase to US$ 174 billion by 2040.

Health Impact of Sugar Economy - India

Dubbed as the diabetes capital of the world, India has the largest number of people suffering from diabetes in the world. There were 41 million cases in 2007 and at the same rate, it is estimated to hit 70 million by 2025.

The average age of developing diabetes in India is also low (45 years), which is 10 years less than the West.

These trends have significant impact on our economy due reduced productivity and channeling of disposable income to health care expenses from other fund starved areas.
Indian Economy on Sugar

Impact of the Prevailing Issues

Producer Perspective

**Issues Faced #1:** Falling Sugar Prices

Unable to pay cane price of farmers resulting in huge arrears.

Unable to service debt, resulting in sickness/ NPAs

In about 5 years, the debt burden increased 4 times

Debt of private mills ~ Rs.40,300 cr. in 2016-17

By including cooperative mills, debt burden much higher at ~Rs.50,000

A Sustainable Solution for the Prevailing Issues Would be To **Move Beyond Sugar Production** and **Explore Opportunities for Value Added Products & Solutions**
Present Sweet Solution Are Not So Sweet

Despite encouraging demand drivers, there are no viable and credible alternatives that can replace sugar in its entirety. Rather, the existing alternatives have issues of their own.

<table>
<thead>
<tr>
<th>Problems Addressed &amp; Trends</th>
<th>(Refer pages 24-28 for More Details)</th>
</tr>
</thead>
</table>
| **Lack of Nutritional Value** | - The existing sweeteners provide sweetness without any nutritional value and also might become addictive.  
                              - Eg: Aspartame (NutraSweet and Equal) |
| **Taste**                    | - Artificial sweeteners usually accomplish their goal of low-calorie sweetness by being hyper-sweet so that only a tiny amount of the active ingredient is needed. This leaves strong and unpleasant aftertaste.  
                              - Eg: aspartame is approximately 200 times sweeter than sugar |
| **Side Effects**             | - The sugars are not natural and chemically derived.  
                              - There are increasing number of reports suggesting that most of sweeteners cause a number of harmful side effects in myriad patients, including those with cancer, severe depression, multiple sclerosis and systemic lupus. |
| **Restricted Application**   | - Stability of sugar under conditions of high temperature/ pressure limits usage.  
                              - Not ideal for applications like baking, fizzy beverages etc. |
| **Cost**                     | - Existing products and processes are not cost effective making it difficult to penetrate the sugar / natural substitute markets. |
Petiva’s Sugar is next generation sugar for post sugar era to meet needs of 21st century without side-effects of existing sugars & sweeteners.

Petiva’s sugars are mono-/disaccharides & their derivatives. They are natural, zero calorie and low GI sugars which are versatile to enough to replace regular sugar in all its applications.

They always existed in nature in trace quantities in nature. Most of them are given GRAS* status by USFDA.

Interesting characteristics: low-calorie, low glycemic index, antioxidant, gelling and bulking properties.

These sugars are isomer of sugar & satisfies all its psychological & physiological needs. It can handle all its applications and beyond (Eg: stable at higher temperature & pressure).

When added, a small fraction of they induces low GI property to regular carbohydrates.

Being a natural product, on consumption, body recognizes it and metabolizes it through normal metabolic pathways.

Petiva’s Products (Refer pages 29-33 for More Details)
### Enzyme Development
- Screened and selected enzyme with best thermostability and specific activity
- Protein Engineered for increased operational stability

### Enzyme Production
- High cell density bioprocess optimized for increased enzyme yields (5.0 g/l)
- Single stage purification strategy with high yields (>90%) and purity (>90%)

### Enzymatic Conversion
- Screened and identified best matrix for immobilization with high loading and enhanced operational stability (>2 months)
- Very short conversion times (6 min)

### Chromatographic Separation
- Novel SMB design with reduced water requirements
- Very high productivity, recovery and purity (>97%)

### Crystallization
- Continuous crystallizer design for high yields and product purity >99.7%

### Energy Integration (future plan)
- Combined cycle gas turbine for power, steam and hot water generation to significantly reduce the utility cost

(Refer pages 34-53 for More Details)
THE TECHNOLOGY

Competitive Landscape for Honeytose (Allulose)

Petiva
Tate & Lyle, Matsutani, CJ

Total Cost
< 2 US$ / Kg
~10-12 US$ per Kg

Non GMO
Yes
(Uses HFCS as raw material)

Allulose is marketed in the US. But, the underlying competing technology deters widespread acceptance due to high cost of production resulting in exorbitant prices.

