Pro- und Präbiotika – Wunsch oder Wirkung?

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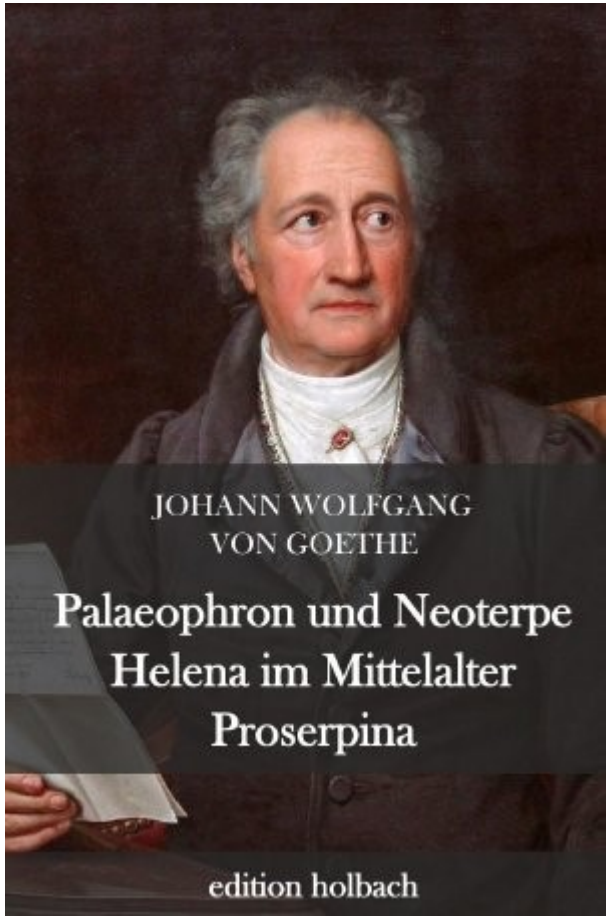
Einleitung
…biotika
Wünsche
Wirkungen
Schlussfolgerungen

- Gut ist der Vorsatz, aber die Erfüllung ist schwer

  - Festspiel zu Ehren von Anna Amalia von Braunschweig-Wolfenbüttel
  - 24.10.1800

  - Allegorische Auseinandersetzung und Versöhnung zwischen alter (Paläaophron) und neuer Zeit (Neoterpe)



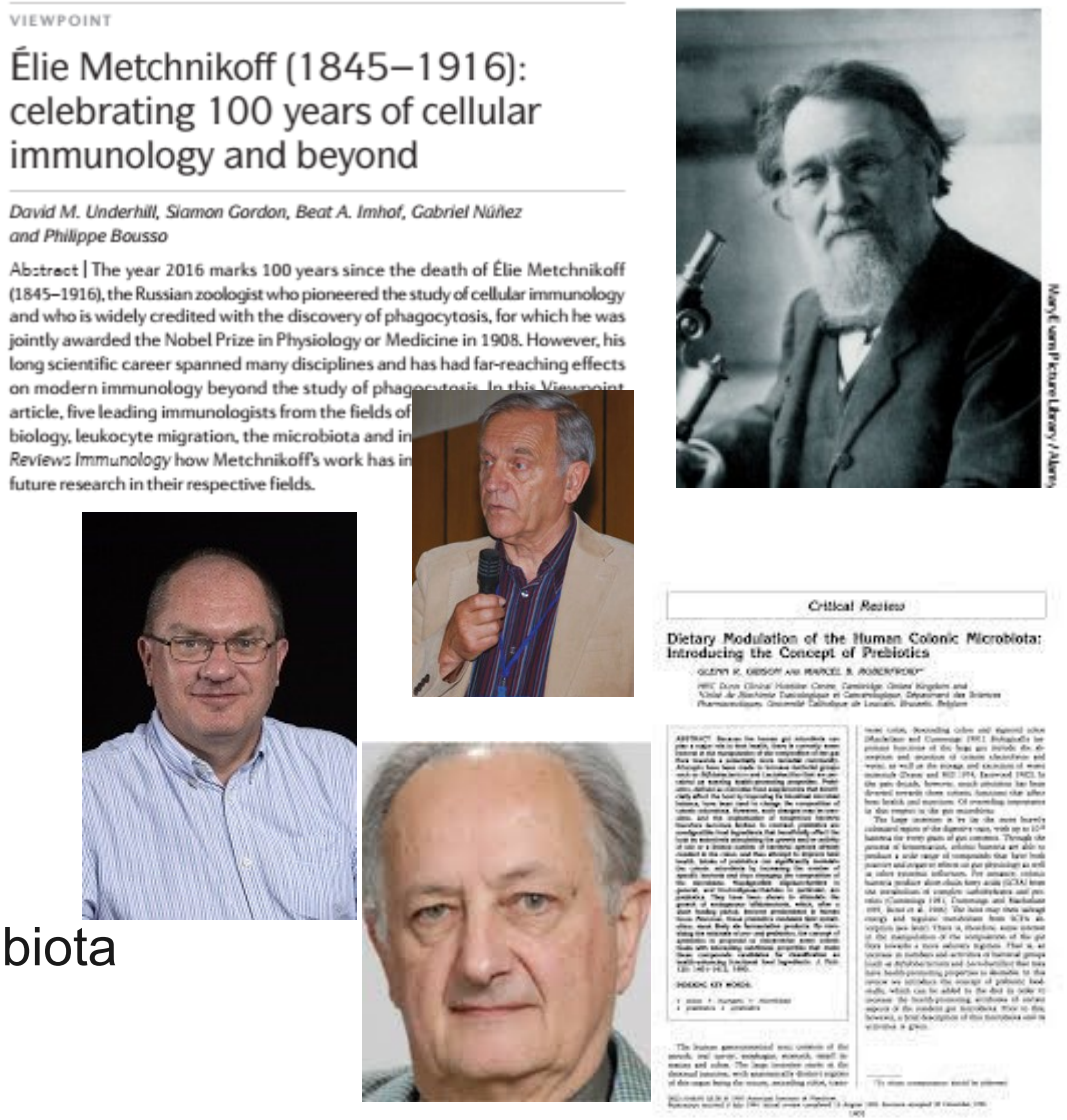
Definitionen

- Probiotika
  - Vermehrungsfähige Mikroorganismen
  - Bakterien und Hefen

    = Futtermittelzusatzstoff

- Präbiotika
  - Durch körpereigene Enzyme nicht verdauliche Kohlenhydrate
  - Fermentierbares Substrat für die intestinale Mikrobiota

    = Einzelfuttermittel


VIEWPOINT

Élie Metchnikoff (1845–1916): celebrating 100 years of cellular immunology and beyond

David M. Underhill, Siamon Gordon, Beat A. Imhof, Gabriel Núñez and Philippe Bousso

Abstract | The year 2016 marks 100 years since the death of Élie Metchnikoff (1845–1916), the Russian zoologist who pioneered the study of cellular immunology and who is widely credited with the discovery of phagocytosis, for which he was jointly awarded the Nobel Prize in Physiology or Medicine in 1908. However, his long scientific career spanned many disciplines and has had far-reaching effects on modern immunology beyond the study of phagocytosis. In this Viewpoint article, five leading immunologists from the fields of biology, leukocyte migration, the microbiota and in *Reviews Immunology* how Metchnikoff's work has in future research in their respective fields.

Critical Reviews

Dietary Modulation of the Human Colonic Microbiota: Introducing the Concept of Prebiotics

Bilder: https://www.editions-tredaniel.com/marcel-roberfroid-auteur-4217.html; https://www.reading.ac.uk/food/our-staff/glenn-gibson; http://www.bio-kult.com/userfiles/file/1756_what_exactly_are_probiotics.pdf

Futtermittelrecht

1.2.2002 DE Amtsblatt der Europäischen Gemeinschaften L 31/1

I

(Veröffentlichungsbedürftige Rechtsakte)

VERORDNUNG (EG) Nr. 178/2002 DES EUROPÄISCHEN PARLAMENTS UND DES RATES

vom 28. Januar 2002

zur Festlegung der allgemeinen Grundsätze und Anforderungen des Lebensmittelrechts, zur Errichtung der Europäischen Behörde für Lebensmittelsicherheit und zur Festlegung von Verfahren zur Lebensmittelsicherheit

28.7.2016 DE Amtsblatt der Europäischen Union C 275/3

Bekanntmachung der Kommission über den EU-Kodex für die gute Kennzeichnungspraxis b… Mischfuttermitteln für der Lebensmittelgewinnung dienende Tiere

(2016/C 275/04)

gemäß Artikel 26 der Verordnung (EG) Nr. 767/2009 des Europäischen Parlaments und des Rates vom 13. Juli 2009 über das Inverkehrbringen und die Verwendung von Futtermitteln, zur Änderung der Verordnung (EG) Nr. 18…03 des Europäischen Parlaments und des Rates und zur Aufhebung der Richtlinien 79/373/EWG des Rates, 80/5…G der Kommission, 82/471/EWG des Rates, 83/228/EWG des Rates, 93/74/EWG des Rates, 93/113/EG des Rat… 96/25/EG des Rates und der Entscheidung 2004/217/EG (1) der Kommission:

Titel: EU CODE OF GOOD LABELLING PRACTICE FOR COMPOUND FEED FOR FOOD PRODUCING ANIMALS

Autoren: European Farmers (COPA, Ausschuss der berufsständischen landwirtschaftlichen Organisationen der EU) und European Agri-Cooperatives (COGECA, Allgemeiner Verband der landwirtschaftlichen Genossenschaften der EU) (http://www.copa-cogeca.be/) sowie European Feed Manufacturers' Federation (FEFAC, Europäischer Verband der Mischfuttermittelindustrie) (http://www.fefac.eu)

Fundstelle: http://ec.europa.eu/food/safety/animal-feed/feed-marketing/index_en.htm

Amtsblatt der Europäischen Union 30.4.2004

ICHTLINIE 2004/28/EG DES EUROPÄISCHEN PARLAMENTS UND DES RATES

vom 31. März 2004

rung der Richtlinie 2001/82/EG zur Schaffung eines Gemeinschaftskodexes für Tierarzneimittel

(Text von Bedeutung für den EWR)

LAMENT UND DER RAT DER

g zur Gründung der Europäischen Ge-
re auf Artikel 95 und Artikel 152 Ab-

(4) Alle Vorschriften auf dem Gebiet der Herstellung und des Vertriebs von Tierarzneimitteln sollten in erster Linie dem Schutz der Gesundheit und des Wohlergehens der Tiere sowie der öffentlichen Gesundheit dienen. Mit den Vorschriften über die Genehmigung für das Inverkehrbringen von Tierarzneimitteln und den Kriterien für die Erteilung dieser Genehmigungen soll der Schutz der öf-

Amtsblatt der Europäischen Union L 229/1

I

(Veröffentlichungsbedürftige Rechtsakte, die in Anwendung des EG-Vertrags/Euratom-Vertrags erlassen wurden)

VERORDNUNGEN

VERO… …NG (EG) Nr. 767/2009 DES EUROPÄISCHEN PARLAMENTS UND DES RATES

vom 13. Juli 2009

…Inverkehrbringen und die Verwendung von Futtermitteln, zur Änderung der Verordnung …1831/2003 des Europäischen Parlaments und des Rates und zur Aufhebung der Richtlinien …G des Rates, 80/511/EWG der Kommission, 82/471/EWG des Rates, 83/228/EWG des …/EWG des Rates, 93/113/EG des Rates und 96/25/EG des Rates und der Entscheidung 2004/217/EG der Kommission

(Text von Bedeutung für den EWR)

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Oktober
…er Stand-
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…icht) und

deren die steigende Zahl von so genannten Grenzprodukten zwischen dem Arzneimittelbereich und anderen Bereichen Berücksichtigung finden, sollte die Begriffsbestimmung des Arzneimittels geändert werden, um zu vermeiden, dass Zweifel an den anzuwendenden Rechtsvorschriften auftreten, wenn ein Produkt, das vollständig von der Definition des Arzneimittels erfasst wird, möglicherweise auch unter die Definition anderer regulierter Produkte fällt. Angesichts der Merkmale pharmazeutischer Rechtsvorschriften sollte auch sichergestellt werden, dass diese Rechtsvorschriften zur Anwendung kommen. Mit dem gleichen Ziel, die Umstände zu klären, unter denen ein bestimmtes Produkt unter die Definition

(1) ABl. L 214 vom 21.8.1993, S. 1. Aufgehoben durch die Verordnung (EG) Nr. 726/2004 (siehe S. 1 dieses Amtsblatts).

18.10.2003 DE Amtsblatt der Europäischen Union L 268/29

VERORDNUNG (EG) Nr. 1831/2003 DES EUROPÄISCHEN PARLAMENTS UND DES RATES

vom 22. September 2003

über Zusatzstoffe zur Verwendung in der Tierernährung

(Text von Bedeutung für den EWR)

DAS EUROPÄISCHE PARLAMENT UND DER RAT DER EUROPÄISCHEN UNION —

gestützt auf den Vertrag zur Gründung der Europäischen Gemeinschaft, insbesondere auf Artikel 37 und Artikel 152 Absatz 4 Buchstabe b),

auf Vorschlag der Kommission (1),

…europäischen Parlaments und des Rates vom 28. Januar 2002 zur Festlegung der allgemeinen Grundsätze und Anforderungen des Lebensmittelrechts, zur Errichtung der Europäischen Behörde für Lebensmittelsicherheit und zur Festlegung von Verfahren zur Lebensmittelsicherheit (2) niedergelegt ist, lautet, dass in die Gemeinschaft eingeführte Lebensmittel und Futtermittel, die in der Gemeinschaft in den Verkehr gebracht werden

sollen, die entsprechenden Anforderungen des Gemeinschaftsrechts oder von der Gemeinschaft als zumindest gleichwertig anerkannte Bedingungen erfüllen müssen. Deshalb müssen Einfuhren von Zusatzstoffen zur Verwendung in der Tierernährung aus Drittstaaten Anforderungen unterliegen, die den für in der Gemeinschaft hergestellte Zusatzstoffe geltenden Anforderungen gleichwertig sind.

Maßnahmen der Gemeinschaft in Bezug auf die Gesundheit von Mensch und Tier sowie auf die Umwelt sollten auf dem Vorsorgeprinzip basieren.

Nach Artikel 153 des Vertrags trägt die Gemeinschaft zur Förderung des Rechts der Verbraucher auf Information bei.

Bei der Durchführung der Richtlinie 70/524/EWG des Rates vom 23. November 1970 über Zusatzstoffe in der Tierernährung (3) hat sich gezeigt, dass alle Bestimmungen über Zusatzstoffe überarbeitet werden müssen, um der Notwendigkeit Rechnung zu tragen, einen besseren Schutz der Gesundheit von Mensch und Tier und der Umwelt zu gewährleisten. Auch ist der Tatsache Rechnung zu tragen, dass der technologische Fortschritt und die wissenschaftlichen Entwicklungen neue Arten von Zusatzstoffen möglich gemacht haben, etwa solche, die in Silagen oder Wasser eingesetzt werden.

An den Endverwender verkaufte Mischungen von Zusatzstoffen sollten ebenfalls von der vorliegenden Verordnung erfasst und nach den in der Zulassung jedes einzelnen Zusatzstoffes festgelegten Bedingungen in Verkehr gebracht und verwendet werden.

