WHAT'S IN A NAME?

Taxonomic Updates to the Genus *Lactobacillus* and Implications to the Probiotic Industry

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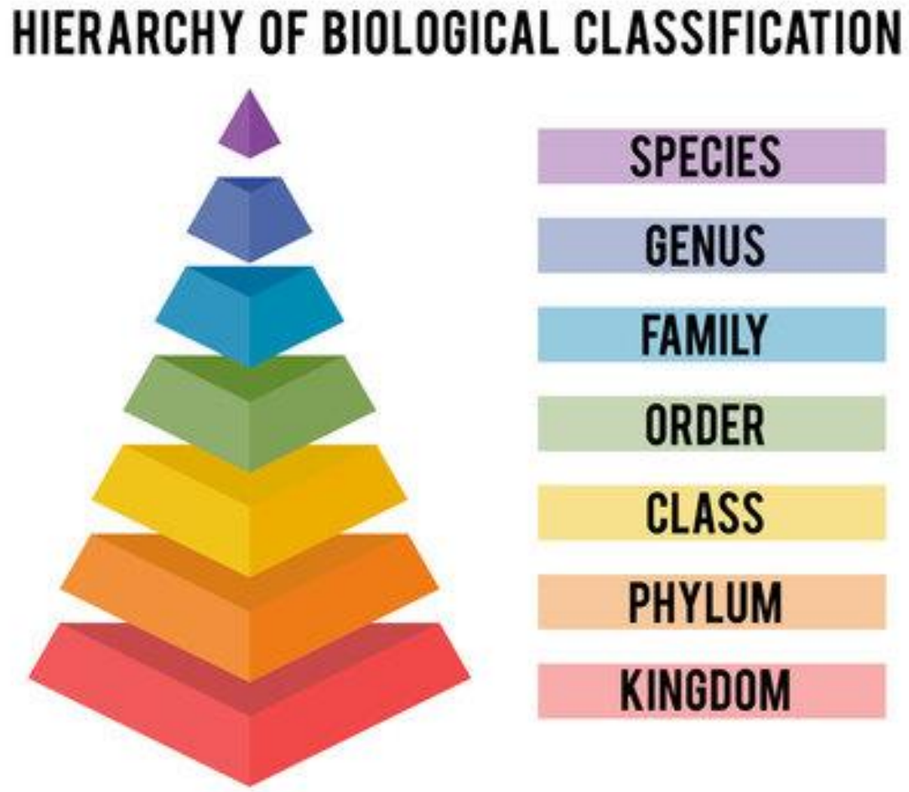
OUTLINE

- Overview of the genus *Lactobacillus*
- Describe the taxonomic update made to the genus
- How the change will be applied to industry and academia
- Implications for the probiotic industry
- Why the taxonomy change is a good thing for the consumer

BINOMIAL NOMENCLATURE

Bi – two, Nomial - name

- Definition – the system of nomenclature in which two terms are used to denote a species of living organism, the first one indicating the genus and the second a specific epithet
- Genus = *Lactobacillus*
- Species = *acidophilus*
- STRAIN = XYZ



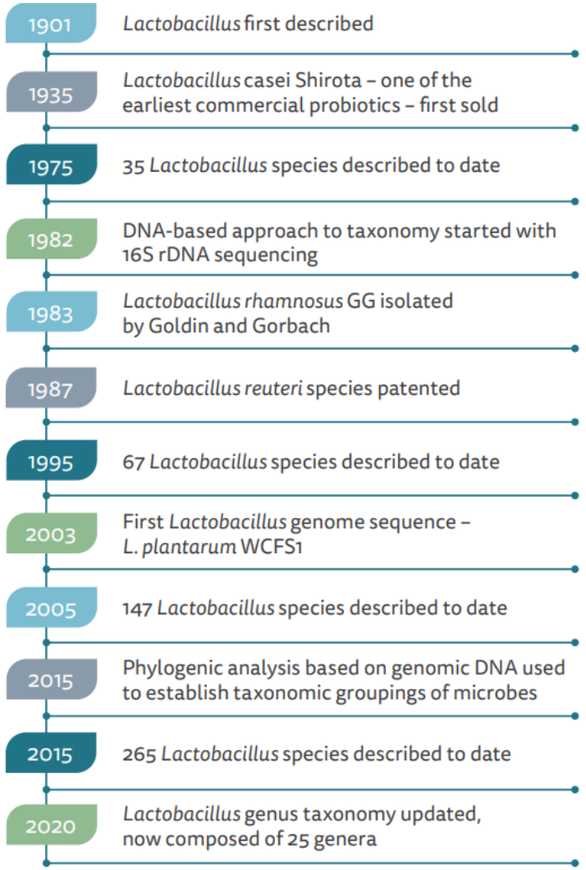
https://stock.adobe.com/search?k=%22binomial+nomenclature%22