Competition advantage

Petiva's novel technology confers advantage of low cost of production and high product purity, thereby enabling affordable price to the consumer and facilitating wider acceptance.

Petiva Sugars positioned as Bulk Premium Sugars

Table:

<table>
<thead>
<tr>
<th>Sugars</th>
<th>Price/Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others Allulose</td>
<td>19</td>
</tr>
<tr>
<td>Erythritol</td>
<td>19</td>
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<tr>
<td>Nature Sweet</td>
<td>07</td>
</tr>
<tr>
<td>Brown Sugars</td>
<td>05</td>
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<tr>
<td>Petiva Allulose</td>
<td>06</td>
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<tr>
<td>Organic Cane Sugar</td>
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</tr>
<tr>
<td>Sugar</td>
<td>01</td>
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</tbody>
</table>

Average Retail Price Comparison (USA$ Per Kg)

No clarity on Allulose Content
PETIVA- IP’S

Patent portfolio of ~25 global patents covering all critical aspects of the technology, process, equipments and enzymes.

Petiva™, Caneose™, Honeytose™ and Petiva The Good Sugar Company™ are registered Trademark under the Brand of classes of 05, 29, 30, 32 & 35. The Brands are registered in different areas of applications under Madrid System.

Freedom to Operate:
Patent portfolio is verified and established to have no infringement by a reputed IP attorney, Patterson & Thuente (USA).

Strong IP’s Base

Patents List
(Refer pages 55-56 for More Details)

Trademarks List
(Refer page 54 for More Details)
Petiva’s Project has the potential to create significant contribution to the country through multiple avenues.

**Manufacturing**
- Creation of manufacturing units for next generation sugar products.
  (Petiva plans multiple capacities of 30,000 TPA in future)
- Creation of F&B mfg. hub focussed on functional & nutraceutical products & formulations
  (Global market to grow @7.8% CAGR)

**Health**
- Petiva’s sugars to help ailing, borderline and healthy segments.
  (Low Calorie, Low GI, Ability to induce Low GI properties to other sugars)
- Reduction in health expenditure on sugar related ailments.
  (Diabetes & Obesity are the key ailments for )

**Economy**
- Creation of specialized industries (food technology, product / ingredients dev. etc.)
  (Opportunities for R&D collaboration with local institutions, IP creation)
- Creation of direct / indirect employment opportunities
  (Each of Petiva’s 30,000 TPA plant to employ ~350 people directly)

**Others**
- Increased export potential
  (India would be first region to have commercial production of rare sugars and cater to a segment projected to grow @ 5.8 % CAGR)
- Scope for local F&B manufacturers to expand product offerings that are in line with emerging consumer preferences
  (Products to have premium pricing of ~20% over regular products)

**Contribution to the Nation**
Petiva’s project has potential to place India as the leader in industrial biotechnology
Petiva through its innovative products and technology, offer a credible solution to the Sugar Producers for Adopting to the Emerging Trends and Challenges.

Petiva offers a sustainable and globally competitive technology for adding value to existing sugars.

By using the sugar produced as a feedstock, Petiva’s technology produces naturally occurring and versatile next generation sugars that can replace sugar in all of its applications without any compromise on the desirable attributes.

The country and its sugar growers can take a global leadership position in offering a viable solution thereby reinforcing their competitiveness.

**BENEFIT TO THE NATION**

- **Farmer**
  - Unstable prices, Low profit
- **Sugar Co-Op/ Mills**
  - Low realization, Mounting Arrears
- **Consumers**
  - Suffering from Sugar related ailments (Diabetes, BP etc.)
- **Country**
  - Low economic productivity, Increased health expenditure

**Contribution to the Sugar Industry**

- **Farmer**
  - Competitive & stable price realization
- **Sugar Co-Op/ Mills**
  - Innovative natural rare sugar products
- **Petiva**
  - Increased value through healthy ingredients, without compromising on taste
- **Consumers**
  - Improved economic and health profile

Strictly Confidential

November 2019
BOTTLENECKS FACED

Reduced Fund Availability

PoC Level

PoV Level

Pre- Commercial Level

Commercialization Level

Catered by various Agencies (BIRAC, TDB, DSIR) Schemes

Lack of appropriate funding schemes

Catered by commercial financial institutions, Equity funds

Other issues:

- Process adopted to evaluate proposals at this stage is amalgamation of the ones used for the preceding and succeeding stages.
- For instance, the expert panel appointed for evaluation are typically from academic background and former PSU’s.
- They stress on issues that are already addressed at PoC/ PoV level (technical) or are more relevant for commercial stage (non-technical).
- There are no appropriate focused channels for availing support for arranging required guarantees, working capital, soft loan etc.
- No fast track regulatory approval for globally approved product.