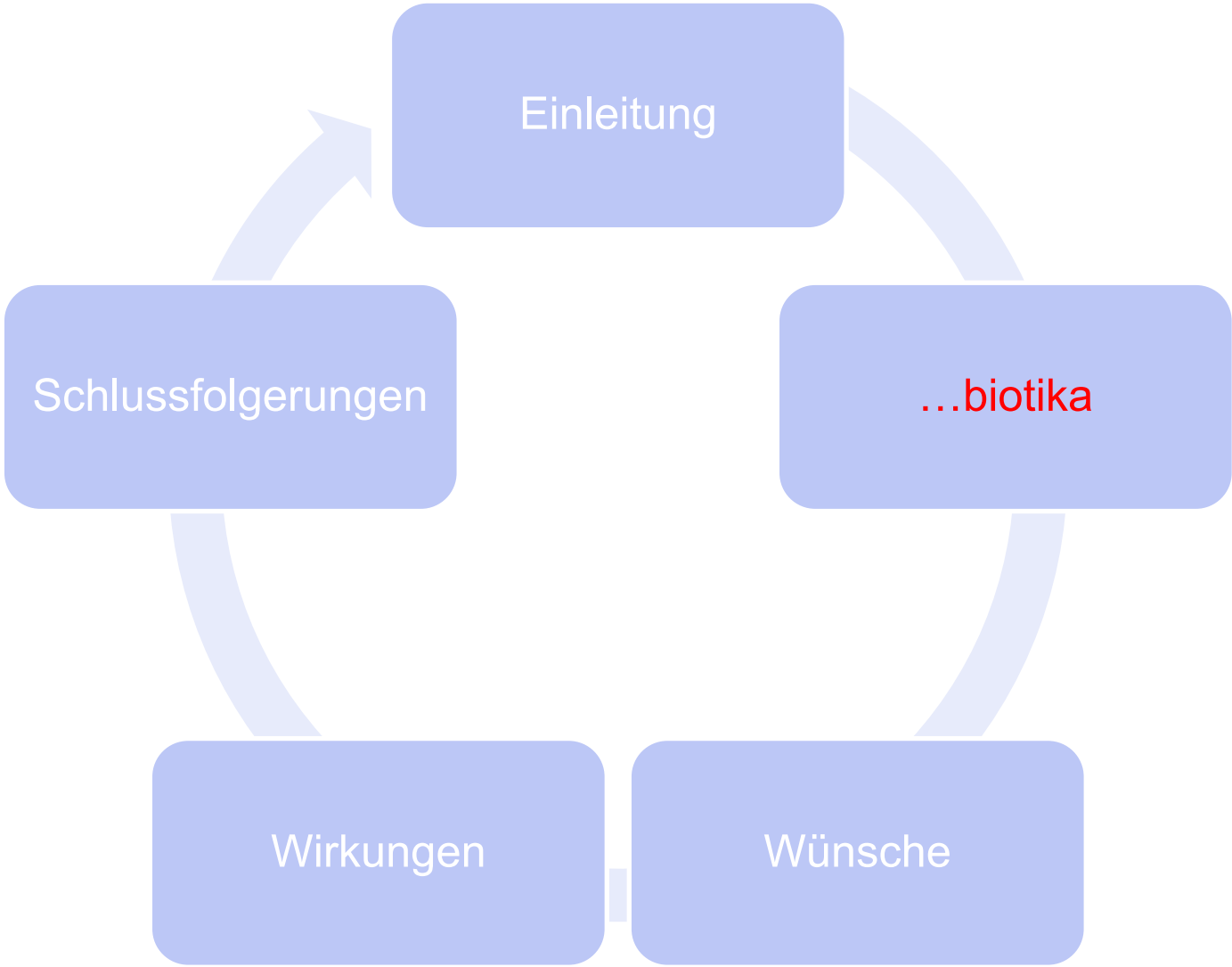
) Vormischungen sollten nicht als Zubereitungen angesehen werden, die unter die Begriffsbestimmung für Zusatzstoffe fallen.

) Hier sollte der Grundsatz gelten, dass nur diejenigen Zusatzstoffe, die nach dem in dieser Verordnung festgelegten Verfahren zugelassen wurden, in Verkehr gebracht, verwendet und in der Tierernährung verarbeitet werden dürfen, und zwar unter den in der Zulassung vorgesehenen Bedingungen.

(12) Die Futtermittelzusatzstoffe sollten in Kategorien eingeteilt werden, um das Bewertungsverfahren im Hinblick auf die Zulassung zu erleichtern. Aminosäuren, deren Salze und Analoge, sowie Harnstoff und seine Derivate, die derzeit unter die Richtlinie 82/471/EWG des Rates vom 30. Juni 1982 über bestimmte Erzeugnisse für die Tierernährung (4) fallen, sollten als eine Kategorie von Futtermittelzusatzstoffen aufgenommen und somit aus dem Anwendungsbereich der genannten Richtlinie in den der vorliegenden Verordnung übernommen werden.

(1) ABl. C 203 E vom 27.8.2002, S. 10.
(2) ABl. C 61 vom 14.3.2003, S. 43.
(3) Stellungnahme des Europäischen Parlaments vom 21. November 2002 (noch nicht im Amtsblatt veröffentlicht), Gemeinsamer Standpunkt des Rates vom 17. März 2003 (ABl. C 113 E vom 13.5.2003, S. 1), Beschluss des Europäischen Parlaments vom 19. Juni 2003 (noch nicht im Amtsblatt veröffentlicht) und Beschluss des Rates vom 22. Juli 2003.
(4) ABl. L 31 vom 1.2.2002, S. 1.

(1) ABl. L 270 vom 14.12.1970, S. 1. Richtlinie zuletzt geändert durch die Verordnung (EG) Nr. 1756/2002 (ABl. L 265 vom 3.10.2002, S. 1).
(2) ABl. L 213 vom 21.7.1982, S. 8. Richtlinie zuletzt geändert durch die Richtlinie 1999/20/EG (ABl. L 80 vom 25.3.1999, S. 20).

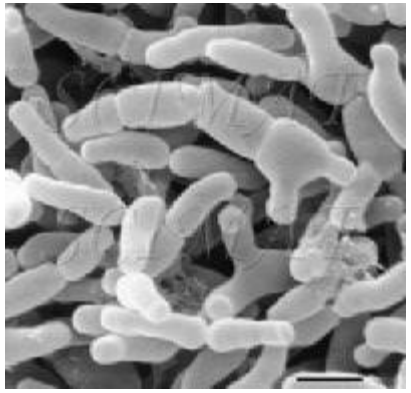

Einleitung
…biotika
Wünsche
Wirkungen
Schlussfolgerungen

Definition

- Probiotika
  - *πρό βίος*: “für das L[illegible]ben”
  - Wirkmechanismus wird oft auf die Mikrobiota bezogen, z.B. Lilly and Stillwell (1965)
  - “a live microbial fe[illegible]nal by improving its [illegible]”

- Enterokokken
- Laktobazillen
- Pediokokken
- Bazillen
- Clostridien
- Bifidobakterien
- *Saccharomyces*

- Fermentierbare Kohlenhydrate – Präbiotika
  - Selektive Förderung
    - *Lactobacillus* spp.
    - *Bifidobacterium* spp.
  - Selektive Hemmung
    - *Salmonella* spp.
    - *Campylobacter* spp.
    - *Clostridium perfringens*



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www. student.britannica.com

- Fermentierbare Kohlenhydrate – Präbiotika
  - Selektive Förderung
    - *Lactobacillus* spp.
    - *Bifidobacterium* spp.
  - Selektive Hemmung
    - *Salmonella* spp.
    - *Campylobacter* spp.
    - *Clostridium perfringens*

→
- Organische Säuren
- pH ↓
- Bakteriozine

- Mannanoligosaccharide (MOS)

  - Eigentlich Glucomannoproteinkomplex
  - Isolierung aus Hefezellwand
  - Bindung von Bakterienfimbrien über Mannoseketten:
    - *E. coli*
    - *Salmonella* spp.

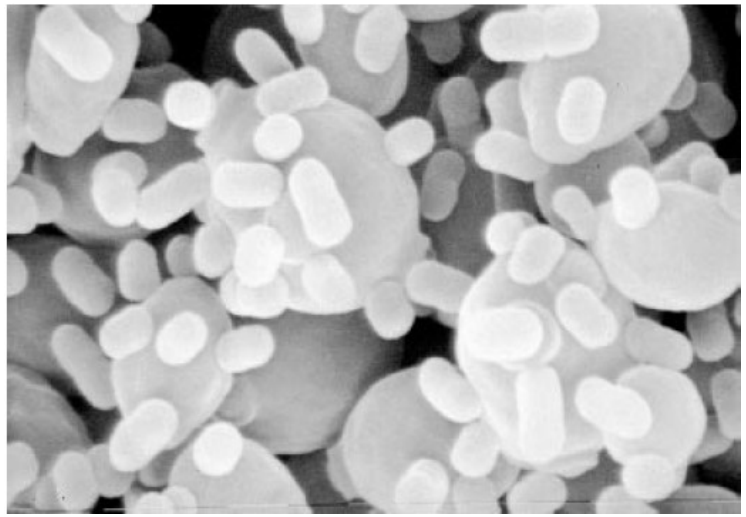


Figure 2. Adherence of enterohaemorrhagic *E. coli* serogroup 0 157 : H – to the surface of *S. boulardii*. Electron microscopic photograph, magnitude 5000 ×.

Gedek 1999

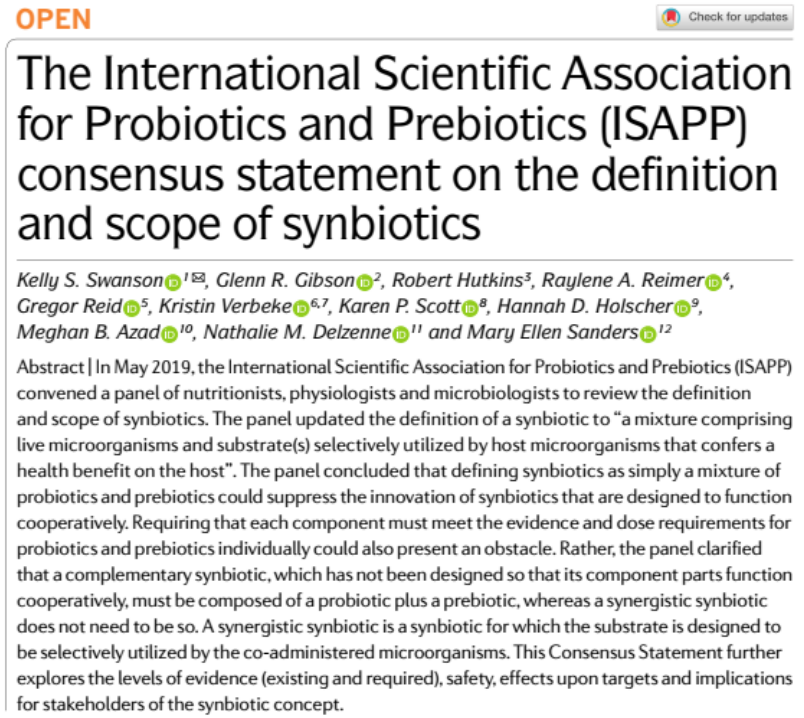
...biotics

- Synbiotika

CONSENSUS STATEMENT

- Aktualisierte Definition:

- Mischung aus lebenden Mikroorganismen und einem oder mehreren Substraten, die von den Wirtsmikroorganismen selektiv verwertet werden und dem Wirt einen gesundheitlichen Nutzen bringen (Swanson et al. 2020)



OPEN

Check for updates

The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of synbiotics

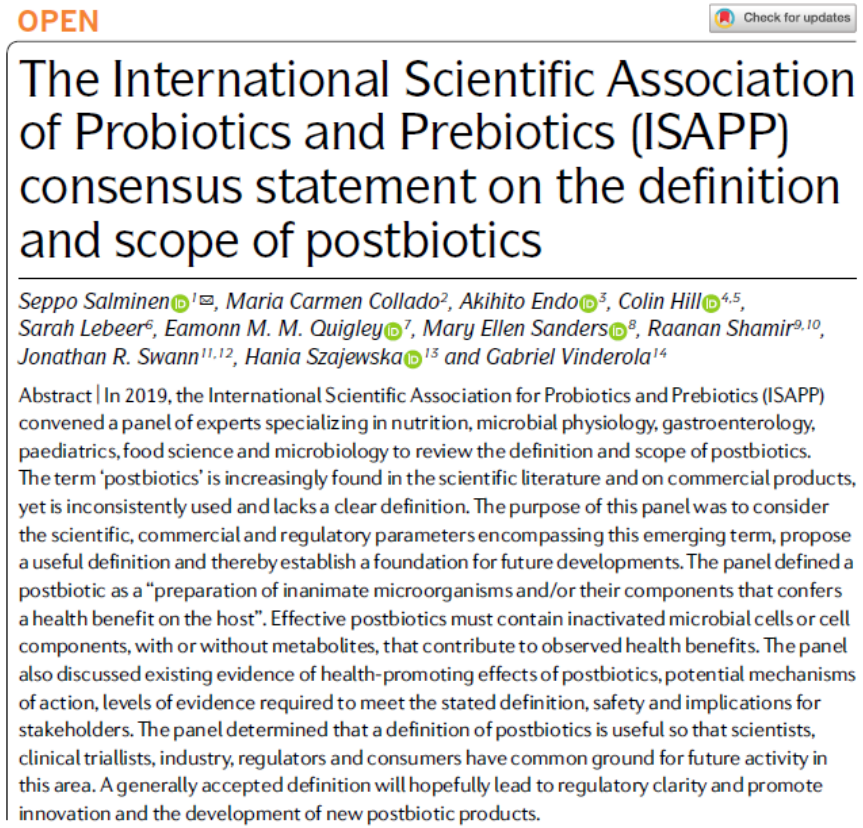
Kelly S. Swanson[1]✉, Glenn R. Gibson[2], Robert Hutkins[3], Raylene A. Reimer[4], Gregor Reid[5], Kristin Verbeke[6,7], Karen P. Scott[8], Hannah D. Holscher[9], Meghan B. Azad[10], Nathalie M. Delzenne[11] and Mary Ellen Sanders[12]

Abstract | In May 2019, the International Scientific Association for Probiotics and Prebiotics (ISAPP) convened a panel of nutritionists, physiologists and microbiologists to review the definition and scope of synbiotics. The panel updated the definition of a synbiotic to "a mixture comprising live microorganisms and substrate(s) selectively utilized by host microorganisms that confers a health benefit on the host". The panel concluded that defining synbiotics as simply a mixture of probiotics and prebiotics could suppress the innovation of synbiotics that are designed to function cooperatively. Requiring that each component must meet the evidence and dose requirements for probiotics and prebiotics individually could also present an obstacle. Rather, the panel clarified that a complementary synbiotic, which has not been designed so that its component parts function cooperatively, must be composed of a probiotic plus a prebiotic, whereas a synergistic synbiotic does not need to be so. A synergistic synbiotic is a synbiotic for which the substrate is designed to be selectively utilized by the co-administered microorganisms. This Consensus Statement further explores the levels of evidence (existing and required), safety, effects upon targets and implications for stakeholders of the synbiotic concept.

...biotics

- Postbiotika
  - Zubereitung aus unbelebten Mikroorganismen und/oder ihren Bestandteilen, die dem Wirt einen gesundheitlichen Nutzen bringen (Salminnen et al. 2021)
  - Enzyme, Metaboliten…

CONSENSUS STATEMENT



OPEN

Check for updates

The International Scientific Association of Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of postbiotics

Seppo Salminen[1]✉, Maria Carmen Collado[2], Akihito Endo[3], Colin Hill[4,5], Sarah Lebeer[6], Eamonn M. M. Quigley[7], Mary Ellen Sanders[8], Raanan Shamir[9,10], Jonathan R. Swann[11,12], Hania Szajewska[13] and Gabriel Vinderola[14]

Abstract | In 2019, the International Scientific Association for Probiotics and Prebiotics (ISAPP) convened a panel of experts specializing in nutrition, microbial physiology, gastroenterology, paediatrics, food science and microbiology to review the definition and scope of postbiotics. The term 'postbiotics' is increasingly found in the scientific literature and on commercial products, yet is inconsistently used and lacks a clear definition. The purpose of this panel was to consider the scientific, commercial and regulatory parameters encompassing this emerging term, propose a useful definition and thereby establish a foundation for future developments. The panel defined a postbiotic as a "preparation of inanimate microorganisms and/or their components that confers a health benefit on the host". Effective postbiotics must contain inactivated microbial cells or cell components, with or without metabolites, that contribute to observed health benefits. The panel also discussed existing evidence of health-promoting effects of postbiotics, potential mechanisms of action, levels of evidence required to meet the stated definition, safety and implications for stakeholders. The panel determined that a definition of postbiotics is useful so that scientists, clinical triallists, industry, regulators and consumers have common ground for future activity in this area. A generally accepted definition will hopefully lead to regulatory clarity and promote innovation and the development of new postbiotic products.

