



Technology Match Maker | Sustainable Ingredients for Functional Foods & Additives | Oct 2023

One-Pot Process For Biosynthesis Of Kojibiose On An Industrial Scale



Lead Scientist: Dr Sudhir Singh

Organization: DBT-CIAB

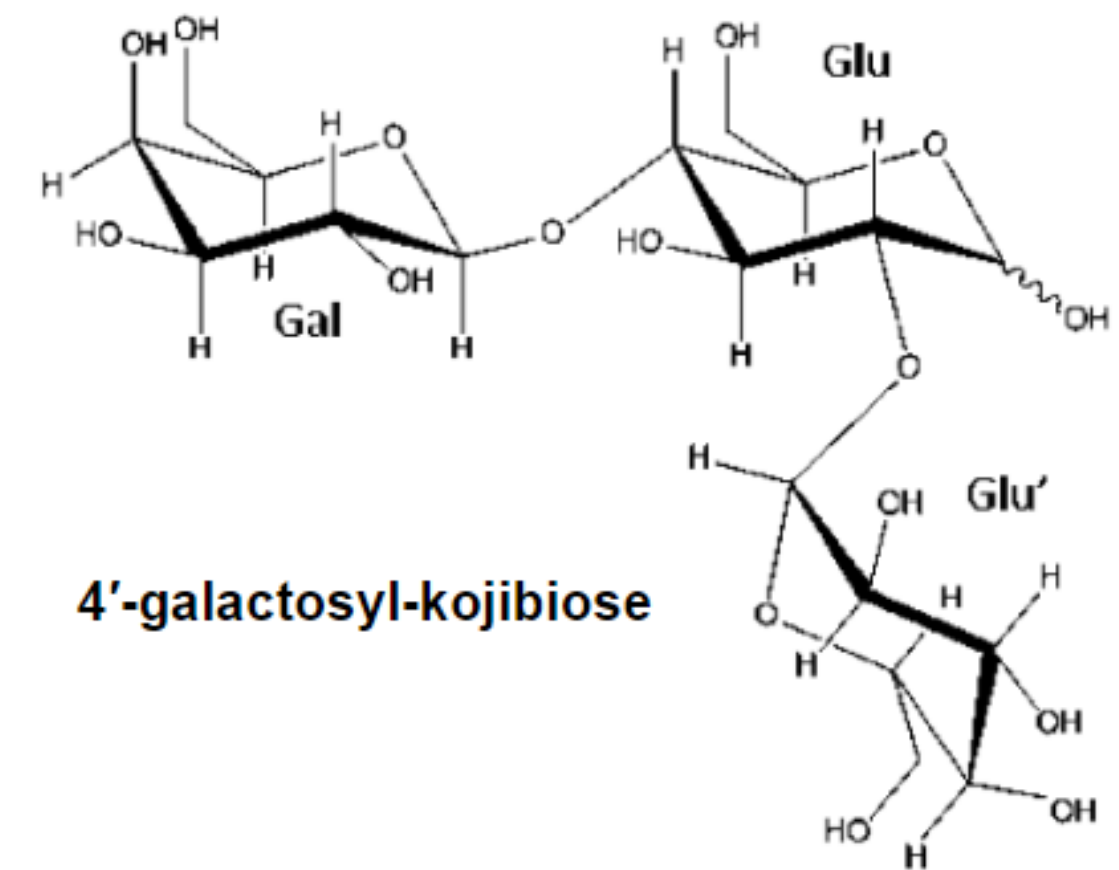
TechEx.in Case Manager: Pradnya Aradhye (pradnya@venturecenter.co.in)

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Kojibiose and derivatives

- Kojibiose is a novel sugar that belongs to Isomalto-oligosaccharide (IMO) carbohydrates:
 - It is naturally present in fermented foods like soy sauce, miso, sake and honey.
 - Low in calories – high resistance of α -(1 \rightarrow 2) linkages to in vitro and in vivo gastrointestinal digestion.
 - Promising prebiotic potential – broken down by gut microbes and the metabolites released are nutrients for the human body.
 - Does not damage teeth – maintains healthy salivary microbiome composition and has low cariogenicity [1].
- **Sensory appeal** – 4'-galactosyl-kojibiose (4GK) can be used to achieve a palatable and well-balanced sweetness profile with an appealing smell [2].
- **Market demand** – Growing health consciousness, demand for natural low-calorie sweeteners and prebiotics gives an opportunity for newer products as well as processes for synthesis of novel products like 4GK.