In USA, to incentivize the renewable sector, the investment/ loan are for the project is backed by sovereign guarantees.

GoI had introduced viability gap funding (VGF) for improving the feasibility of 2G bioethanol projects.

Singapore Govt. through HIDS scheme will fund up to 80% of total qualifying project investment.

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Policy Solutions:

- Utilize facilities of existing PSU’s for setting up of brownfield production facilities. This would reduce lead time, capex, risk and redundancies.
  - Subsidies for IP’s filing and maintenance would greatly reduce expenses for startups and encourage their global competitiveness.
  - Sensitize commercial wing of Indian Embassy globally to promote technologies with global potential.
  - Fast track regulatory approval window for products having international approvals/ high national impact.

Creating SPV/ separate agency like Mudra Bank focused on investing in biotechnology arena. Investment vehicles like equity (preferential having agreeable coupon rates and duration), soft loan (with nominal rates and unsecured lending to reduce overall cost), trade financing etc.

Focus should be on strong governance and monitoring.
BOTTLENECKS FACED

Project Funding

- Funding available for PoC, PoV and Commercialization stage. Meager/ no funding available for pre- commercialization stage to enable engineering data generation for commercial plant and to undertake business development.
- With regards to funding of the 1,500 TPA facility, there are no particular schemes available that can support the early commercialization stage of a startup company.
- While there are commercial lending institutions, they have certain financial and operating criteria which are non- conducive for company in our stage of growth.
- While we have applied to Government agencies like the Technology Development Board (TDB), our experience with them has been that TDB’s scheme and approach is in contradiction to its stated mission.
- The process adopted by TDB in reviewing our application is prolonged & bureaucratic and does not comply with its stated mission of encouraging technology development in the country. This situation is despite a MoU in place between DBT/ BIRAC and TDB as per which the BIRAC supported projects are to be processed expeditiously by TDB.
- For our application to DBT/ BIRAC, the agency is neither supporting through fast track processing of our application, nor pushing TDB using the MoU route.

Regulatory Approval

- We have also submitted our application to FSSAI for obtaining the required product approval which is pending for over a year and is obstructing our foray into the Indian market
- Allulose and Isomaltulose is already accorded GRAS status by USFDA and are approved in several other countries
- The status is despite, a provision to approve the products which has been approved by USFDA on a fast track basis
- FSSAI’s procedure is long-drawn and lacks urgency. This raises the threat of foreign companies capturing the domestic market at the cost of local industries.
SUPPORT REQUIRED

Project Level Support

• Support in expediting our application with FSSAI and also for help in speedy processing of our proposal to TDB.
• Support through providing us with required funding under pertinent schemes in form of equity, soft loan, grant or any other form.

Policy Level Support

• Support in formulating guidelines so as to enable FSSAI to expedite our application.
• Creation of special funds for projects that are in early stage of commercialization and have high socio-economic impact on a fast track basis.
• Support in creating framework under which the project like ours are backed by Government and accorded required guarantees necessary for project financing.

Information/ Awareness Support

• Help in creating public awareness about the disadvantages of currently available products and efficacy of our novel natural, zero calorie and low GI sugars.
• Help in sensitizing the Ministry of Food Processing regarding our products and for creating policy for encouraging food processing industry to incorporate our products.
• Help in sensitizing the Ministry of Health regarding our products and in enabling it to recommend our products for diabetic/obese population.
India has Opportunity to Gain Global Leadership Position in Industrial Biotechnology. But with prevailing implementation mechanism, we would be rendered as followers.

India has huge scope to add value to the agricultural sector by utilizing agri produce & biomass through innovative industrial biotech solutions.

No current viable domestic solution

Globally, only handful of companies are engaged in this field resulting in a virtual monopoly.

There is a gap between policy stance / framework and implementation machinery that is hampering realization of true potential of various national level initiatives.