…biotics

- Psychobiotika

  - Lebende Bakterien (Probiotika)

    …Nutzen für die psychische Gesundheit bringen…

  - Emotionale, kognitive, systemische und neuronale Variablen, die für Gesundheit und Krankheit relevant sind

The microbiome may yield a new class of psychobiotics for the treatment of anxiety, depression and other mood disorders

Schmidt 2015


Einleitung
…biotika
Wünsche
Wirkungen
Schlussfolgerungen

- Wunsch = Gesundheit des Darms

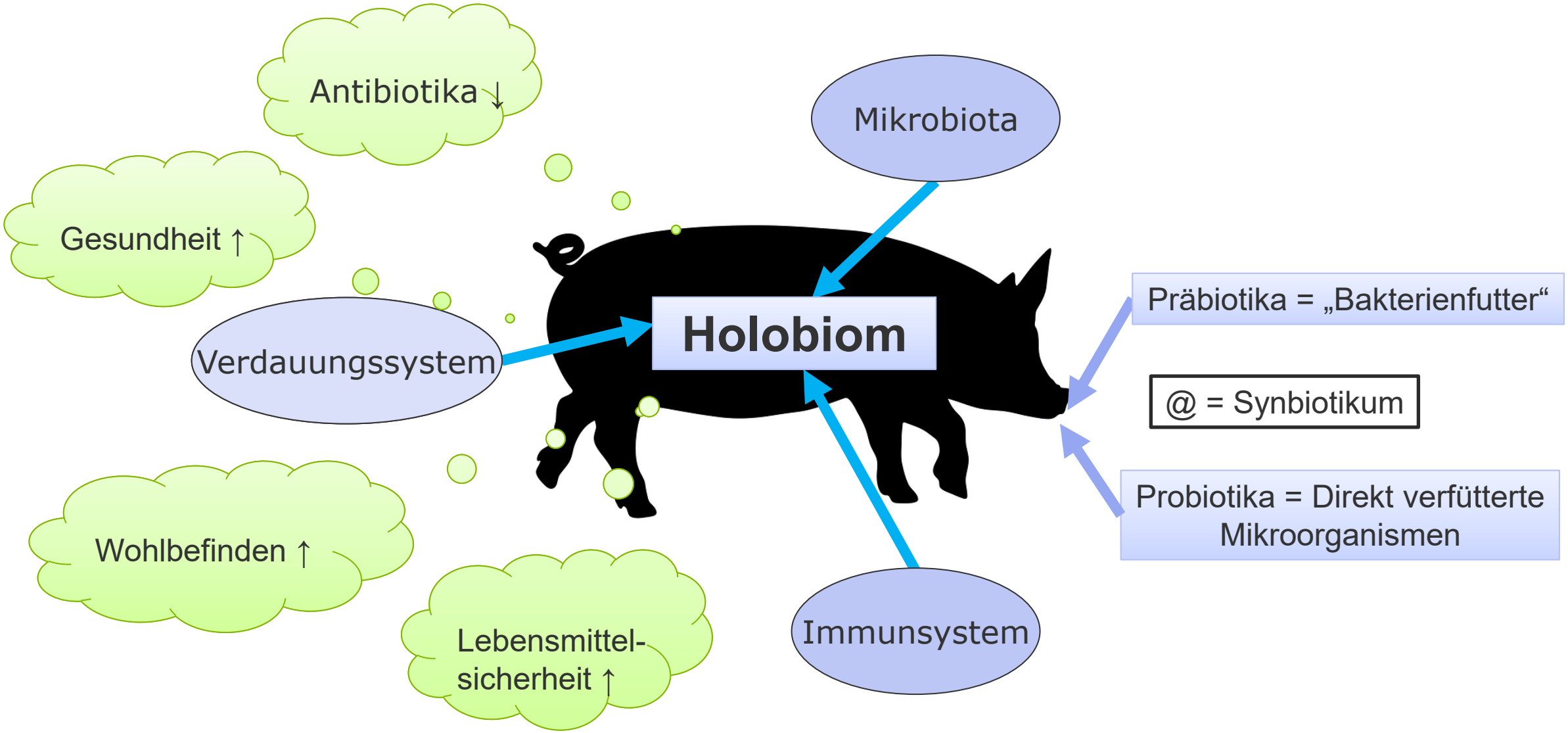
- Physiologische und funktionelle Merkmale →
- Nährstoffverdauung und –aufnahme →
- Wirtsstoffwechsel und Energiegewinnung →
- Stabiles Mikrobiom →
- Entwicklung der Schleimschicht →
- Barrierefunktion →
- Immunreaktionen der Schleimhaut →

Kogut and Arsenault 2016

- Physiologische Homöostase
- Fähigkeit, infektiösen und nicht-infektiösen Stressoren zu widerstehen

Gesundheit des Darms

Ziele von Pro- und Präbiotika



Definitionen

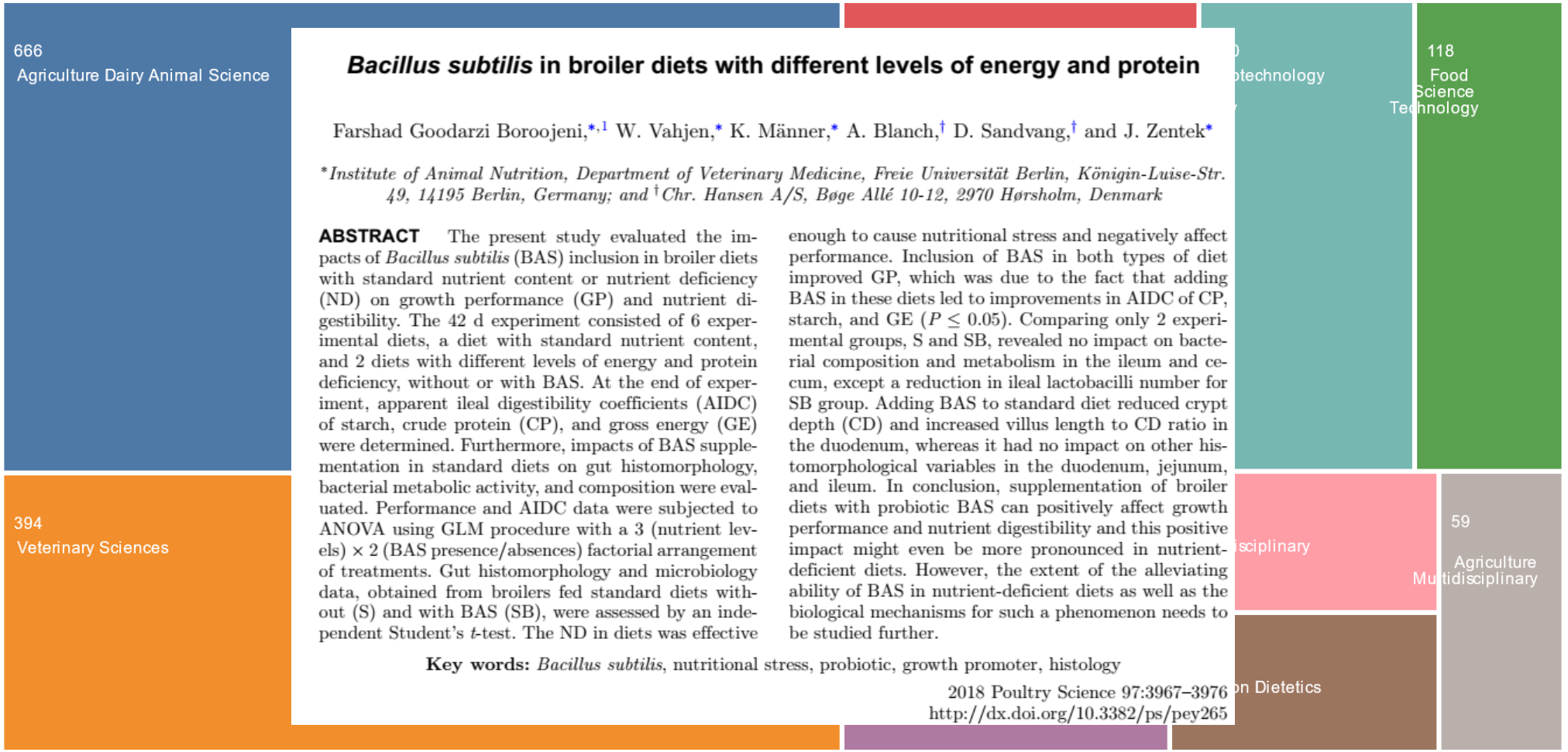
- Holobiom

HoloFood - Exploring host - gut interactions in major food systems

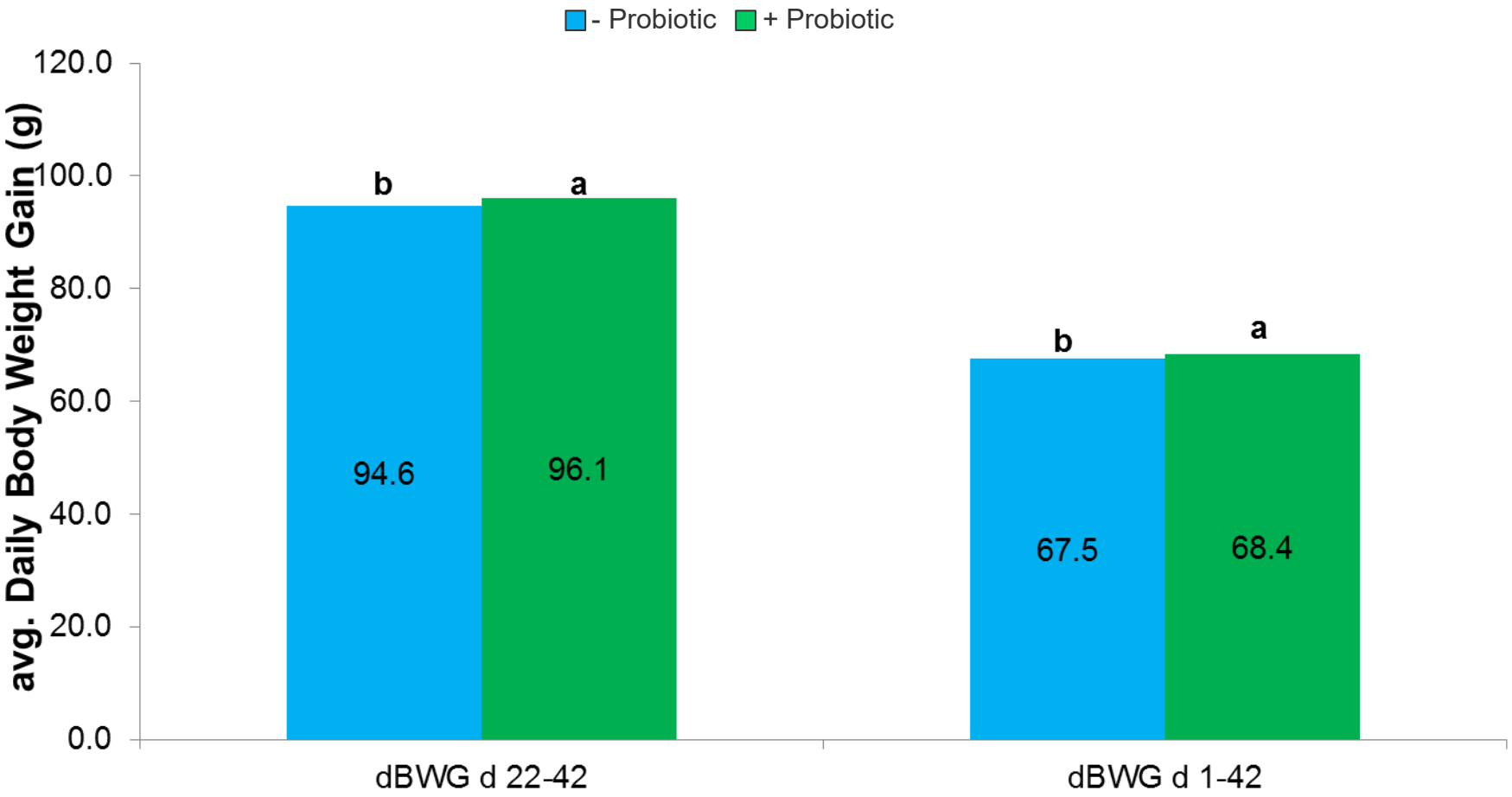

Einleitung
…biotika
Wünsche
Wirkungen
Schlussfolgerungen

...biotics

- Wirkung – (prebiotics OR probiotics) AND (pigs OR chicken)



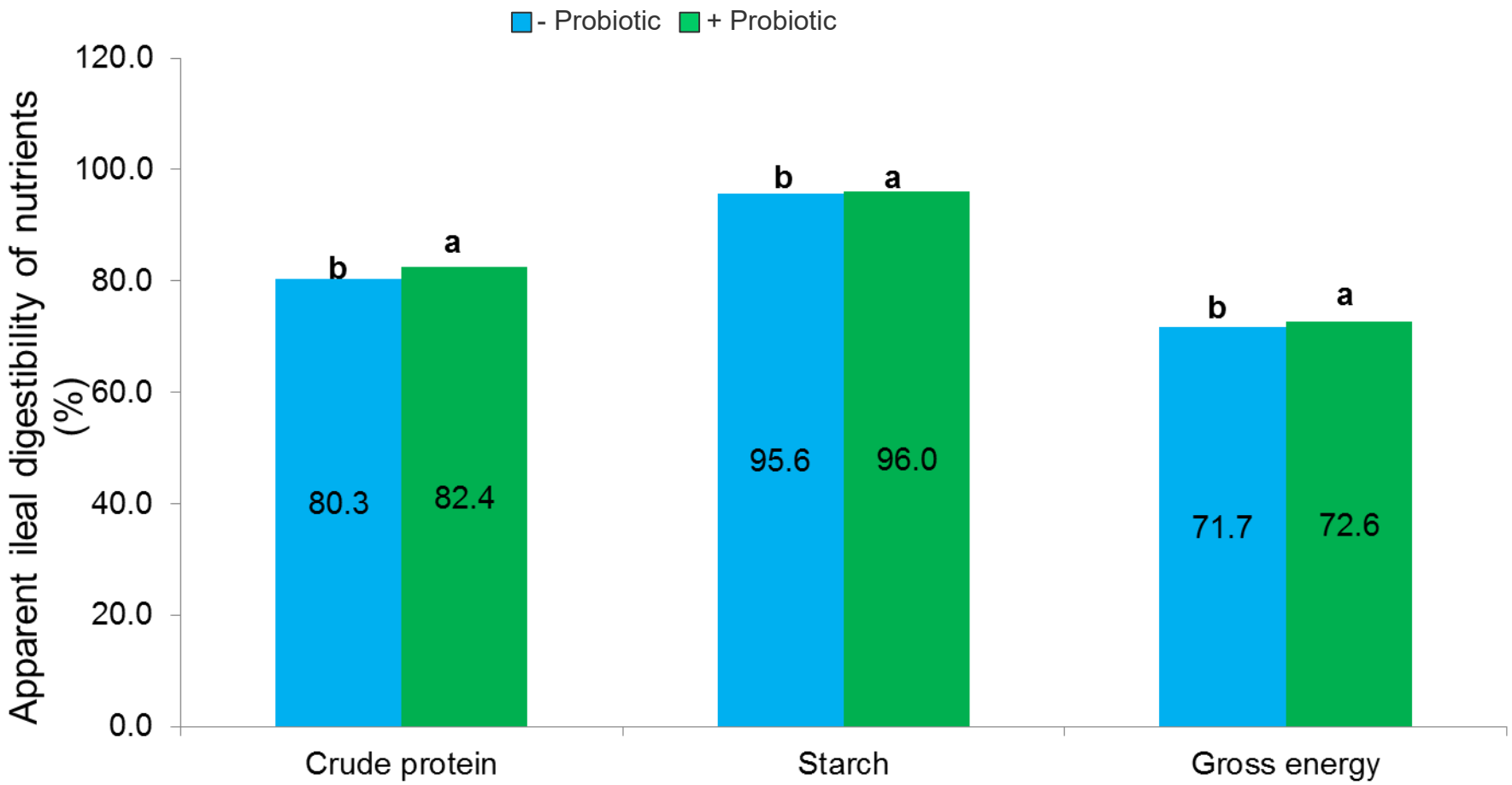
Leistungsdaten bei Gabe eines *Bacillus subtilis*-Probiotikums bei Broilern