THE *LACTOBACILLUS* GENUS

Characteristics

- First characterized in 1901
- Gram-Positive, rod-shaped, facultatively anaerobic or microaerophilic, non-spore-forming, and acid-tolerant.
- Mutualistic relationship with the human body
- Produce lactic acid as a by-product of glucose metabolism
- Heterofermentative versus homofermentative

Lactobacillus Timeline



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THE *LACTOBACILLUS* GENUS

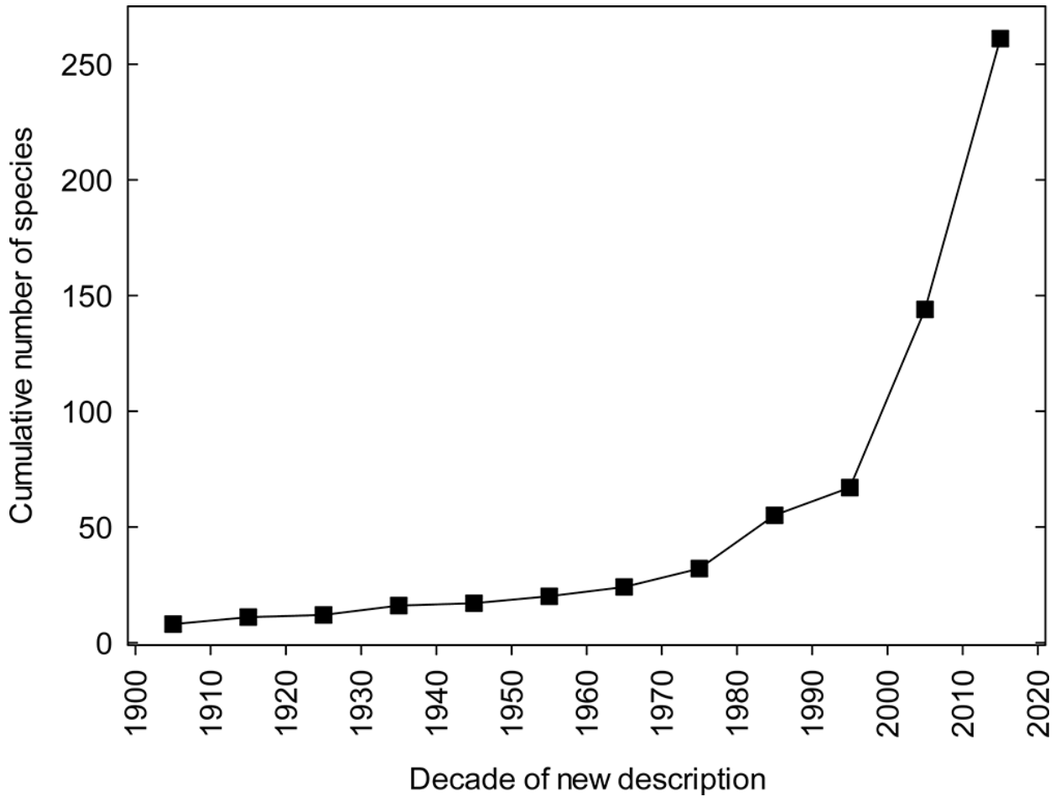
Applications

- Used in foods for decades:
  - Food Preservation
  - Dairy Starters
  - Fermented Vegetables
  - Fermented fish and sausage