Scientific/ Technical Agencies

Available Schemes

Expert Panel

Benefits

5 trillion economy
By 2024

Environmental Sustainability

Make in India

Doubling Farmer’s Income
Thank You

For More Details Contact Us at pandey@petiva.com
PETIVA- IT’S JOURNEY

Proof of Concept (Supported through BIRAC)

Proof of Value (Supported through BIRAC)

Enzyme Development

Pre-R&D

Critical Equipment Dev., Process Dev. & Integration, Scale up

Commercialisation (On Going)

- Product Selection
- Gap Analysis
- Tech. Conceptualization
- Development Roadmap
- Capabilities Building

- Confirmed Process & technology concept
- Established production at Lab level
- Developed novel enzymes

- Scale-up of production & purification of enzymes
- Optimization of immobilization techniques
- Enhanced efficiency & stability of enzymes
- Comparative analysis and process selection
- Process validation at multi-kg level (10-50 kg/day of Allulose and 50-100 kg/day of Isomaltulose Trehalulose

- Developed novel SMB for efficient sugar separation.
- Developed novel continuous crystallization unit.
- Integrated/ Optimized /Scaled the process and production to pilot plant (100 Kgpd/ 30 TPA) level
- Generated data for engineering of phase-I commercial plant
- Vetted the pilot plant operation and scalability of data through third party

... The journey – developing alternative sugars

PETIVA™
PETIVA- CURRENT STATUS

We have established an integrated 30 TPA pilot plant that has been operating on a continuous basis.

Scalability report prepared by an independent third party engineering company. As per the assessment, the process scalability to multi-ton capacities has been established.

Non-GMO certification obtained from TUV, a reputed independent agency in this area.

Have applied for obtaining the product related approval from FSSAI.

Required team is in place to undertake technical, regulatory and business development related activities.

Engineering work for 1,500 TPA plant initiated by Tata Consulting Engineers (TCE).

Supplying of product samples to potential customers globally (Europe, Middle East, Asia, N. America) underway.

Business development is ongoing and supply of product samples to potential customers is made with the intent of receiving LOI and entering into a production off take agreement.

The Facility is USFDA registered.

30 tons per year pilot plant (Evaluation of the process done by Biopharmax)

Enzyme Certified Non-GMO by TUV

Scalability of process data for multi-ton level

Submitted Application to FSSAI Approval

November 2019
PETIVA- MEDIA

@ IFT’16, Chicago, USA

@ FIE’17, Frankfurt, Germany

Petiva in Events

From 'good sugar' to reformulation R&D: The companies that welcome sugar taxes

By Nanett Mihalic
06 Aug 2016 19:02 | Updated on 06 Aug 2016 19:02

The companies that welcome sugar taxes

One of The Good Sugar Company's products is Honeytose, which contains 95% crystalline isomaltose. The company's sugar substitute is as natural and virtually calorie-free sugar present in honey.

The company says it can reduce the glycemic load of the carbohydrates it is consumed with and has no impact on blood sugar levels. It also contains isomaltase, made of 60% trehalulose and 40% isomaltose, and isomaltose, which contains pure isomaltose.

Could a sugar tax have a positive impact on business for The Good Sugar Company?

If sugar tax will help business for us as we are absolutely for it,” said director Bomborin Perys, speaking at Foodnavigator from the floor of Nestle's IF in Chicago. But not only for business, I personally feel that it will bring awareness to the people that sugar is good – it's really, it's required for physiological and psychological needs, but it's also required to be in moderate [consumption] and the good style.

“Thanks only why it makes it very clear – we are The Good Sugar Company.”
SEED MARKETING FACILITY

We are proposing to establish 1,500 TPA (Honeytose & Caneose) plant in the initial phase of commercialization.

Data Generation for 30,000 TPA,

1,500 TPA (per product) is the minimum size required to generate reliable scalable data for designing 30,000 TPA plant (40X).

Operation of 1,500 TPA would be sustainable without requiring any further cash.

Enable developing the market gradually without oversupply.

Serve as a training facility to operate future commercial plant as there is no other facility like it in the world.

Seed marketing to develop the markets

Showcasing the technology to potential investors and customers

Test bed for technology and process improvements

We have applied to DBT and TDB for seeking funds for the project in form of soft loan/ equity.

November 2019
Sample List of Customers Petiva is working with,

Received LOI from Callery’s and Goh Joo Hin for complete production off take of 1,500 TPA project. They will be the distributors for Singapore for market seeding and supplying to other potential customers.
PROPOSED 1,500 TPA PROJECT

PROPOSED PROJECT IN INDIA

1,500 TPA TEST MARKETING FACILITY (EXPORT ORIENTED)

Capacity
1700 Tons per Annum

Products
Honeytose™/ Caneose™

Project Cost
~Rs. 49 Crores

Project Completion
7 months from the date of financial closure

Raw Materials
Refined Sugar

Feedstock Quantity
1800 Tons per Annum

Capacity
The facility, products & packaging would comply with local food regulatory standards.