P ≤ 0,05

Goodarzi Boroojeni et al. 2018

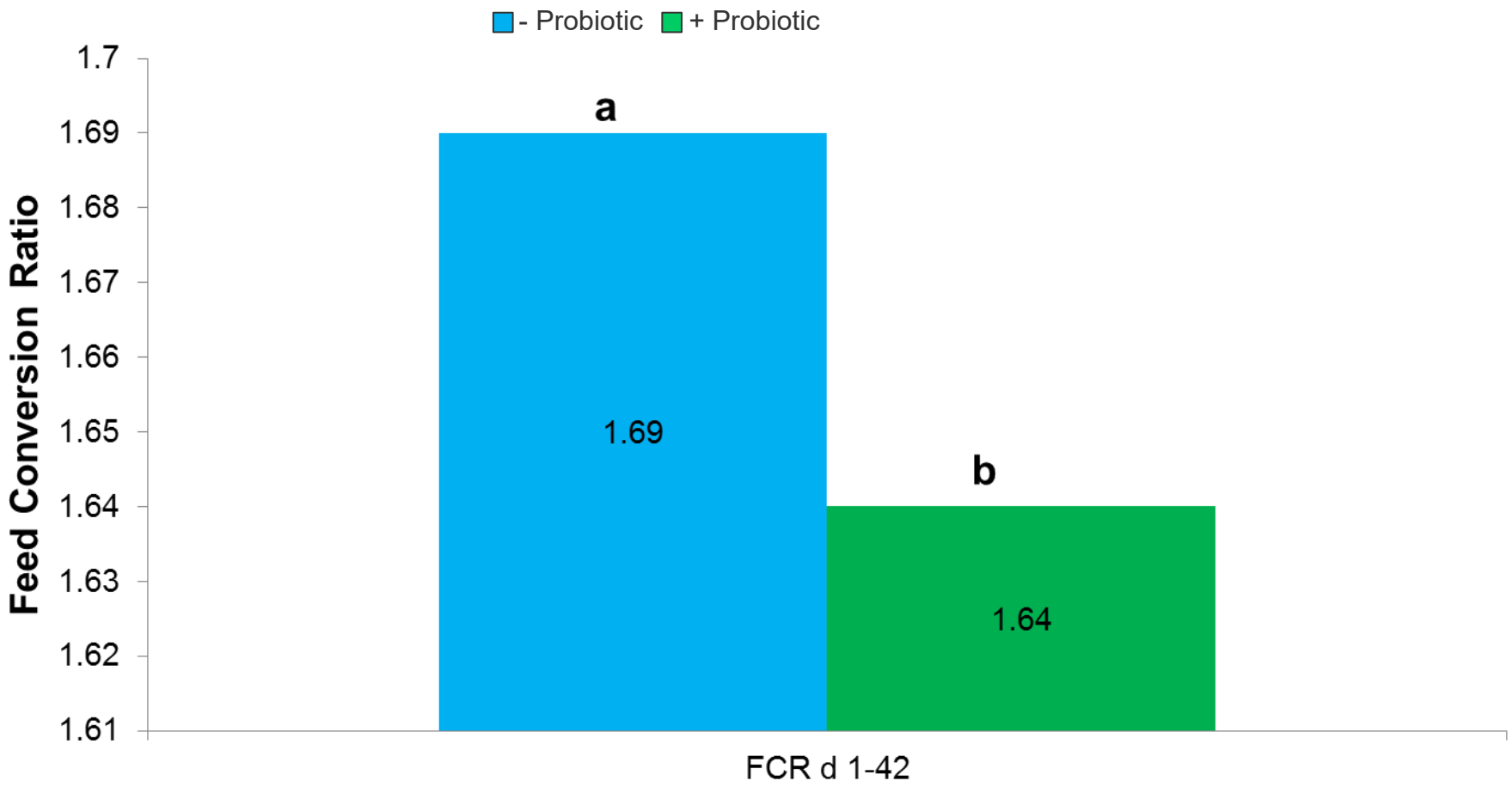
Bacillus subtilis und scheinbare präzäkale Nährstoffverdaulichkeit von Broilern



P ≤ 0,05

Goodarzi Boroojeni et al. 2018

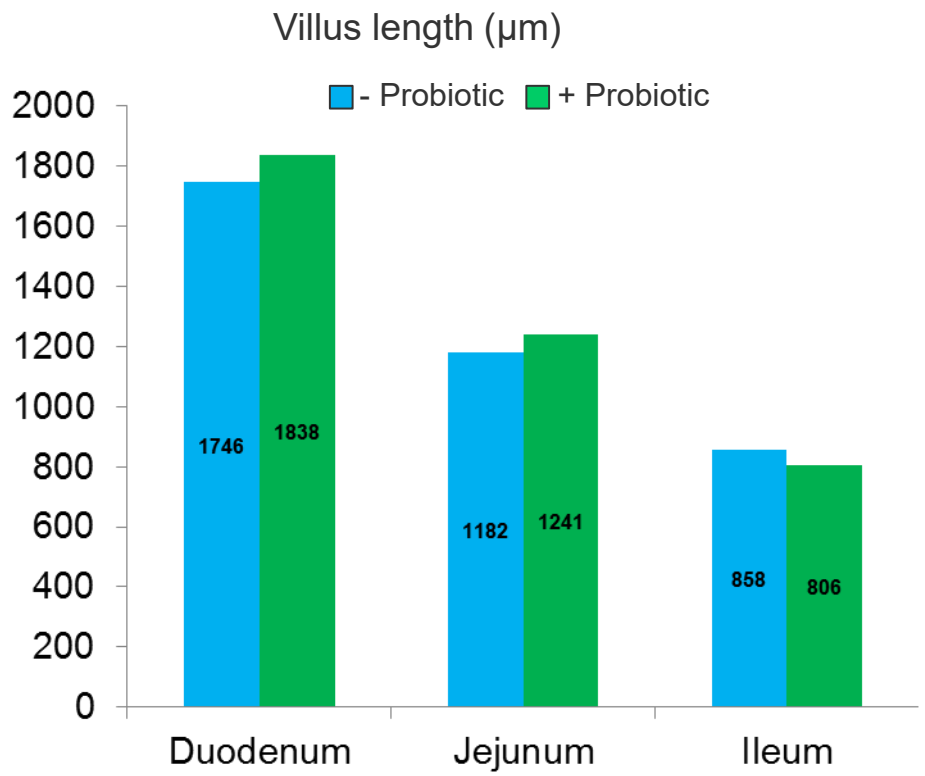
Futteraufwand bei Gabe eines *Bacillus subtilis*-Probiotikums bei Broilern

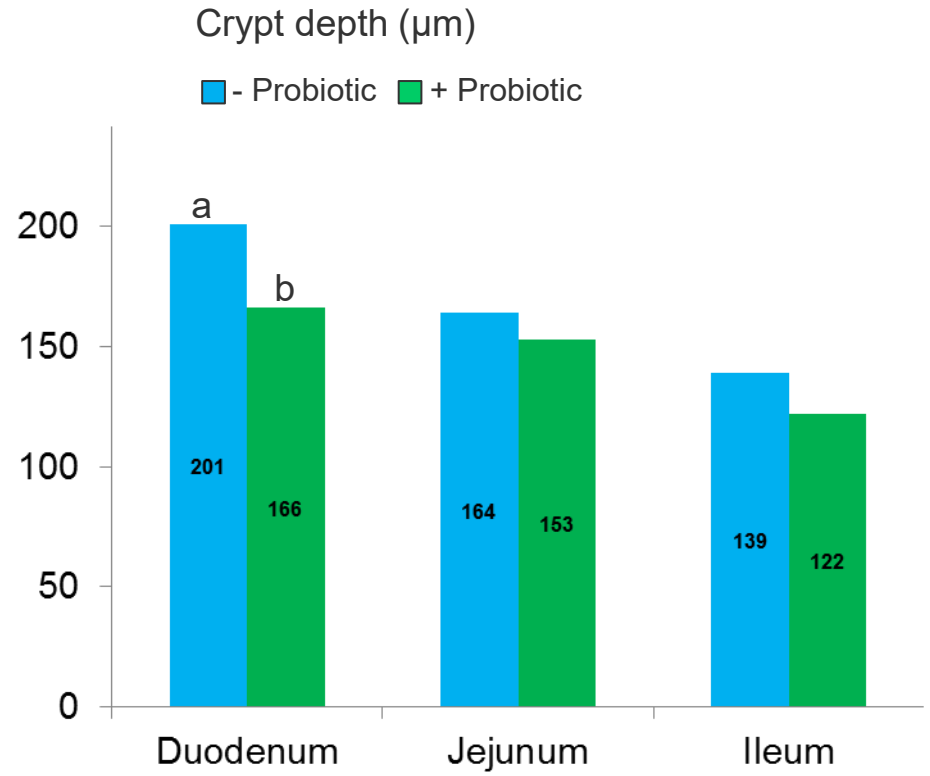


P ≤ 0,05

Goodarzi Boroojeni et al. 2018

Histomorphologische Veränderungen bei Broilern, die mit Standardfutter mit und ohne *B. subtilis* gefüttert wurden





P ≤ 0,05

Goodarzi Boroojeni et al. 2018

https://www.pig333.com/tags/diarrhoea/page_2

Einsatz von Probiotika mit dem Ziel der Verbesserung der Tiergesundheit

- Effekte von Probiotika und Diarrhöeprophylaxe bei Ferkeln

Proceedings of the Nutrition Society (2007), **66**, 260–268 DOI:10.1017/S0029665107005484

Nutritional management of gut health in pigs around weaning

Jean-Paul Lallès[1]*, Paolo Bosi[2], Hauke Smidt[3] and Chris R. Stokes[4]
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[2]*Diproval, University of Bologna, Reggio Emilia, Italy*
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Early weaning of piglets is often accompanied by a severe growth check and diarrhoea. It is well established that this process is multi-factorial and that post-weaning anorexia and under-nutrition are major aetiological factors. Gastrointestinal disturbances include alterations in small intestine architecture and enzyme activities. Recent data indicate transiently-increased mucosal permeability, disturbed absorptive–secretory electrolyte balance and altered local inflammatory cytokine patterns after weaning. These responses appear to operate according to two distinct temporal patterns, an acute response followed by a long-lasting adaptation response. Pigs coexist with a diverse and dense commensal microbiota in their gastrointestinal tract. Most of these microbes are beneficial, providing necessary nutrients or protection against harmful pathogens for the host. The microbial colonisation of the porcine intestine begins at birth and follows a rapid succession during the neonatal and weaning period. Following the withdrawal of sow's milk the young piglets are highly susceptible to enteric diseases partly as a result of the altered balance between developing beneficial microbiota and the establishment of intestinal bacterial pathogens. The intestinal immune system of the newborn piglet is poorly developed at birth and undergoes a rapid period of expansion and specialisation that is not achieved before early (commercial) weaning. Here, new insights on the interactions between feed components, the commensal microbiota and the physiology and immunology of the host gastrointestinal tract are highlighted, and some novel dietary strategies are outlined that are focused on improving gut health. Prebiotics and probiotics are clear nutritional options, while convincing evidence is still lacking for other bioactive substances of vegetable origin.

Pig: Weaning: Diet: Intestine

Journal of Animal Physiology and Animal Nutrition
DOI: 10.1111/j.1439-0396.2012.01284.x

REVIEW ARTICLE

Gastrointestinal health and function in weaned pigs: a review of feeding strategies to control post-weaning diarrhoea without using in-feed antimicrobial compounds

J. M. Heo[1,2,*], F. O. Opapeju[1,*], J. R. Pluske[2], J. C. Kim[3], D. J. Hampson[2] and C. M. Nyachoti[1]

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2 Animal Research Institute, School of Veterinary and Biomedical Sciences, Murdoch University, Murdoch, WA, Australia, and
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Keywords
Antimicrobial growth promoters, pigs, dietary protein level, dietary protein source, organic acids, prebiotics, probiotics, post-weaning diarrhoea, trace minerals

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accepted: 23 January 2012

Summary

For the last several decades, antimicrobial compounds have been used to promote piglet growth at weaning through the prevention of subclinical and clinical disease. There are, however, increasing concerns in relation to the development of antibiotic-resistant bacterial strains and the potential of these and associated resistance genes to impact on human health. As a consequence, European Union (EU) banned the use of antibiotics as growth promoters in swine and livestock production on 1 January 2006. Furthermore, minerals such as zinc (Zn) and copper (Cu) are not feasible alternatives/replacements to antibiotics because their excretion is a possible threat to the environment. Consequently, there is a need to develop feeding programs to serve as a means for controlling problems associated with the weaning transition without using antimicrobial compounds. This review, therefore, is focused on some of nutritional strategies that are known to improve structure and function of gastrointestinal tract and (or) promote post-weaning growth with special emphasis on probiotics, prebiotics, organic acids, trace minerals and dietary protein source and level.

frontiers in Microbiology
REVIEW
published: 07 February 2022
doi: 10.3389/fmicb.2022.801827

Bacillus spp. Probiotic Strains as a Potential Tool for Limiting the Use of Antibiotics, and Improving the Growth and Health of Pigs and Chickens

Diana Luise[1], Paolo Bosi[1], Lena Raff[2], Laura Amatucci[1], Sara Virdis[1] and Paolo Trevisi[1]*

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The pressure to increasingly optimize the breeding of livestock monogastric animals resulted in antimicrobials often being misused in an attempt to improve growth performance and counteract diseases in these animals, leading to an increase in the problem of antibiotic resistance. To tackle this problem, the use of probiotics, also known as direct in-feed microbials (DFM), seems to be one of the most promising strategies. Among probiotics, the interest in *Bacillus* strains has been intensively increased in recent decades in pigs and poultry. The aim of the present review was to evaluate the effectiveness of *Bacillus* strains as probiotics and as a potential strategy for reducing the misuse of antibiotics in monogastric animals. Thus, the potential modes of action, and the effects on the performance and health of pigs (weaning pigs, lactation and gestation sows) and broilers are discussed. These searches yielded 131 articles (published before January 2021). The present review showed that *Bacillus* strains could favor growth in terms of the average daily gain (ADG) of post-weaning piglets and broilers, and reduce the incidence of post-weaning diarrhea in pigs by 30% and mortality in broilers by 6–8%. The benefits of *Bacillus* strains on these parameters showed results comparable to the benefit obtained by the use of antibiotics. Furthermore, the use of *Bacillus* strains gives promising results in enhancing the local adaptative immune response and in reducing the oxidative stress of broilers. Fewer data were available regarding the effect on sows. Discordant effects have been reported regarding the effect on body weight (BW) and feed intake while a number of studies have supported the hypothesis that feeding probiotics to sows could benefit their reproductive performance, namely the BW and ADG of the litters. Taken all the above-mentioned facts together, this review confirmed the effectiveness of *Bacillus* strains as probiotics in young pigs and broilers, favoring their health and contributing to a reduction in the misuse of direct in-feed antibiotics. The continuous development and research regarding probiotics will support a decrease in the misuse of antibiotics in livestock production in order to endorse a more sustainable rearing system in the near future.