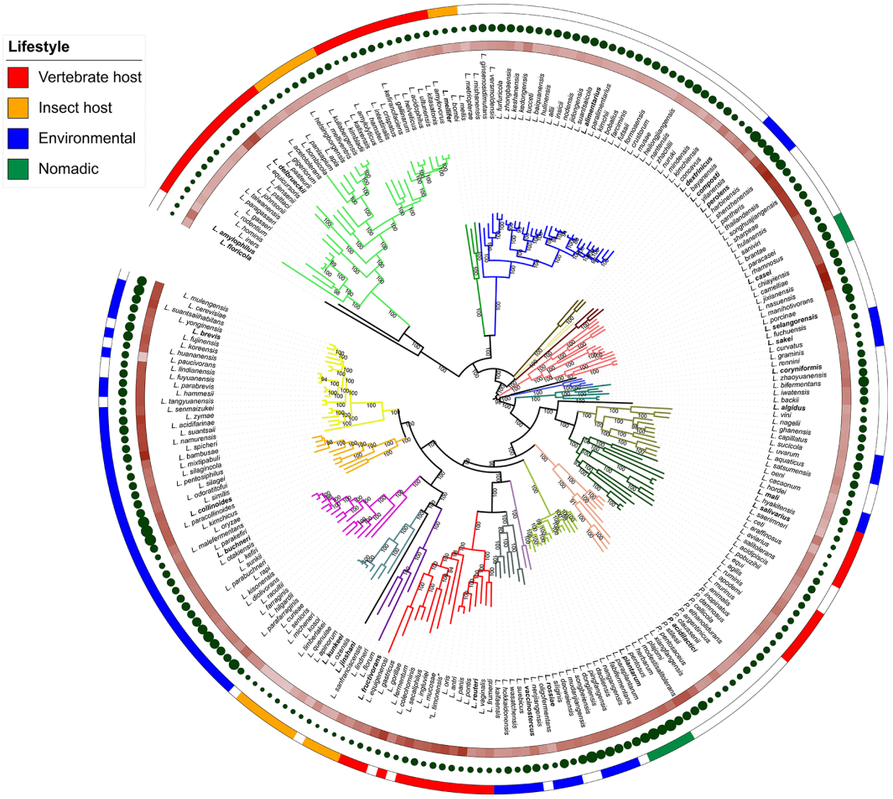
- Functional Foods/Dietary Supplements
  - Probiotics
  - "*Live microorganisms which when administered in adequate amounts confer a health benefit to the host.*
  - Strain-specific
  - Documented scientific evidence of a health benefit.

A LARGE AND DIVERSE GENUS

261 Species



Cumulative number of species described in the genera *Pediococcus* and *Lactobacillus* until January 2020. The species description in January 2020 is included in the 2010–2019 count. Zheng et al. https://doi.org/10.1099/ijsem.0.004107



Core genome phylogenetic tree of *Lactobacillaceae* . The phylogenomic analysis is based on the concatenated alignment of protein sequences for the 114 single-copy core genes. The maximum likelihood tree was inferred by RAxML as described previously using the 244 *Lactobacillus* and *Pediococcus* species for which genome sequence data was available on the NCBI database on 19 August 2019. The tree was rooted via midpoint rooting. Bootstrap support values were calculated from 500 replicates, and only values above 90 % were labelled. Members of the same phylogenetic group that are the basis for the proposed taxonomy are indicated by the same colour for branches, and the type strain of each group is printed in bold. Outer rings provide information on genomic features and the inferred lifestyle of the species. The colour gradient in red represents the GC content of each genome sequence; higher GC contents are indicated by darker shading. The solid circles in brown represent genome sizes; the area of the circle correlates with the genome size. The second ring indicates the inferred natural habitats of the species as vertebrate host-adapted (red), insect-adapted (orange), nomadic (green), free-living (blue) or unassigned (white). This assignment of species to lifestyle was based on.