Market Opportunity

The global market for IMO is at USD 850M in 2023 and expected to reach 1.69B by 2033 growing at a CAGR 7.1% CAGR during the forecast period.

Key Market Drivers include:

- Raising consumption of prebiotics.
- Demand for high fiber and natural ingredients in food products.

Current Price: Varies over a range from USD 75 to USD 600 based on sample quantity [1].

Challenges: Production of Kojibiose at industrial scale.



Who Should Be Interested?

| Who? | Why? |
|--|---|
| Manufacturers of prebiotics like IMO, FOS, GOS etc. | <ul style="list-style-type: none">• New product with market potential |
| Manufacturers of food ingredients | <ul style="list-style-type: none">• New product addition in portfolio |
| Sugar and Rare sugars manufacturers | <ul style="list-style-type: none">• Higher value products from sugar building blocks• New product in portfolio |
| Manufacturers of bio-synthesized value added chemicals | <ul style="list-style-type: none">• New products and forays into new markets• Opportunity to disrupt markets |

About the Technology

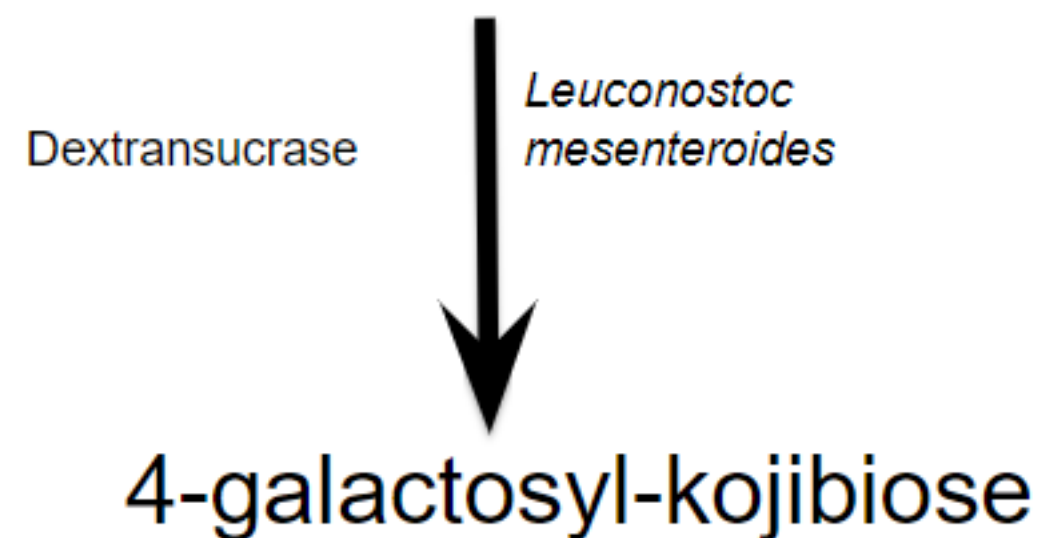
Process features:

- **Novel one-pot bioprocess for production of trisaccharide 4'-galactosyl-kojibiose (4GK):**
 - High yielding process, converts 40% of sucrose and lactose to 4GK.
 - Cost effective transformation of feedstock (table sugar & whey lactose) into high value product (4GK).
 - Low cost starting material contributes to reduced cost of final product.