Keywords: antibiotics, *Bacillus*, gut health, pig, probiotics, broiler

2007 2012 2022

Mikrobiota

animals

MDPI

Article

Effect of Feed Additives as Alternatives to In-feed Antimicrobials on Production Performance and Intestinal *Clostridium perfringens* Counts in Broiler Chickens

Silje Granstad [1,*], Anja B. Kristoffersen [1], Sylvie L. Benestad [1], Siri K. Sjurseth [1], Bruce David [2], Line Sørensen [3], Arnulf Fjermedal [4], Dag H. Edvardsen [5], Gorm Sanson [3], Atle Løvland [2] and Magne Kaldhusdal [1]

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2 Nortura SA, P.O. Box 360 Økern, 0513 Oslo, Norway; robert.bruce.david@nortura.no (B.D.); atle.lovland@nortura.no (A.L.)
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4 Fiskå Mølle AS, Fiskåvegen 1010, 4120 Tau, Norway; arnulf.fjermedal@fiska.no
5 Norgesfôr AS, Torggata 10, 0181 Oslo, Norway; dag.henning.edvardsen@norgesfor.no
* Correspondence: silje.granstad@vetinst.no

Figure 1: Score = 1

Figure 2: Score = 2

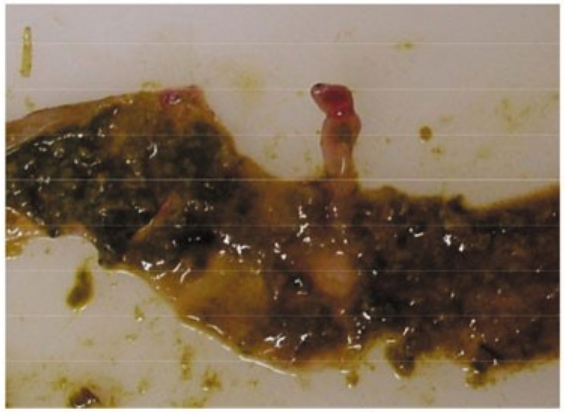


Figure 3: Score = 3

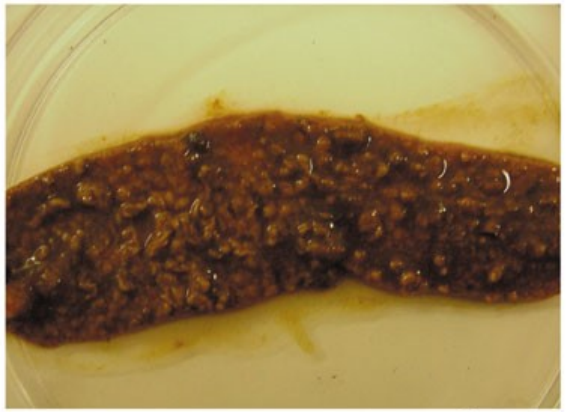


Figure 4: Score = 4

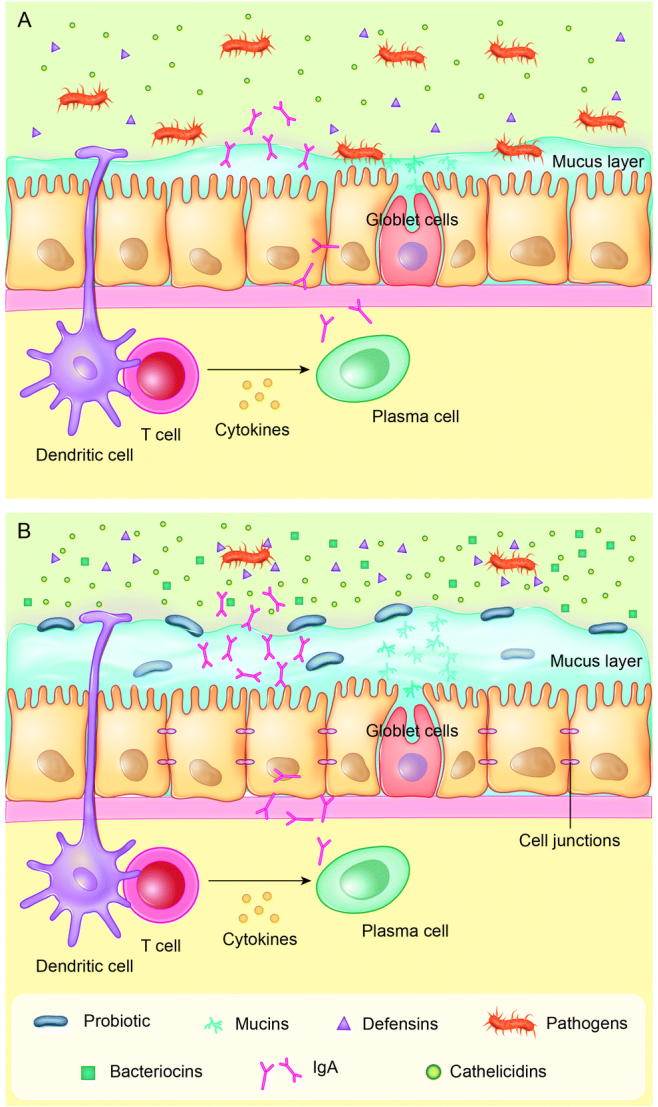
Animals 2020, 10(2), 240; https://doi.org/10.3390/ani10020240

http://www.poultryhub.org/wp-content/uploads/2012/06/Necrotic-enteritis-lesions.jpg

Wirkungsweise von Probiotika

- Schutzmechanismen von Probiotika gegen bakterielle Infektionen des Darms:

  - Mucin-Produktion
  - Antimikrobielle Peptide
  - Barrierefunktion
  - IgA-Freisetzung
  - Hemmung des Pathogenwachstums



Santos do Carmo et al. 2018

- Ausgewogene mikrobielle Besiedlung

  - „Eubiose“ (Haenel 1960)
    - Unterstützt den Wirtsorganismus
    - Fermentation unverdaulicher Futterinhaltsstoffe

Sitzung vom 24. November 1959

Vorsitz: Prof. Dr. K. Lohmann.

HAENEL, H. (Potsdam-Rehbrücke): **Makroorganismus und Mikrobiocönose.** Der Stoffwechsel des Makroorganismus kann nicht isoliert betrachtet werden, er steht in ständigen Wechselbeziehungen zu mikroorganismischen Lebensvorgängen. Sie gehen von den Mikrobiocönosen, den mikroskopischen Lebensgemeinschaften der verschiedenen Organe, besonders des Darmes aus. — Es wird über Versuche berichtet, diese Mikrobiocönosen des menschlichen und tierischen Körpers durch selektive Kulturverfahren in einzelne Keimgruppen quantitativ aufzugliedern, Gesetzmäßigkeiten in der Zusammensetzung festzustellen und die Grenzen der „normalen“ Zusammensetzung — als Eubiose bezeichnet — von der „gestörten“ Zusammensetzung — der Dysbiose — abzugrenzen. — In der Darmflora des Erwachsenen besteht die züchtbare Flora vorwiegend aus anaeroben Lactobacillen und Fäulnisbakterien, konstant begleitet von einer Minderheit anderer Keimarten. Diese Besiedlung ist im ganzen Dickdarm etwa gleich, während die Keimzahlen im Magen und Dünndarm niedriger liegen. Kriterien der Dysbiose sind besonders das Fehlen der anaeroben Lactobacillen unter Zunahme aerober Keime und stärkere Aszension von Dickdarmkeimen in den Dünndarm. Beim

Verhandlungen ärztlicher Gesellschaften 1960

microorganisms

MDPI

Review

Timely Control of Gastrointestinal Eubiosis: A Strategic Pillar of Pig Health

Paolo Trevisi *, Diana Luise, Federico Correa and Paolo Bosi

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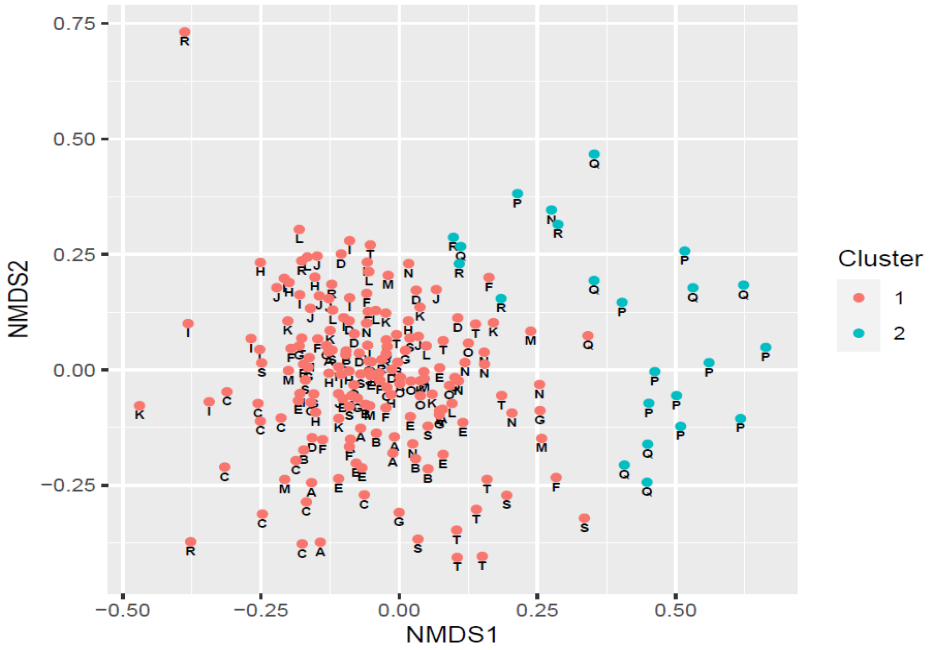
* Correspondence: paolo.trevisi@unibo.it

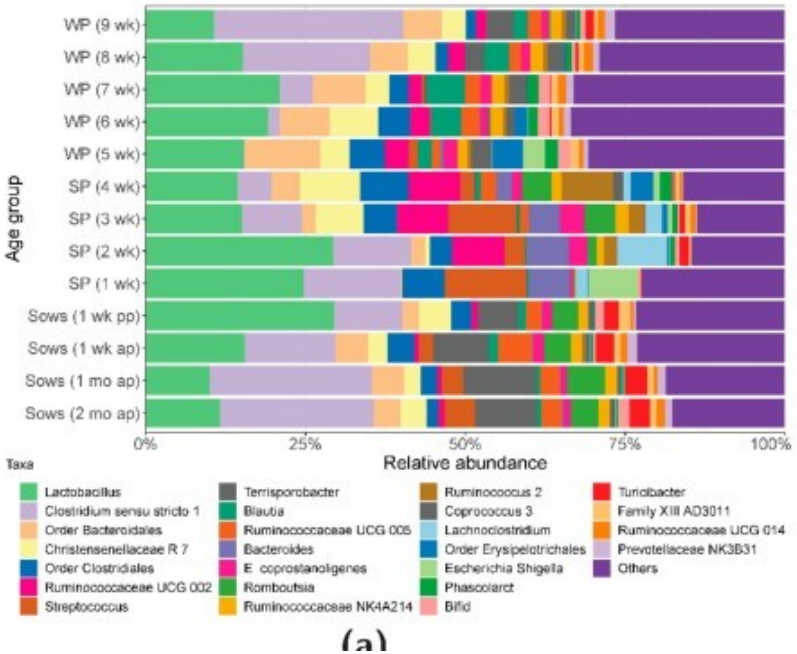
Abstract: The pig gastrointestinal tract (GIT) is an open ecosystem in which microorganisms and their host are mutually involved and continually adapt to different factors and problems which may or may not be host dependent or due to the production system. The aim of the present review is to highlight the factors affecting the GIT microbial balance in young pigs, focusing on the pre- and post-weaning phases, to define a road map for improving pig health and the production efficiency of the food chain. Birth and weaning body weight, physiological maturation, colostrum and milk (composition and intake), genetic background, environmental stressors and management practices, antibiotic use and diet composition are considered. Overall, there is a lack of knowledge regarding the effect that some factors, including weaning age, the use of creep feed, the composition of the colostrum and milk and the use of antibiotics, may have on the gut microbiome of piglets. Furthermore, the information on the gut microbiome of piglets is mainly based on the taxonomy description, while there is a lack of knowledge regarding the functional modification of the microbiota, essential for the exploitation of microbiota potential for modulating pig physiology.

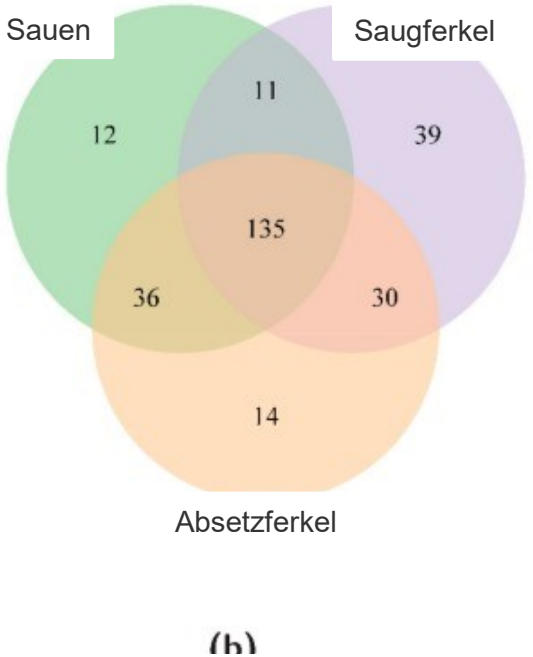
Keywords: weaning transition; gut microbiota; milk; antibiotic; genetics; diet

Citation: Trevisi, P.; Luise, D.; Correa, F.; Bosi, P. Timely Control of

Entwicklung der Mikrobiota und "Prägung"







PLOS ONE

RESEARCH ARTICLE

Characterization of the fecal microbiota of sows and their offspring from German commercial pig farms

Anja Lührmann[1]*, Ksenia Ovadenko[2], Justinus Hellmich[1], Christoph Sudendey[1], Vitaly Belik[2], Jürgen Zentek[1], Wilfried Vahjen[1]

1 Department of Veterinary Medicine, Institute of Animal Nutrition, Freie Universität Berlin, Berlin, Germany, 2 Department of Veterinary Medicine, System Modeling Group, Institute of Veterinary Epidemiology and Biostatistics, Freie Universität Berlin, Berlin, Germany

* anja.luehrmann@fu-berlin.de

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microorganisms

MDPI

Article

Developing Gut Microbiota Exerts Colonisation Resistance to *Clostridium* (syn. *Clostridioides*) *difficile* in Piglets

Łukasz Grześkowiak *, Temesgen Hailemariam Dadi, Jürgen Zentek and Wilfried Vahjen

Institute of Animal Nutrition, Freie Universität Berlin, Königin-Luise Strasse 49, 14195 Berlin, Germany
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Received: 24 May 2019; Accepted: 15 July 2019; Published: 26 July 2019

check for updates

Domestizierung und Fütterung

- Wildschwein → Bifidobakterien ↗
- Domestizierte Schweine oder in Gefangenschaft gehaltene Wildschweine → *Lactobacillus* spp. + *Enterobacteriaceae* ↗
- Domestizierung und Fütterung > Genetik + geografische Faktoren (Ushida et al. 2016)

Animal Science Journal
Animal Science Journal (2016) **87,** 835–841 doi: 10.1111/asj.12492

ORIGINAL ARTICLE

Domestication and cereal feeding developed domestic pig-type intestinal microbiota in animals of suidae

Kazunari USHIDA,[1] Sayaka TSUCHIDA,[1] Yoshitoshi OGURA,[2] Atsushi TOYODA[3] and Fumito MARUYAMA[4]

[1]*Graduate School of Life and Environmental Sciences, Kyoto Prefectural University, Shimogamo,* [2]*Division of Bioenvironmental Science, Frontier Science Research Center, University of Miyazaki, Miyazaki,* [3]*Comparative Genomics Laboratory, National Institute of Genetics, Mishima, and* [4]*Department of Microbiology, Graduate School of Medicine, Kyoto University, Kyoto, Japan*

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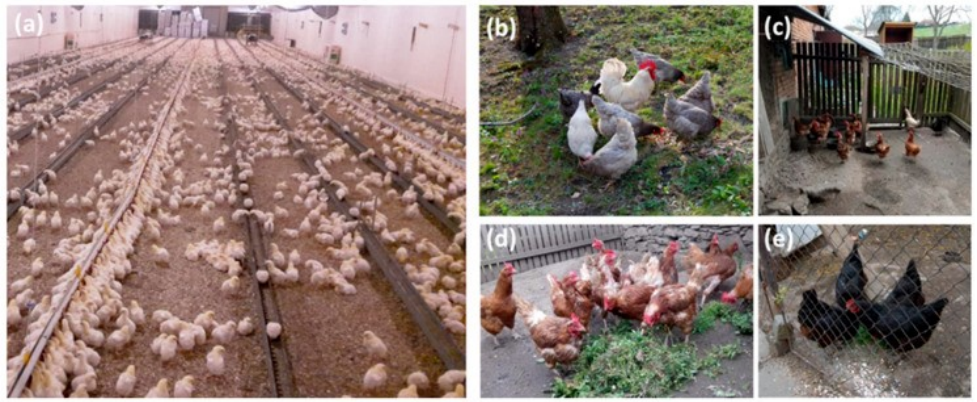

microorganisms

MDPI

Article

Environmental Impact on Differential Composition of Gut Microbiota in Indoor Chickens in Commercial Production and Outdoor, Backyard Chickens

Zuzana Seidlerova, Tereza Kubasova, Marcela Faldynova, Magdalena Crhanova, Daniela Karasova, Vladimir Babak and Ivan Rychlik *