Zheng J., Wittouck S., Salvetti E. *et al.*,(2020). *A taxonomic note on the genus Lactobacillus: Description of 23 novel genera, emended description of the genus Lactobacillus Beijerink 1901, and union of Lactobacillaceae and Leuconostocaceae.* https://doi.org/10.1099/ijsem.0.004107

A LARGE AND DIVERSE GENUS

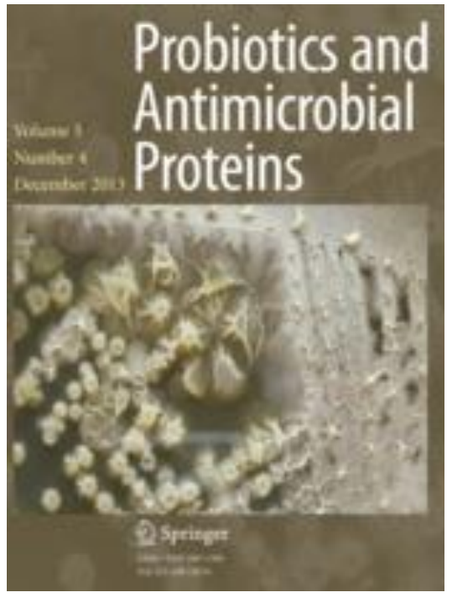
The Problem

- “Umbrella” genus
  - As new bacteria were discovered with antiquated research tools, diverse species were listed as *Lactobacillus* .
  - More refined DNA analyses found the bacteria in the same genus more unrelated than others of different genera – excessive diversity
  - No longer conforms to nomenclature conventions
  - A similar as a human and a marmot

DIVIDING *LACTOBACILLUS* IN 25 GENERA

Landmark Publications

Salvetti, E., Torriani, S. & Felis, G.E. The Genus *Lactobacillus*: A Taxonomic Update. *Probiotics & Antimicro. Prot.* **4,** 217–226 (2012). https://doi.org/10.1007/s12602-012-9117-8



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Need to create new genera in order to accommodate new discoveries without having to further reclassify!

DIVIDING *LACTOBACILLUS* INTO 25 GENERA

23 NOVEL GENUS NAMES

- *Acetilactobacillus*
- *Agrilactobacillus*
- *Amylolactobacillus*
- *Apilactobacillus*
- *Bombilactobacillus*
- *Companilactobacillus*
- *Dellaglioa*
- *Fructilactobacillus*
- *Furfurilactobacillus*
- *Holzapfelia*
- *Lacticaseibacillus*
- *Lactiplantibacillus*
- *Lapidilactobacillus*
- *Latilactobacillus*
- *Lentilactobacillus*
- *Levilactobacillus*
- *Ligilactobacillus*
- *Limosilactobacillus*
- *Liquorilactobacillus*
- *Loigolactobacillus*
- *Paucilactobacillus*
- *Schleiferilactobacillus*
- *Secundilactobacillus*

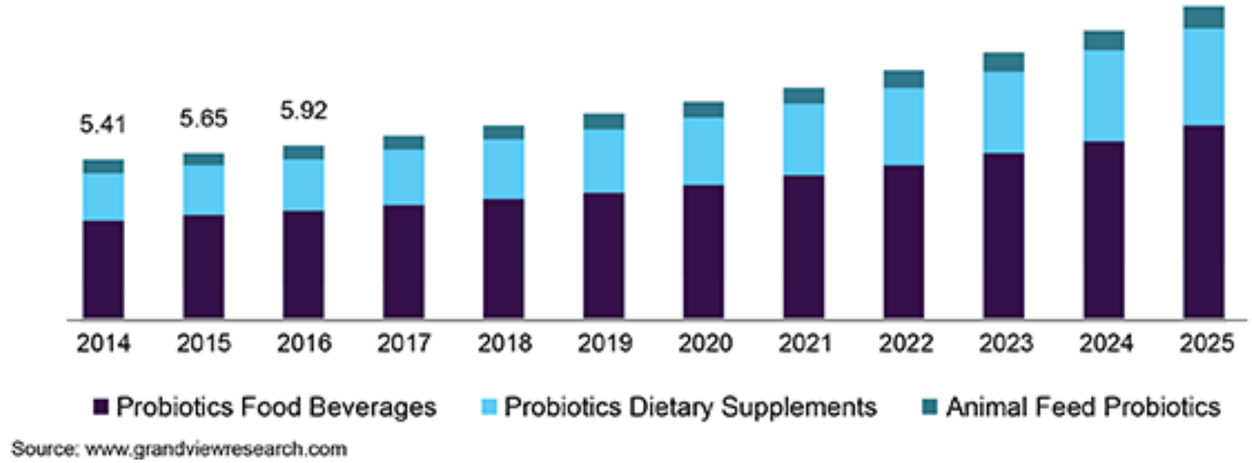
DIVIDING *LACTOBACILLUS* INTO 25 GENERA

What's in a Name?