Product features:

- **Conversion yield: 40% 4GK with minimal by-products.**
- **4GK has about 25% of the sweetness of sucrose and is sweeter than IMO syrup and oligofructosides [1].**
- **It has higher rated perfume note adding to sensory attributes.**
- **4GK can be combined with high intensity sweeteners to achieve a balanced sweetness profile.**

Table sugar + Whey lactose



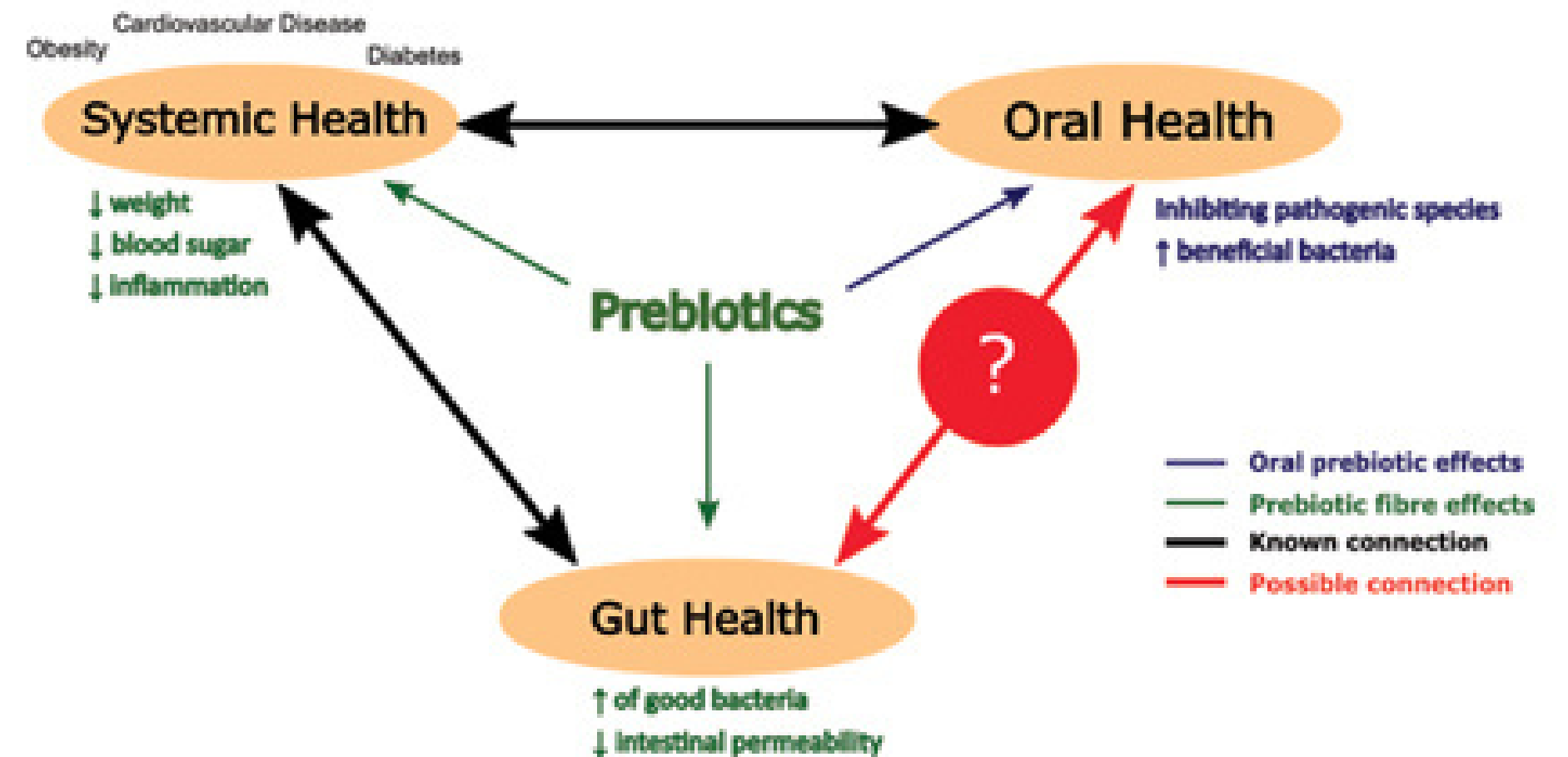
About 11–14 g /L 4-galactosyl-kojibiose from the feedstock containing about 30 g/ L sucrose and lactose each