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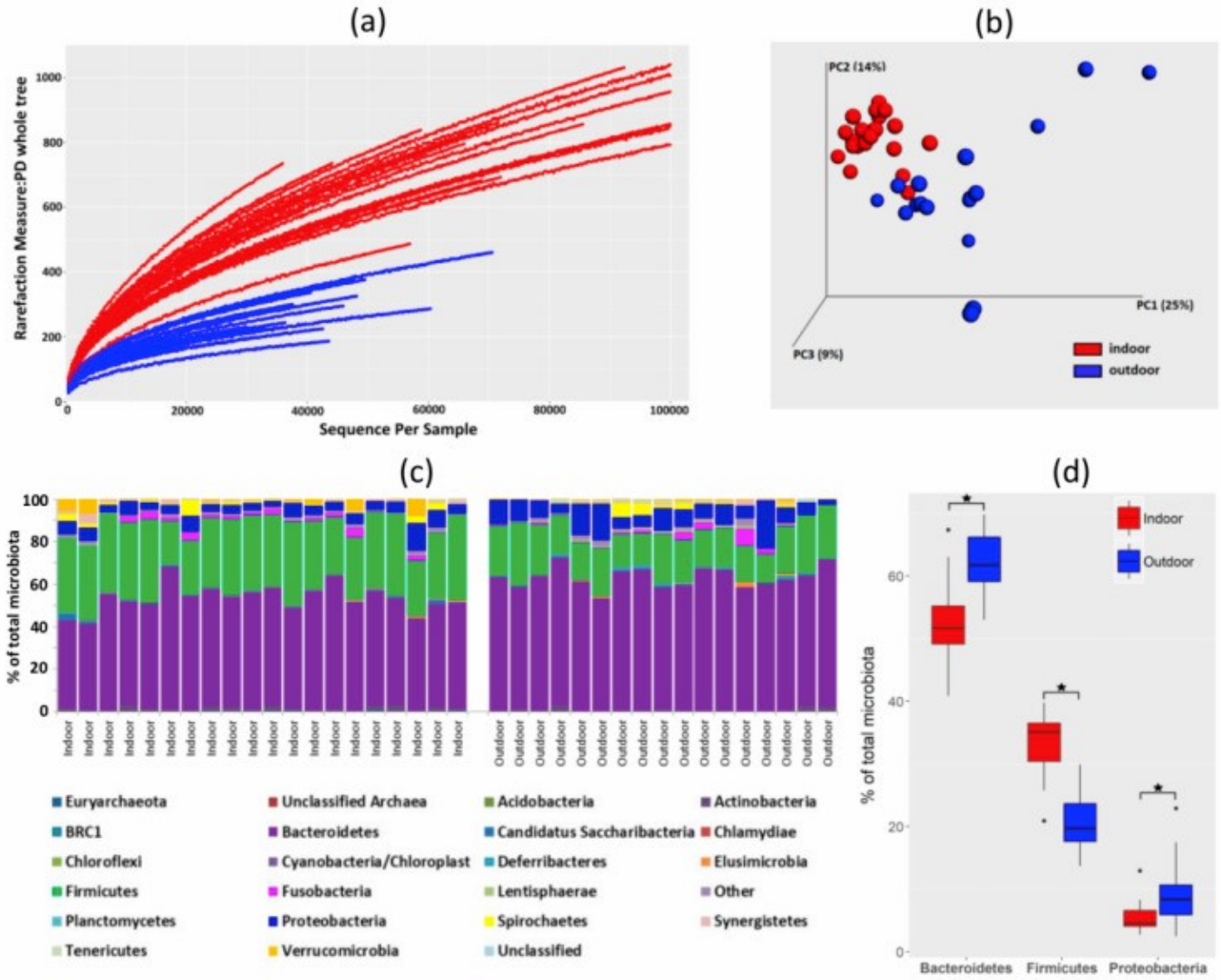

Mikrobiota ist mit Leistung korelierbar

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Beneficial Microbes, December 2013; 4(4): 345-356

Wageningen Academic Publishers

038/nature09944

Individual responses of mother sows to a probiotic *Enterococcus faecium* strain lead to different microbiota composition in their offspring

iome

I.C. Starke, R. Pieper, K. Neumann, J. Zentek and W. Vahjen

Institute of Animal Nutrition, Freie Universität Berlin, Königin-Luise-Str. 49, 14195 Berlin, Germany;
wilfried.vahjen@fu-berlin.de

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Nielsen[8],
Torrents[10,19],
Vos[15,24],

Received: 4 April 2013 / Accepted: 13 July 2013

RESEARCH PAPER

Abstract

Pregnant gilts were fed the probiotic *Enterococcus faecium* NCIMB10415 (SF68) one month before birth of piglets. DNA extracts of sow faeces taken in weekly intervals as well as extracts from the intestine of their offspring during the suckling period at 12 and 26 days of life were analysed by denaturing gradient gel electrophoresis (DGGE) and quantitative PCR. DGGE profiles of faecal bacterial communities from three out of six probiotic-fed sows were distinctly different from the control and other probiotic-fed sows at all time points after probiotic supplementation. The probiotic-fed sows and their offspring were therefore divided into non-responder (n=3) and responder (n=3) groups. The probiotic strain significantly increased faecal lactobacilli cell numbers in mother sows, which could be assigned to a significant increase of *Lactobacillus amylovorus* and *Lactobacillus acidophilus*. Responding sows showed a more pronounced increase than non-responding sows. Similarly, suckling piglets from non-responding and responding sows showed numeric and significant differences for different bacterial groups and species. DGGE profiles of suckling piglets from responding sows also grouped more closely than profiles from control animals. Non-metric multiscaling of suckling piglets showed the same tendency for suckling piglets, but not for post-weaning piglets. This study showed that the probiotic *E. faecium* strain modified the faecal microbiota of sows. This modification is carried over to their offspring, but leads to changes that do not mirror the quantitative composition in the mother sow. Individual variations in the bacterial composition of mother sows before probiotic feed intake may influence the impact of a probiotic in sows and their offspring.

Keywords: probiotics, microbiota, piglets, individuality, DGGE

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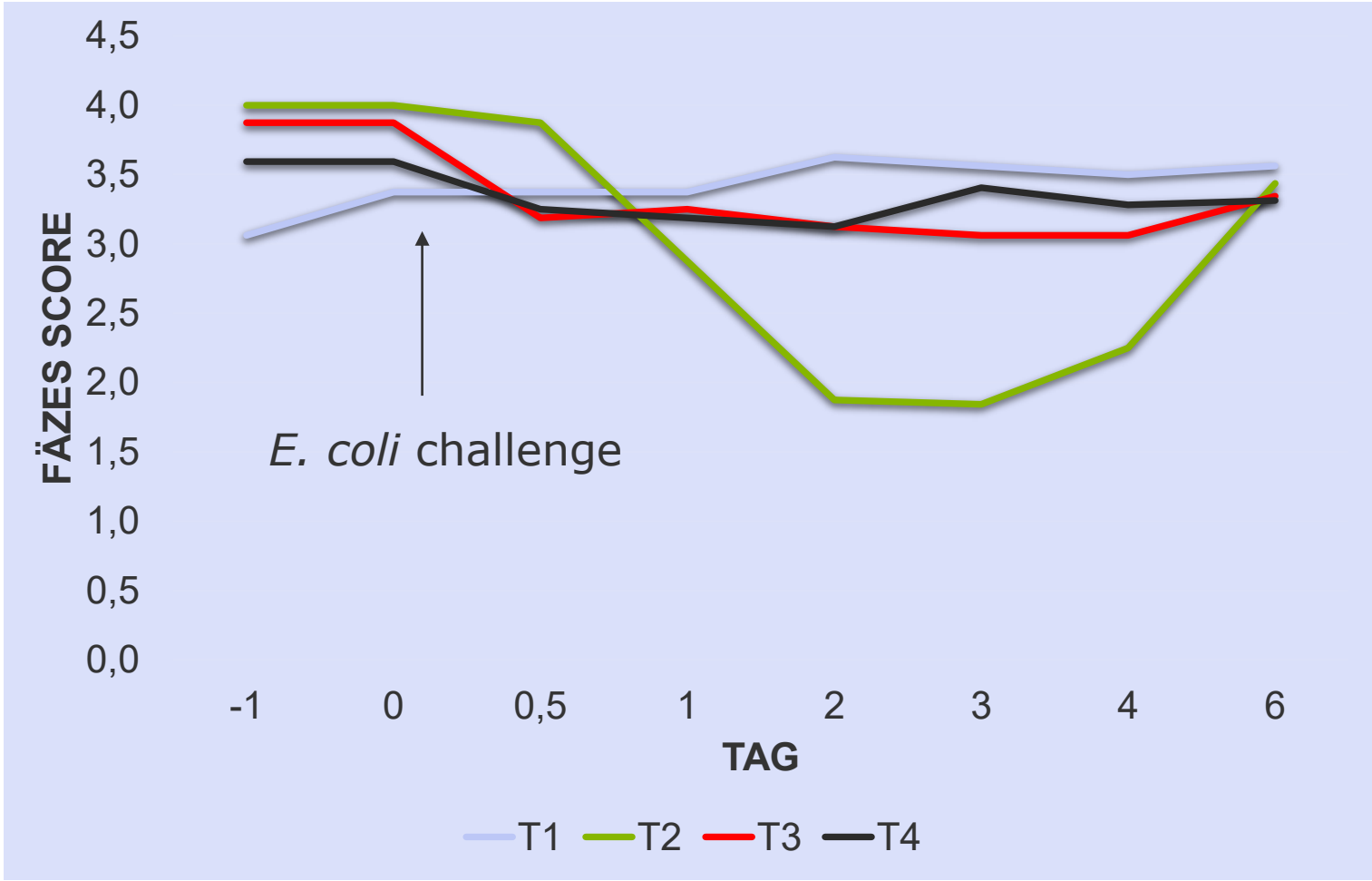
Ramayo-Caldas et al. 2016

Escherichia coli Infektion und Durchfall bei Schweinen

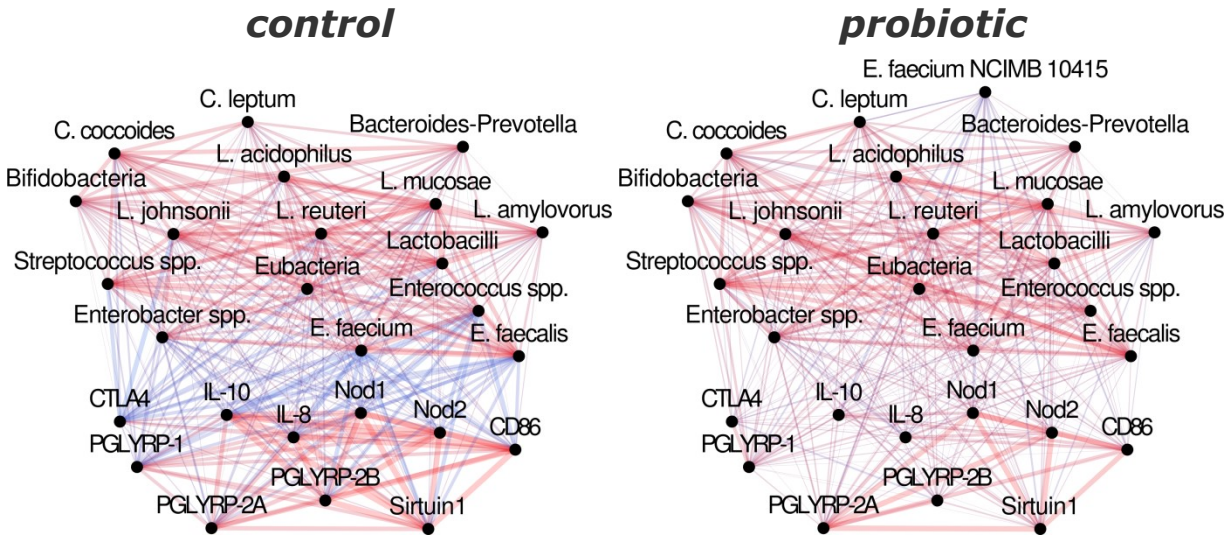


Score 1 = Durchfall; 5 = Harter Kot

Lehre aus vielen Studien mit Probiotika

- Stammspezifität bei der Wirkung

  - Mikrobiota – Immunsystem → deutliche Unterschiede



Association networks

Full Paper www.molinf.com molecular informatics

DOI: 10.1002/minf.201300147

Cross-talk Between Host, Microbiome and Probiotics: A Systems Biology Approach for Analyzing the Effects of Probiotic *Enterococcus faecium* NCIMB 10415 in Piglets

S. O. Twardziok,*[a] R. Pieper,[b] J. R. Aschenbach,[c] C. Bednorz,[d] G. A. Brockmann,[e] M. Fromm,[f] S. Klingspor,[c] S. Kreuzer,[e] U. Lodemann,[c] H. Martens,[c] L. Martin,[b] J. F. Richter,[f, g] L. Scharek-Tedin,[b] B. F. Siepert,[d] I. C. Starke,[b] K. Tedin,[d] W. Vahjen,[b] L. H. Wieler,[d] S. S. Zakrzewski,[f] J. Zentek,[b] and P. Wrede[a]

Abstract: A comprehensive data-set from a multidisciplinary feeding experiment with the probiotic *Enterococcus faecium* was analyzed to elucidate effects of the probiotic on growing piglets. Sixty-two piglets were randomly assigned to a control (no probiotic treatment) and a treatment group (*E. faecium* supplementation). Piglets were weaned at 26 d. Age-matched piglets were sacrificed for the collection of tissue samples at 12, 26, 34 and 54 d. In addition to zootechnical data, the composition and activity of intestinal microbiota, immune cell types, and intestinal responses were determined. Our systems analysis revealed clear effects on several measured variables in 26 and 34 days old animals, while response patterns varied between piglets from different age groups. Correlation analyses identified reduced associations between intestinal microbial communities and immune system reactions in the probiotic group. In conclusion, the developed model is useful for comparative analyses to unravel systems effects of dietary components and their time resolution. The model identified that effects of *E. faecium* supplementation most prominently affected the interplay between intestinal microbiota and the intestinal immune system. These effects, as well as effects in other subsystems, clustered around weaning, which is the age where piglets are most prone to diarrhea.

Keywords: Host · Microbiome · Probiotics · *Enterococcus faecium* NCIMB 10415 · Piglets

Journal of Animal Physiology and Animal Nutrition

DOI: 10.1111/jpn.12666

REVIEW ARTICLE

Review on the effects of potential prebiotics on controlling intestinal enteropathogens *Salmonella* and *Escherichia coli* in pig production

T. H. T. Tran[1,2], N. Everaert[1,2] and J. Bindelle[1,2]

1 Precision Livestock and Nutrition Unit, University of Liege, Gembloux, Belgium, and
2 AgriculturelsLife, TERRA, Gembloux Agro-Bio Tech, University of Liege, Gembloux, Belgium

Prebiotic in *Salmonella* and *E. coli* in pigs

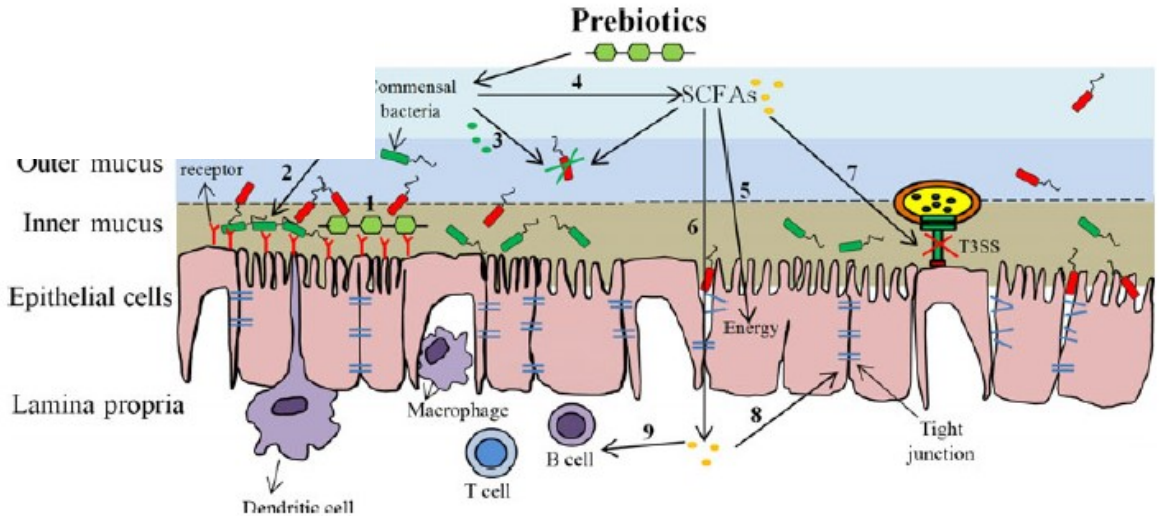
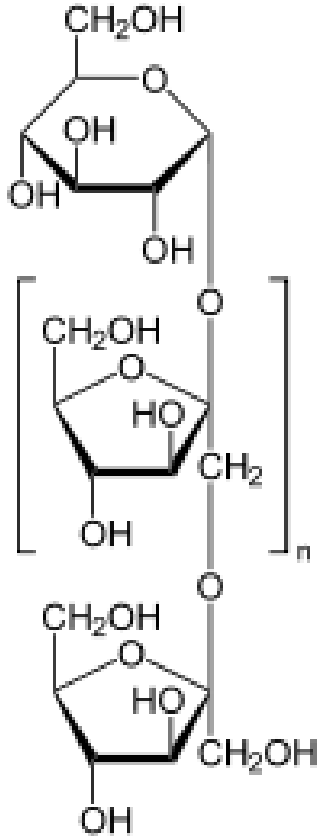