Product
The production would be mainly to develop global markets.

Raw Materials
The products would be distributed directly to large & premium F&B manufacturers.

Feedstock Quantity
We would be working with potential partners in developing solution best suited for their application.

Project Funding:
TDB Funds 50% of Project Cost Through Soft Loan; BIRAC & Petiva contributes to the remaining fund requirement through Equity

Financial Summary:

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<tr>
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<th>Rs Cr</th>
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<tr>
<td>EBIDTA</td>
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<tr>
<td>PAT Margin</td>
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</tbody>
</table>

We are in discussions with TDB & DBT/ BIRAC for Funding the Debt & Equity Component of the Project Cost.

Funding Structure (Rs. Crores)

- Petiva, 12.5
- BIRAC, 12.5
- TDB, 24.5

November 2019
**COMMERCIALIZATION**

- **Petiva’s growth plans is focused on establishing global rare sugar and industrial scale enzyme production facilities**

### Growth Plans

<table>
<thead>
<tr>
<th>Phase</th>
<th>Rare Sugar Production Expansion Plan</th>
<th>Enzyme Production Expansion Plan (Centralized-Based in India)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1,500 TPA</td>
<td>Current Facility (2 Kg Enzymes per Day)</td>
</tr>
<tr>
<td>II</td>
<td>30,000 TPA</td>
<td>12 Kg per Day (Would cater to 6 proposed commercial plants and for supplying to 6 additional such units)</td>
</tr>
<tr>
<td>III</td>
<td>6 X30,000 TPA</td>
<td></td>
</tr>
</tbody>
</table>

- **The first commercial plant would be established in India and used for catering to the Indian sub-continent and other international markets.**
- **Eventually, we plan to undertake global expansion by establishing commercial plants in USA, Europe, Middle East, South Africa, East Asia and Australia.**
- **Other avenues of commercialization include supplying of technology license, proprietary enzymes and proprietary equipments.**
- **We already have binding agreement for three of our global projects which includes a technology fee of US$ 15 Mn per plant and 8% royalty.**
- **Once the engineering package is ready (one year of operation) using the data from the 1,500 TPA plant, 1/3rd of licensing fee would be paid by each project (total of US$ 15 Mn).**
The global life style disease epidemic (including cancer, coronary heart diseases (cholesterol, hypertension...), type II diabetes, strongly correlate with obesity and calorie intake) is arguably this century’s primary social health concern (involving medical research, healthcare professionals, insurance companies and society at large). With breakthroughs in the field of research and medicine people around the globe are, on average, living much longer and healthier than they were decades ago. The focus on wellness is shifted from medicine and disease management to diet and lifestyle.
30%–40% of healthcare expenditures in the USA go to help address issues that are closely tied to the excess consumption of Sugar.

U.S. healthcare system alone spends about $1 trillion per year and more fighting the effects of excess sugar consumption.

“U.S. health care spending grew 5.8 percent in 2015, reaching $3.2 trillion or $9,990 per person. As a share of the nation's Gross Domestic Product, health spending accounted for 17.8 percent.”

Diseases Caused by or Enhanced by Excess Sugar Consumption

- Cancer
- Coronary Heart Disease
- Fatty Liver
- Speeds Aging
- Suppresses Immunity
- Disturbs Mineral Balance
- Raises Cholesterol
- Increases Risk of Alzheimer's, Diabetes and Hypoglycemia
- Tooth Decay
- Periodontal Disease
- Weight Gain and Obesity
- Increases Yeast Infections
- Kidney Disease
- Depression and Anxiety
- Weakened Eyesight
- Increases Risk of Osteoporosis, Arthritis, Gall Stones
- Kidney Stones, Hormonal Imbalance, Appendicitis
- Decreased Growth Hormones
- Constipation and Gas
- Fluid Retention
- Headaches and Migraines
- MSE, Emphysema

**PROBLEM ADDRESSED**

...Healthcare costs & diseases caused by excess sugar consumption
**PROBLEM ADDRESSED**

...Dominant & Upcoming Sweeteners – Drawbacks

<table>
<thead>
<tr>
<th>IDEAL SUGAR ATTRIBUTES</th>
<th>ASPARTAME</th>
<th>SUCRALOSE</th>
<th>STEVIA/MF*</th>
<th>XYLITOL</th>
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* Monk Fruit (MF) and Stevia Extracts are available in salt form and not in naturally available state.

Despite several alternatives, there is no credible solution that replaces sugar in all its applications. These alternatives are merely sweetness replacers.