The first report on 2- α -D-glucopyranosyl-lactose from India

Unique Prebiotic For Gut and Oral Health

- Trisaccharide 4'-galactosyl-kojibiose (4GK) as a novel sugar:
 - Helps maintain healthy oral hygiene.
 - Good for intestinal flora.
 - Low in calories.
- Unique positioning – Prebiotic promoting oral, gut and systemic health.
- Additive for various oral formulations:
 - Mouth fresheners
 - Chewable products
 - Tooth pastes and dental products
 - Pharmaceuticals



Current Status

Technology Status:

- Demonstrated at lab-scale 5L fermenter.

IP Status: Patent filed and granted in India.

- Priority date: 21st February 2017
- Coverage: IN
- Granted Patent No. IN 353513

Publications:

- An integrated bio-process for production of functional biomolecules utilizing raw and by-products from dairy and sugarcane industries. Lata K, Sharma M, Patel SN, Sangwan RS, Singh SP, Bioresource Technology Bioprocess and Biosystems Engineering 41 (8), 1121-1131. (IF 2.419) 2018.



Team & Organisation



Lead Scientist:

Dr Sudhir P Singh, FNAAS

- **Scientist D at DBT – CIAB.**
- **Honors and Awards:** Fellow of the National Academy of Agricultural Sciences (FNAAS); Member of NASI; HIRALAL Chakravarty Award (DST); Young Scientist Award, IBA (France); SBS–Madurai Kamraj Univ Genomics Award.
- **Expertise:** Gene mining, biocatalyst engineering, bioprocessing, bioproduct generation and enzyme characterization

CIAB – Center of Innovative and Applied Bioprocessing, Mohali, is an autonomous institute of DBT, India, mainly focused in research work related to secondary Agriculture and development of value added products from different types of bio resources.

Key assets and strengths of the team:

- 10 total patents filed, 5 granted in India; 50+ publications in bioprocess, enzyme characterization and functional biomolecules.
- **Team Strength:** 6
- **Well equipped labs and analytical facilities:**
 - 5 L fermenter
 - Enzyme characterization assays
 - Protein Purification system
 - Membrane separation unit
 - HPLC and Gas chromatography
- **Industry projects/ Tech transfer:** Good track record of technology transfer and working with industries.

Next Steps

- Team has developed new process for the production of 4'-galactosyl-kojibiose which has high demand as a prebiotic.
 - The process has been demonstrated at lab scale.
- Next phase includes identifying industrial partners for co-development of the technology involving:
 - Process optimization.
 - Downstream processing and purification.
 - Scale up as per industry requirements for pilot-plant demonstration.

Seeking:

- **Industrial partners interested in technology licensing.**
- **Industrial partners interested in sponsoring further technology advancement and scale up.**
- **Industrial partners interested in raising 3rd party funds for a collaborative project.**
- **Industry interested in tapping scientist capabilities as an expert/consultant.**



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References

- Slide 2 - [1] <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7414948/>
- Slide 2 - [2] Ruiz-Aceituno et al, Sweetness and sensory properties of commercial and novel oligosaccharides of prebiotic potential, LWT, Vol 97, 2018, Pages 476-482.
- Slide 3 - Image: <https://www.factmr.com/report/3751/isomalto-oligosaccharide-market>
- Slide 3 - [1] <https://www.chemicalbook.com/Price/KOJIBIOSE.htm>
- Slide 5 - [1] Ruiz-Aceituno et al, Sweetness and sensory properties of commercial and novel oligosaccharides of prebiotic potential, LWT, Vol 97, 2018, Pages 476-482.
- Slide 6 - Image: <https://www.oralhealthgroup.com/features/prebiotics-not-only-for-gut-health/>