Genus Name	Meaning (if any)
Acetilactobacillus	Lactobacilli from vinegar
Agrilactobacillus	Lactobacilli from fields
Amylolactobacillus	Starch degrading lactobacilli
Apilactobacillus	Lactobacilli from bees
Bombilactobacillus	Lactobacilli from bees and bumblebees
Companilactobacillus	Companion lactobacilli
Dellaglioa	Named after Prof. Franco Dellaglio
Fructilactobacillus	Lactobacilli utilizing fructose
Furfurilactobacillus	Lactobacilli utilizing bran
Holzapfelia	Named after Prof. Wilhelm Holzapfel
Lacticaseibacillus	No meaning (includes the casei species group name)
Lactiplantibacillus	No meaning (includes the plantarum species group name)
Lapidilactobacillus	Lactobacilli from stones
Latilactobacillus	Wide-spread lactobacilli
Lentilactobacillus	Slow growing lactobacilli
Levilactobacillus	(Dough) leavening lactobacilli
Ligilactobacillus	Uniting (host adapted) lactobacilli
Limosilactobacillus	Slimy lactobacilli
Liquorilactobacillus	Lactobacilli from liquor or liquids
Loigolactobacillus	Food spoiling lactobacilli
Paucilactobacillus	Lactobacilli utilizing few carbohydrates
Schleiferilactobacillus	Named after Prof. Karl-Heinz Schleifer
Secundilactobacillus	Second Lactobacillus

THE PROBIOTIC INDUSTRY

Consumed by millions



Unprecedented Impact

First time a taxonomy change will impact the probiotic space

- *Lactobacillus* widely administered in functional foods and dietary supplements worldwide.
- Safety, efficacy, structure-function claims, commercialization, marketing

DIVIDING *LACTOBACILLUS* INTO 25 GENERA

Officially Re-Classified

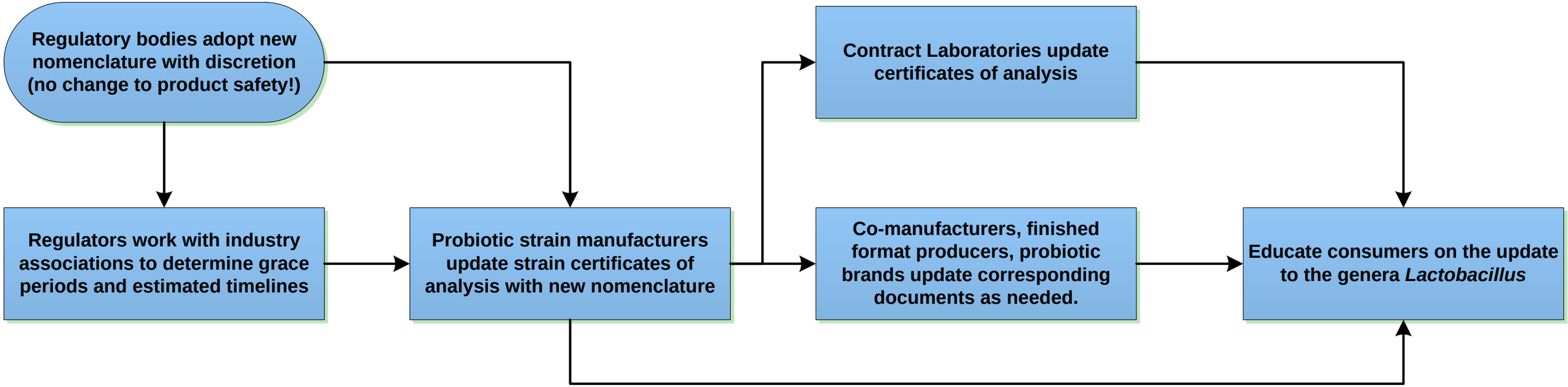
April 2020

- Prominent species' genus start with letter "L" to minimize disruption – abbreviation remains the same
- Species/strain names have not changed
- "lactotax"
  - http://www.lactobacillus.uantwerpen.be
- *Only a nomenclature change that has no impact on safety or efficacy of the microorganisms previously determined to be safe and suitable for use in foods and food supplements*