Sweeteners have several limitations including functions and can’t truly displace sugar.
Several scientific associations, institutions & authorities have issued policy recommendations that aim to reduce intake of sugars. These policy recommendations include,
- reformulating processed foods & labels
- Levying fiscal taxes such as sugar taxes on products with high sugar content.

In the UK and EU, major policy intervention has directed food and beverage manufacturers to decrease sugar content and associated calories by 20% in products including foods like chocolate & sweet confectionery.
With the rise in health and wellness awareness, consumers are willing to pay more for low-calorie food products formulated using natural ingredients. More than 90% of consumers in the US and 80% in Australia are ready to pay more for healthier foods.

To increase their revenue shares, several food and beverage manufacturers are increasingly focusing on niche products such as sugar-free products and confectionery. Market research analysts estimate that the markets of such new segments will grow at a CAGR of >20% by 2021 compared to the overall sugar confectionery segment.

As per Euromonitor, between 2016 and 2021, global retail sales volumes of health and wellness chocolate will grow at double the rate i.e., @ CAGR of 2.6% compared to 1.3% for a regular chocolate confectionery.
Honeytose™ is virtually a calorie free natural sugar which is found in Honey. Honeytose tastes like table sugar. It is a free flowing crystalline powder. Honeytose has very good antioxidant and antimicrobial properties. Honeytose reduces the glycemic load of the carbohydrate containing products it is combined with. It also helps to regulate blood sugar levels and to lower lipid production & accumulation in the body. It performs better than sugar in baking and other applications. And preserves food better in applications like Jam etc...
PETIVA'S SOLUTION

CANEOSE™

Caneose is rare complex sugar present in cane.

Caneose™ is a clear syrup and is a natural antioxidant and an ultra low GI Sugar (50% Lower GI than table sugar and 70% Lower GI than Glucose). Caneose being a complex sugar takes 300% longer time to break down than simple sugars.

It combines the goodness of complex carbohydrates (whole grains) with the sweetness of sugar.

It provides consistent blood glucose and lasting energy along with lowering food cravings.

Caneose can replace liquid sugars (Sucrose, HFCS, Maple Syrup…)

PETIVA'S SOLUTION

... Caneose (Isomaltulose)
PETIVA’S PRODUCTS

Brand name for Allulose, a natural rare sugar with near zero calories and anti-oxidant properties.

- Available in crystal form.
- Available in liquid form.

Brand for Trehalulose, a natural rare sugar with low GI attributes, providing sustained energy release.

- Ultra Low GI (32)
- Available in liquid form.

Composed of Isomaltulose, a smart carbohydrate with low GI attributes, providing sustained energy release.

- Ultra Low GI (32)
- Available in crystal form.
- Available in liquid form.

Also approved in Japan, Chile, Mexico, Singapore

Also approved for topical & dental applications.

Available in liquid form.

For those seeking to trim their calorie intake.

All Areas Sugar is Used

For those seeking sustained energy release with same calories

Energy Drink
- Powdered Drink

Sports Drink
- Energy Bar

Also approved in EU and India

For those seeking sustained energy release with same calories

Compatible with Other Sugars

Compatible with Other Sugars

Tooth Friendly

Under Progress

Also approved in Japan, Chile, Mexico, Singapore

Zero calories compared to sugar

Nil GI

Reduces Calories of Carbohydrate

Compatible with Other Sugars

Natural Preservative

Antioxidant Protection

Tooth Friendly

100% NATURAL

Gluten Free

GMO FREE

No Added Preservatives

No Chemical

HONEYTOSE™

Can eos NECTAROSE™
Honeytose and Caneose are Sugars and can not only replace all the functions of sugar, are more functional and address the major concerns of sugar today.

---

**PETIVA’S SOLUTION**

...All functions of Sugar, cleaner and more functional

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Honeytose and Caneose are Sugars and can not only replace all the functions of sugar, are more functional and address the major concerns of sugar today.
PETIVA- REGULATORY

... from a regulatory perspective

• Allulose has been approved as Generally Recognized as Safe (GRAS) status by US Food and Drug Administration (FDA) for use as an independent food ingredient as well as in conjunction with other sweeteners.

• Allulose is also approved in Singapore, Chile, Mexico, Columbia, Japan & South Korea

• Petiva has already received production license from FSSAI and is USFDA registered

• Applied to European EFSA for obtaining approval for the products. Application is final stages of approval.

• Petiva is in the process for obtaining regulatory approval of Honeytose (Allulose) and Caneose (Isomaltulose) in India.