Fig. 2 Schematic representation of the mechanisms of prebiotics against pathogen infection: coating of the host surface receptors by adhesin analogs (1), or by commensal bacterial biofilm formation (2); bacteriocins (3) or short-chain fatty acids (SCFAs) (4) produced by favourable bacteria (3); use of SCFAs as energy source for epithelial cells (5) and metabolic regulation (6); inhibition of the type-III secretion system (T3SS) (7); improvement of tight junction, mucin production (8) or immunomodulation (9) (based on the figures in reviews of Sansonetti (2004) and Kalita et al. (2014)). [Colour figure can be viewed at wileyonlinelibrary.com]

- Inulin
  - Extraktion aus Topinambur, Chicoree oder Artichoke
  - Heterogene Struktur
  - Kettenlänge 3 bis 60

Wikipedia



Präbiotika beim Schwein

Journal of Animal Physiology and Animal Nutrition

DOI: 10.1111/j.1439-0396.2012.01284.x

REVIEW ARTICLE

Gastrointestinal health and function in weaned pigs: a review of feeding strategies to control post-weaning diarrhoea without using in-feed antimicrobial compounds

J. M. Heo[1,2,*], F. O. Opapeju[1,*], J. R. Pluske[2], J. C. Kim[3], D. J. Hampson[2] and C. M. Nyachoti[1]

1 Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada,
2 Animal Research Institute, School of Veterinary and Biomedical Sciences, Murdoch University, Murdoch, WA, Australia, and
3 Animal Research and Development, Department of Agriculture and Food, South Perth, WA, Australia

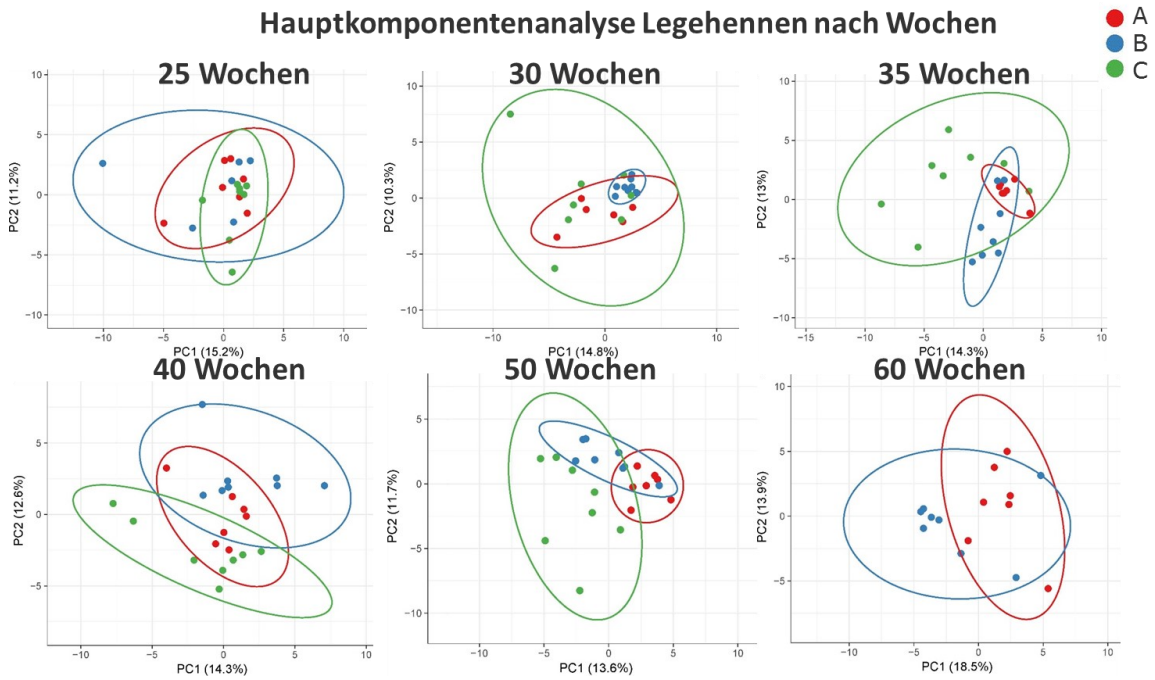
- Etablierung einer stabileren und vielfältigen Mikrobiota
- *Lactobacillus* und *Bifidobacterium* spp. ↑
- Reduzierter Ammoniakgehalt im Dickdarm

- Inulin

  - Mikrobieller Abbau von Inulin ist von seiner Kettenlänge abhängig, kurzfristig wirksam (Paßlack et al. 2012)
  - Positiver Effekt auf Glukosetransport und Darmbarriere (Awad et al. 2013)
  - Kann die gastrointestinale Mikrobiota von Sau und Ferkeln beeinflussen → Bedeutung des Mutter-Ferkel-Paares für die mikrobielle Entwicklung (Paßlack et al. 2015)

- Synbiotika bei Geflügel

  - Microbiota in broiler breeders



Proben
- Zäkuminhalte von drei Broilerelterntierherden (n=30)
- 25. und 50. Lebenswoche

1. Inkubation, anaerob, 37°C, 24 h
- **Pathogene:** *E. coli*, *S.* Enteritidis (10^4,10^5 Zellen/mL)
- **Präbiotika:** Inulin, FOS (2 mg/mL)
- **Probiotika**: *Enterococcus faecium* (DSM 7134), *Bacillus coagulans* (DSM 32016) (10^7 KbE/mL)

Überführung in antibiotikahaltiges Medium
- Clindamycin (250 µg/mL) + Lincomycin (250 µg/ml) in BHI-Medium

→ Selektives Wachstum der Pathogene

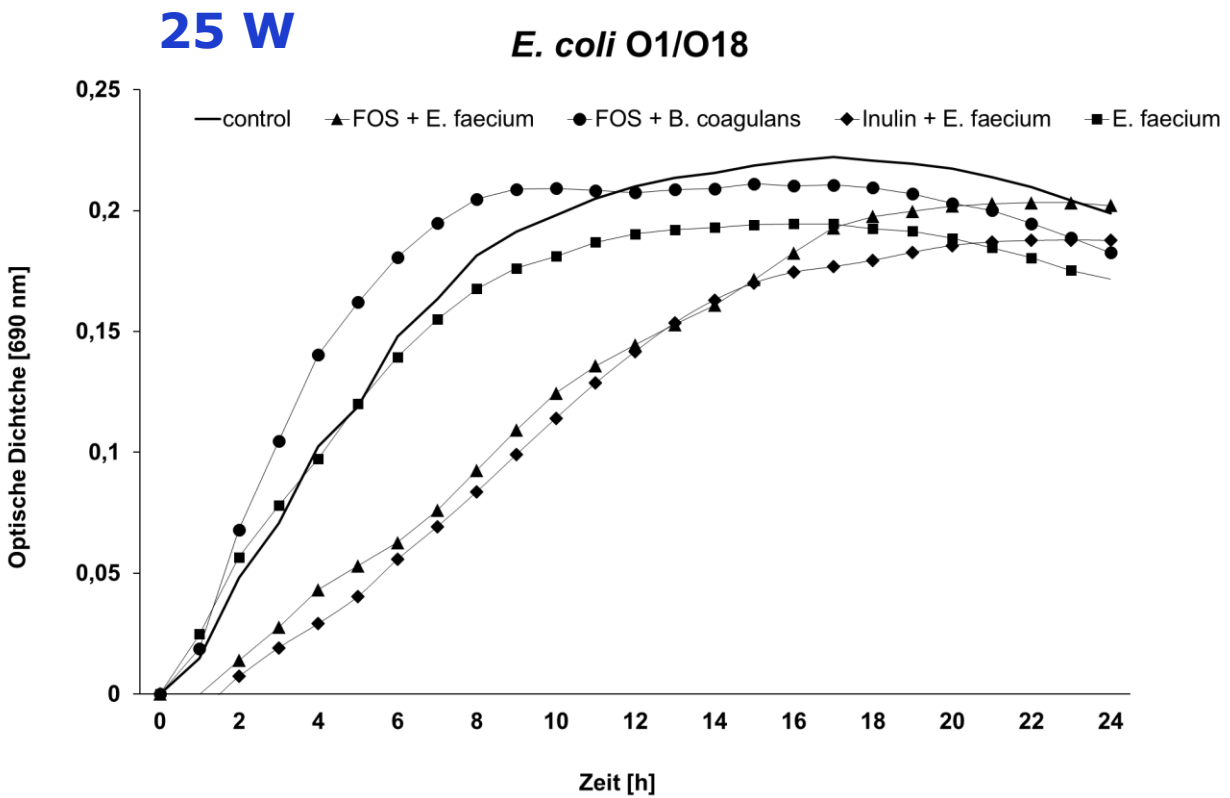
→ Unterdrückung des Wachstums intestinaler Mikrobiota

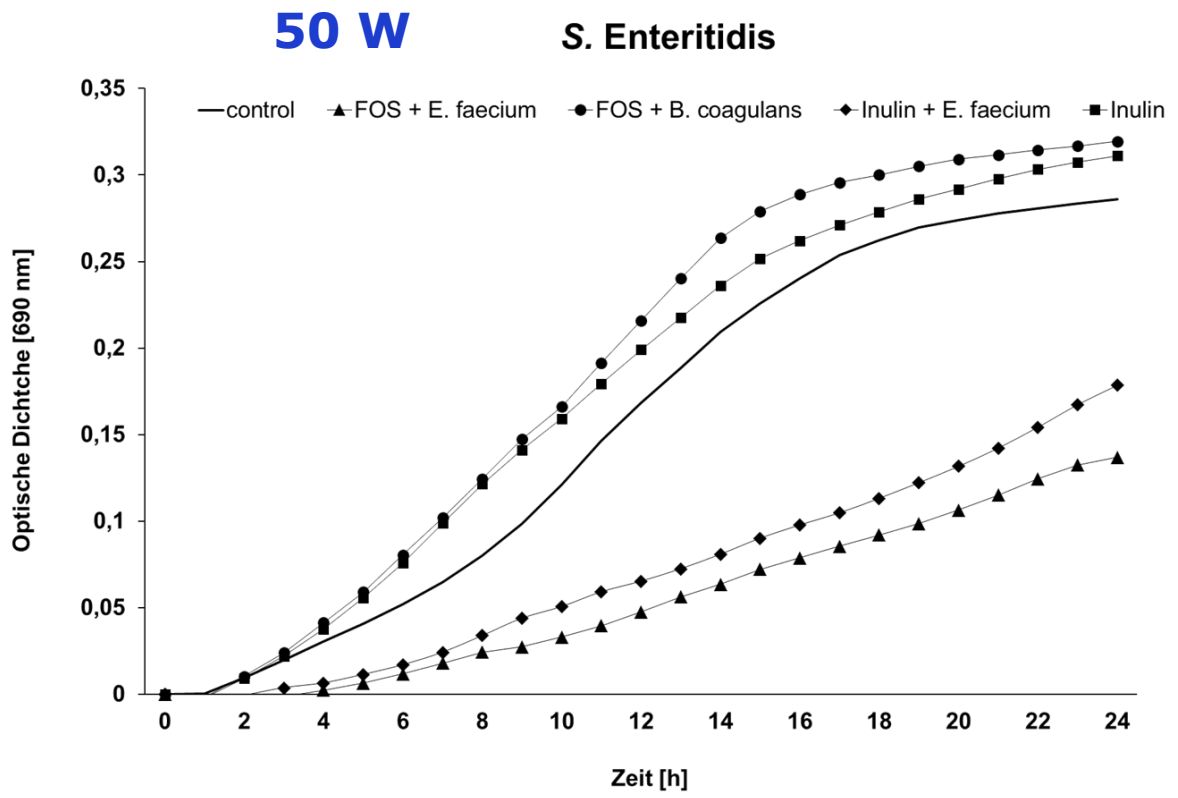
2. Inkubation, anaerob, 37°C, 24 h
- Messung der Trübung (**OD 690 nm**) in einem Mikroplatten-Lesegerät (Infinite®200Pro, Tecan, Schweiz)
- Berechnung von Wachstumskurven der Pathogenen unter Einfluss der verschiedenen Zusätze

→ Lag-Zeiten kennzeichnen den Beginn des exponentiellen Wachstums und dienen als Maß für die Wachstumshemmung

Laura Fuhrmann, 2021, Dissertation

- Synbiotika – Effekte auf *E. coli* O1/O18 und *S.* Enteritidis





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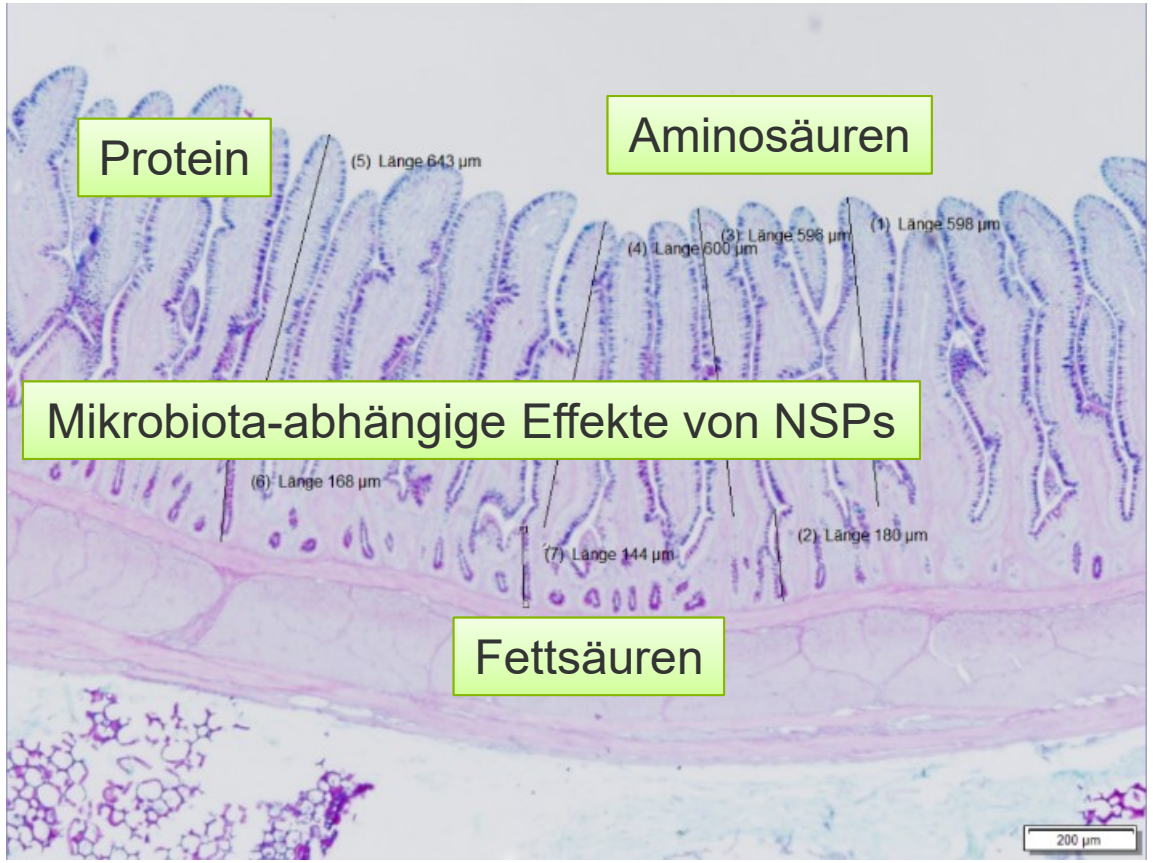
Postbiotika



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frontiers in Immunology

REVIEW
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Development and Functional Properties of Intestinal Mucus Layer in Poultry

*Yada Duangnumsawang[1,2], Jürgen Zentek[1] and Farshad Goodarzi Boroojeni[1]**

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Intestinal mucus plays important roles in protecting the epithelial surfaces against pathogens, supporting the colonization with commensal bacteria, maintaining an appropriate environment for digestion, as well as facilitating nutrient transport from the lumen to the underlying epithelium. The mucus layer in the poultry gut is produced and preserved by mucin-secreting goblet cells that rapidly develop and mature after hatch as a response to external stimuli including environmental factors, intestinal microbiota as well as dietary factors. The ontogenetic development of goblet cells affects the mucin composition and secretion, causing an alteration in the physicochemical properties of the mucus layer. The intestinal mucus prevents the invasion of pathogens to the epithelium by its antibacterial properties (e.g. β-defensin, lysozyme, avidin and IgA) and creates a physical barrier with the ability to protect the epithelium from pathogens. Mucosal barrier is the first line of innate defense in the gastrointestinal tract. This barrier has a selective permeability that allows small particles and nutrients passing through. The structural components and functional properties of mucins have been reviewed extensively in humans and rodents, but it seems to be neglected in poultry. This review discusses the impact of age on development of goblet cells and their mucus production with relevance for the functional characteristics of mucus layer and its protective mechanism in the chicken's intestine. Dietary factors directly and indirectly (through modification of the gut bacteria and their metabolic activities) affect goblet cell proliferation and differentiation and can be used to manipulate mucosal integrity and dynamic. However, the mode of action and mechanisms behind these effects need to be studied further. As mucins resist to digestion processes, the sloughed mucins can be utilized by bacteria in the lower part of the gut and are considered as endogenous loss of protein and energy to animal. Hydrothermal processing of poultry feed may reduce this loss by reduction in mucus shedding into the lumen. Given the significance of this loss and the lack of precise data, this matter needs to be carefully investigated in the future and the nutritional strategies reducing this loss have to be defined better.