Genus name before reclassification	Genus name after reclassification	Abbreviated name
Probiotics		
Lactobacillus brevis	Levilactobacillus brevis	L. brevis
Lactobacillus casei	Lacticaseibacillus casei	L. casei
Lactobacillus fermentum	Limosilactobacillus fermentum	L. fermentum
Lactobacillus paracasei	Lacticaseibacillus paracasei	L. paracasei
Lactobacillus plantarum	Lactiplantibacillus plantarum	L. plantarum
Lactobacillus reuteri	Limosilactobacillus reuteri	L. reuteri
Lactobacillus rhamnosus	Lacticaseibacillus rhamnosus	L. rhamnosus
Starter cultures		
Lactobacillus acidophilus	Lactobacillus acidophilus	L. acidophilus
Lactobacillus casei	Lacticaseibacillus casei	L. casei
Lactobacillus curvatus	Latilactobacillus curvatus	L. curvatus
Lactobacillus delbrueckii	Lactobacillus delbrueckii	L. delbrueckii
Lactobacillus fermentum	Limosilactobacillus fermentum	L. fermentum
Lactobacillus helveticus	Lactobacillus helveticus	L. helveticus
Lactobacillus plantarum	Lactiplantibacillus plantarum	L. plantarum
Lactobacillus sakei	Latilactobacillus sakei	L. sakei

https://site.unibo.it/subcommittee-lactobacillus-bifidobacterium/en/genus_lactobacillus_reclassified_ok.docx/@@download/file/genus_lactobacillus_reclassified_ok.docx

THE TRANSITION (INDUSTRY)



THE TRANSITION (ACADEMIA)

Living with two names

- New publications on *Lactobacillus* strains should use the new genus names. Explanations may need to be given to editors and reviewers.
- Literature searches will need to be conducted by searching for both the basonym and the new genus name.
- Scientific patents need to be filed with the new names.

IMPLICATIONS FOR INDUSTRY

From

***Lactobacillus rhamnosus* GG**

To

"*Lacticaseibacillus rhamnosus* GG, formerly classified as *Lactobacillus rhamnosus* GG

https://www.culturelleprobiotic.ca/resources/Something-To-Digest

IMPLICATIONS FOR INDUSTRY

Nomenclature Updates

- Informational Material
- Product Labels
- Advertisements
- Import/Export Documents
- Regulatory Dossiers
- Approvals/Ingredient Lists
- **NOT** Previously Published Literature

Transition Period

- Communication Challenges
- Gradual Replacement
- Coordinated Approach

IMPLICATIONS FOR INDUSTRY

How will the change affect my brand?

- Change is currently globally applicable
- Time is on our side – a lengthy transition
- A number of common species are not changing at all! (still *Lactobacillus*)
  - i.e. *Lactobacillus acidophilus, Lactobacillus delbrueckii* subsp. *bulgaricus*
- Species and strains are not changing!
- Health claims are not changing!
- Most relevant species have new genus names that still start with the letter “L”
- Customer education on nomenclature and what is not changing (see above)
- Industry associations are here to help

BENEFITS TO INDUSTRY AND CONSUMERS

Shared mechanisms among probiotic taxa

- Classically strain-specific structure function claims
- Health benefits may derive from mechanisms that are shared among strains
  - i.e short chain fatty acid production
- Assignment of benefits to taxa beyond the strain

Increased discriminatory power

- Link and identify particular properties such as health and safety benefits to a specific genus
- Ensure stronger scientific evidence and more clarity within the group

The new taxonomic situation will be more stable and will stop unrestrained growth of the former genus

KEY TAKEAWAYS

- The *Lactobacillus* taxonomic update is only a nomenclature change that does not have an impact on the efficacy or safety of the probiotic organisms previously determined to be safe and suitable for use in functional foods and dietary supplements. It is a good thing!

- The International Probiotic Association (IPA) in partnership with EFFCA and IFAC is working with international regulatory bodies to inform and provide a rationale for the changes and request regulatory discretion for label enforcement, recognizing both old and new Genus listings in the interim. While the implications for industry are wide-ranging involving significant investment, the newly associated grouping will benefit future research and better inform consumers on the purported health claims

THANK YOU

(SEE YOU AT SUPPLY SIDE WEST!)

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