• HALAL and KOSHER certifications process initiated by Petiva

FDA allows the zero-calorie sweetener Allulose to be excluded from total and added sugars counts on Nutrition and Supplement Facts labels
Petiva’s patented sugar production technology is a commercially viable process capable of economically competing in the sugar market. At the heart of the breakthrough process is a novel biocatalyst and a patented process that’s proven to be multiple times superior over competition*. Unique innovations across the production process provide:
1. Non GMO
2. Substantial Capex and Opex cost advantage,
3. Flexibility in using a variety of raw materials from low cost bulk raw sugars to refined sugar, to glucose and fructose depending on the availability and price
4. Large scale, single stream, low footprint capacity,
5. Production of high purity products at competitive rates,
6. Process Reliability

* Independently verified (against Tate and Lyle, Matsutani etc…)

THE TECHNOLOGY

... PETIVA’s breakthrough is a process innovation

Novel Production Processes for Producing Honeytose™, Caneose™
THE TECHNOLOGY

Patent List (Applied & Granted)

Enzyme Related

6 Patents (D-Psicose 3-epimerase mutant and uses thereof, Modified xylose isomerase and uses thereof, Refolding of isomaltulose synthase, Refolding of sucrose isomerase, Cell surface display of isomaltulose synthase and Cell surface display of sucrose isomerase)

Process Related

9 Patents (Process for isolating pure sugars from the acid hydrolyzate of a material, A Method Of Production Of Rare Disaccharides, Method Of Production Of Monosaccharides, Process for separating ketoses, Process for producing glucose and fructose from sucrose and separating glucose and fructose thereof, Process for production of IMO and GOS, Novel end to end process for production of d-Allulose from sucrose, Novel process and advanced SMB for efficient separation of sugars, Novel process and equipment for continuous crystallization of d-Allulose).

Material Patents

9 Patents (Low calorie, low glycemic index (GI) and sustained energy release brown sugar substitute, Process for preparing non-cariogenic, sustained energy release juice, Process and reactor for producing low-calorie sugar composition, Nutritious dietary supplement, Nano Sweetener Rare Sugars, Sweetness And Taste Enhancement Formulations Of Rare Sugars With Disaccharides, Sweetness And Taste Enhancement Formulations Of Rare Sugars With Oligosaccharides, Sweetness And Taste Enhancement Formulations Comprising Rare Sugars And Licorice Extract, Efficient process for production of sugar dimers using monosacharides)
THE TECHNOLOGY

... Critical Gaps Challenged Widespread Use

Typically HFCS which is a GMO derived product.

Non-compliance with consumer preference and issues in regulatory certifications.

Production: Batch fermentation, 1-2 g/l yield
Based on enzymes having low efficiency & life (16-18 hrs), narrow operating range (55°C)

Requires higher capacities and standby equipment to offset low productivity/life and strict controls to monitor process conditions.

Overall impact is large investment requirement with high operation cost and product with low purity, high pricing and presence of unwanted sugars (fructose etc.)

Batch process, Multiple crystallizers required, Smaller crystal size <25 μ, Low yields 40%
Requires higher capacities and small crystal sizes (effecting taste).

Dependence on standard equipment results in high dilution (D/F > 3.5) low purity.
Requires higher capacities to offset low productivity and yields product which is not preferred by customers.
THE TECHNOLOGY

Dependence in HFCS Feedstock (GMO Product)

Process Using Regular Sugar/ Additional Module for Backward Integration

Enzymes with high productivity/ robustness under process conditions & long life

Inefficient/ Sensitive Enzymes

Inefficient Separation System

Batch Crystallization

Continuous Crystallizer with high productivity and large crystals

Designed own SMB specific for Allulose separation having high efficiency

... Petiva’s Technological Intervention
Advantages of higher thermostability
- Eliminates contamination
- Reduced viscosity of substrate
- Improved reaction kinetics
- Shifts reaction equilibrium in favour of product

Obtained an increase of 10 °C in the temperature optima
Advantages of enhanced operational stability

- Reduces the enzyme requirement
- Increases the duty cycle
- Minimizes operational complexity

The engineered enzyme had negligible loss in activity after 60 days at 60 °C compared to the native enzyme (half life 2 days at 50 °C)
The Technology

Comparison of enzymes

Petiva Enzyme
- Specific activity very high
- Stability – 60 days
- Temperature optima 65 – 70 °C
- Protected with patent

Native/Competitor
- Specific activity - low
- Stability – 6 to 18 hrs
- Temperature optima 55 °C
THE TECHNOLOGY