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Postbiotika

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Lythrum salicaria L. herb and gut microbiota of healthy post-weaning piglets. Focus on prebiotic properties and formation of postbiotic metabolites in *ex vivo* cultures.

Temesgen H. Dadi[a], Wilfried Vahjen[a], Jürgen Zentek[a], Matthias F. Melzig[b], Sebastian Granica[c], Jakub P. Piwowarski[a,b,c,*]

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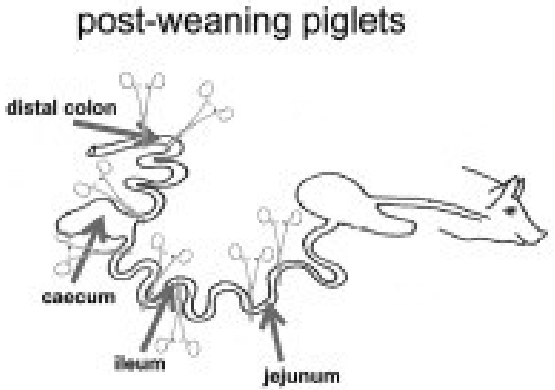
[c] Department of Pharmacognosy and Molecular Basis of Phytotherapy, Medical University of Warsaw, Poland

Lythrum salicaria L.



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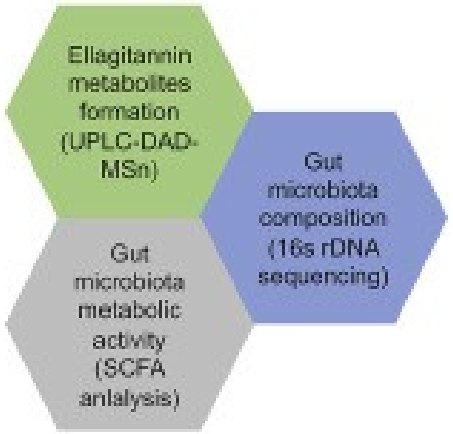

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Article

Lythrum salicaria Ellagitannins Stimulate IPEC-J2 Cells Monolayer Formation and Inhibit Enteropathogenic *Escherichia coli* Growth and Adhesion

Sebastian Granica, Wilfried Vahjen, Jürgen Zentek, Matthias F. Melzig, Karolina A. Pawłowska, and Jakub P. Piwowarski*

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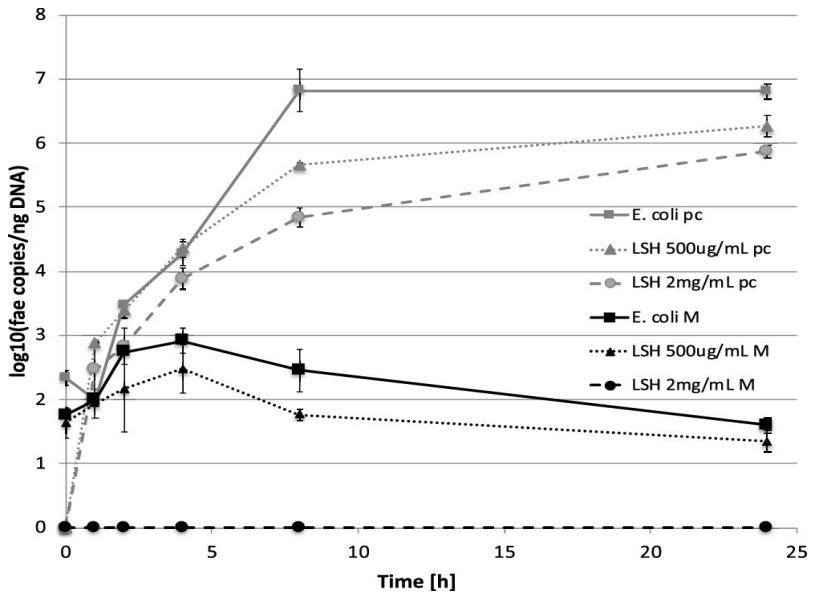

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Review

Types and prevalence of extended–spectrum beta–lactamase producing *Enterobacteriaceae* in poultry

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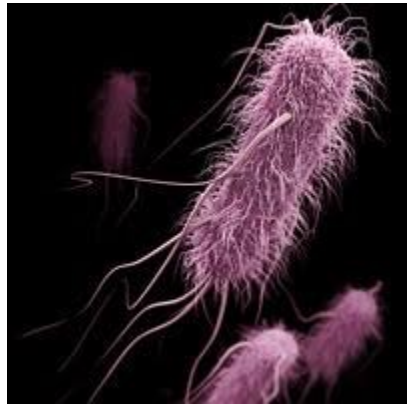
Abstract

For several billion years, bacteria have developed mechanisms to resist antibacterial substances. In modern time, antibiotics are frequently used in veterinary and human medicine for prevention and treatment of diseases, globally still also for their growth promoting effects as feed additives. This complex situation has evolved in accelerating development and prevalence of multi-drug resistant bacteria in livestock and people. Extended-spectrum beta-lactamase (ESBL) producing bacteria are resistant to a wide range of ß-lactam antibiotics. They are currently considered as one of the main threats for the treatment of infections in humans and animals. In livestock and animal products, poultry and poultry products show the highest prevalence of ESBL-producers with CTX-M-1, TEM-52 and SHV-12 being the most common ESBL-types in poultry. *Escherichia coli* and *Salmonella* spp. are the bacteria in poultry, which carry ESBL-genes most frequently. ESBL-producing bacteria are present at every level of the poultry production pyramid and can be detected even in the meconium of newly hatched chicks. The environment close to poultry barns shows high prevalence rates of these bacteria and contributes to an ongoing infection pressure with further ESBL-types. Probiotics have been shown to successfully reduce ESBL-producers in chicken, as well as ESBL-gene transfer. Other feed additives, such as zinc and copper, increase the prevalence of ESBL-producing bacteria when fed to animals. To our best knowledge, this is the first publication presenting a comparative overview of the prevalence of ESBL-types using data from different countries. To reduce the hazard for public health from poultry carrying high numbers of ESBL-producers, preventive measurements must include the surrounding environment and avoidance of antibiotic usage at all levels of the production pyramid. The first results, of the research on the impact of feed additives on the spread of ESBL-genes, indicate the diet as a further, possible magnitude of influence.



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Article

The Impact of Direct-Fed Microbials and Phytogenic Feed Additives on Prevalence and Transfer of Extended-Spectrum Beta-Lactamase Genes in Broiler Chicken

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Article

Synergistic Effects of Probiotics and Phytobiotics on the Intestinal Microbiota in Young Broiler Chicken

Hao Ren *, Wilfried Vahjen, Temesgen Dadi, Eva-Maria Saliu, Farshad Goodarzi Boroojeni and Jürgen Zentek *

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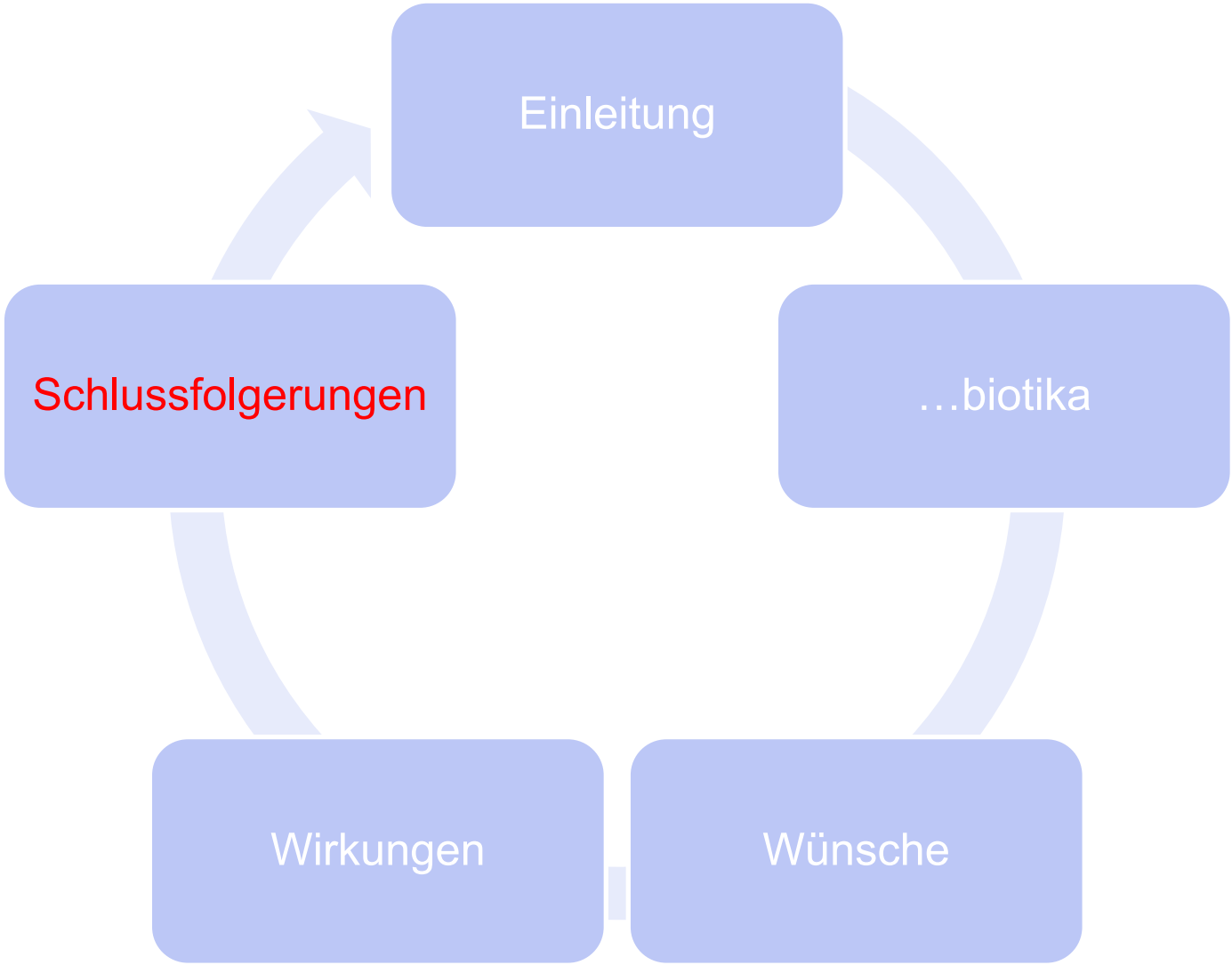
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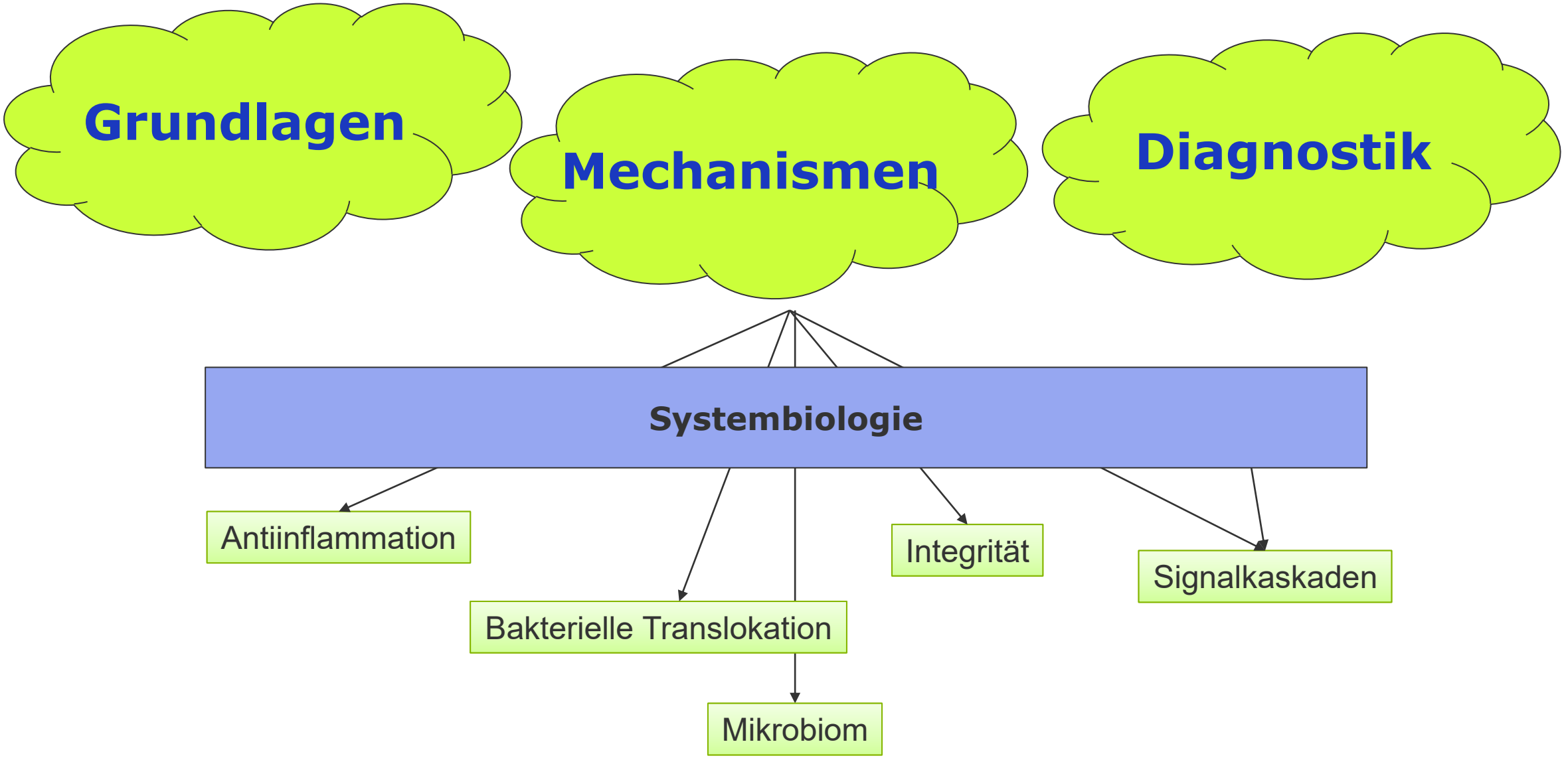
Schlussfolgerungen

Schlussfolgerung



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