Optimized Bio-Process for production
• High cell density fed batch fermentation
• Exponential feeding of concentrated substrate to maintain optimum $\mu$ pre and post induction
• Final OD obtained > 100
• Temperature reduction post induction to reduce insoluble protein product

Total protein yields > 5 g/l with more than 60% in the soluble fraction
Comparison of Enzyme Production Process

**Conventional**
- Cell OD – 40 (max)
- Protein Yield 1 to 2 g/l
- Batch fermentation

**Petiva Process**
- Soluble protein expression
- Cell OD – 100
- Protein yield – 5 g/l
- Fed batch fermentation process
Designing a Single Stage Enzyme Purification Method

Advantages

- Reduces the cellular protein load into the system
- Enhances the enzyme loading in the reactors
- Increases reactor efficiencies and reducing their size
- Improves enzyme operational stability

SDS PAGE showing 90% pure enzyme in single step chromatography

Obtained >90% yield and >90% recovery using single step purification in an ion exchange column with a step gradient combining salt and pH

Lane 1: control (purified DPEase); Lane 2: load (total cell Lysate) Lane 2: Load -20 ug; Lane 3: -Flow through-20 ug; Lane 4: wash -20 ug; Lane 5: 70 mM NaCl wash-20 ug; Lane 6: 120 mM NaCl-20 ug; Lane 7: 1M NaCl wash -20ug
THE TECHNOLOGY

**Advantages of packed bed operation**

- Time required for conversion: 6 min
- Highly stable: >2 months
- 1 enzyme molecule therefore converts ≈ 200 million sugar molecules

---

**Enzymatic Conversion**

Sucrose → Fructose

Packed bed reactor

Enzyme immobilized on bead

Honeytose
Optimizing Process Parameters for Enzymatic Conversion

Optimized conversion process
• Reduced residence time of 6 min
• Substrate concentration of 50% for reduced water in the system
• Small reactor size due to high productivity
• Percent conversion > 95% of the equilibrium value.
• Column height of 2 m chosen to increase flow rate and reduce mass transfer effects
Comparison of Enzymatic Conversion Process

Conventional
- Lower conversion rates
- Poor binding therefore leaching
- Large reactors

Petiva Process
- Residence time only 6 min
- No enzyme leaching
- Small reactor
- 60 days operation, higher substrate conc, higher conversion
Chromatographic Separation of Fructose and Honeytose

First Generation SMB

Next Generation SMB
Chromatographic Separation with Novel Resins

Improved Resins
Shallow shell technology

- Faster adsorption and desorption kinetics
- More efficient operation
- Reduced water required
- High product purity

Novel resin design with reduced water requirements
Very high productivity, recovery and purity
**THE TECHNOLOGY**

Chromatographic Separation (Improved Design)

Extract purity of one cycle during cyclic steady state. Demonstrating very high Honeytose purity

The innovative process developed in-house uses diverts the initial part of the extract flow back into the system to enhance the productivity in a simple four column design.

Net purity of >97%, net recovery of 96% and reduced water requirement
Comparison of Chromatographic Separation Process

**Conventional**
- Very high CapEx
- High dilution D/F >3.5
- Lower purity and recovery

**Petiva Process**
- 30% the OEM
- Low dilution D/F <2
- Purity and recovery >97%
- Simpler DSP, lower OpEx, superior resin etc
**THE TECHNOLOGY**

**Crystallization**

Due to entrainment of mother liquor with crystals the final crystal purity is 99.7%.

Two stage crystallization setup to enhance overall crystal recovery of 70%.

Mother liquor from second stage is the liquid product with 95% purity (remaining is fructose).

The crystal size distribution is between 50 and 100 µ leading to easy recovery.
Comparison of Crystallization Process

Conventional
- Batch process
- Multiple crystallizers will be required at every stage
- Higher CapEx and OpEx
- Smaller crystal size <25 µ
- Lower yields 40%

Petiva Process
- Continuous process
- Single crystallizer for each stage
- About 20% lower CapEx and OpEx
- Crystal size 50 to 100 µ
- High Yield of 70% & Purity >99.7%
## NATIONAL TRADEMARKS

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**Note:** The table above lists various patents from different countries, detailing the application numbers and titles of the patents. Each patent entry includes the country of filing, the application number, and a brief description of the patent's title. The table also includes a list of countries and their respective patent filings, along with the application numbers and titles. The table concludes with a list of countries and their respective patent filings, along with the application numbers and titles.