付属資料１　論文の分析
（論文数、被引用数、キーワード）

付属資料１　論文の分析（論文数）

（1）調査のアプローチ

- **論文データベースとしてLens.orgを用い、対象期間は2015年1月～2025年9月とし、本調査が対象とする研究領域に該当する論文数を調査した。**

実施手順

1．検索クエリ設計	- 対象研究領域に対して、25の検索クエリを策定。
2．初期データセット作成	- Lens.org（https://www.lens.org/）に検索クエリを入力し、初期的なデータセットを作成（検索期間は2015年1月～2025年9月）。
3．AIによる整合性判断	- 本プロジェクトの制約条件や、検索クエリの設計意図をAIに入力し、初期データセットの各論文に対して、その対象項目との整合性をAIが判断。
4．人間によるデータセット最終化	- AIの判断を人間がサンプルチェックし、その対象項目に含まれるべき論文を最終化（データセット最終化）。
5-1.国別年次別の定量分析（付属資料１ 論文の分析（論文数））	- 最終化されたデータセットの書誌情報（出版年、著者所属機関の国名）を用いて、国別・年次別の論文数を分析。
5-2.被引用数Top10%の定量分析（付属資料１ 論文の分析（被引用数））	- 最終化されたデータセットから、年毎の被引用数Top10%の論文（整数カウント法, 境界同率は全件含む）を抽出。その被引用数Top10%の論文データセットにおいて、国別の論文数を分析。
5-3.キーワードの定量分析（付属資料１ 論文の分析（キーワード））	- 最終化されたデータセットの書誌情報（キーワードタグ）を用いて、国別（中国とそれ以外）・年次別・キーワード別の論文数を分析

（１）調査のアプローチ

（補足１）Lens.orgについて

- **Journal Articleを約1.4億件収録するデータベース**

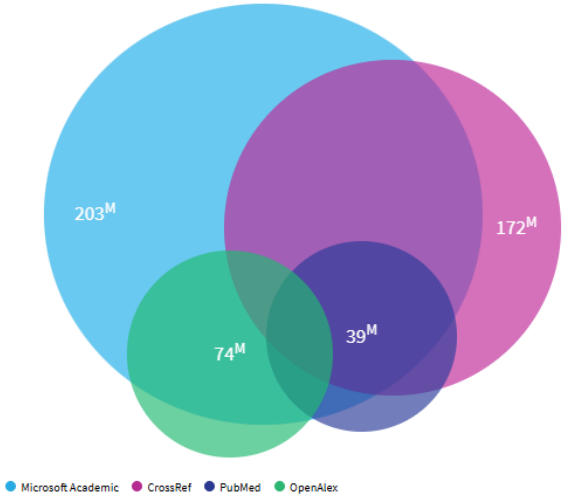
参考比較）Scopus（Elsevier）：9,060万件の文献[1]

参考比較）Web of Science Core Collection（Clarivate）：9700万件の文献[2]

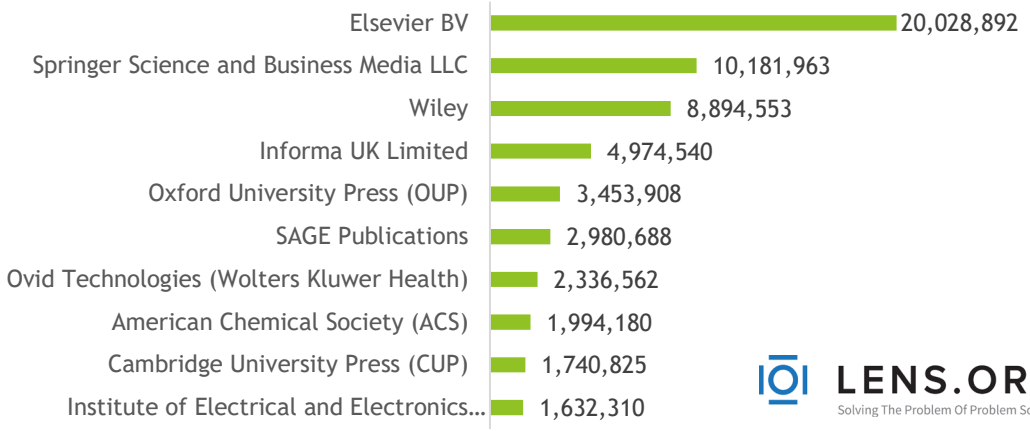
Lens.org概要

Lens.orgは世界的な非営利の社会的企業であるCambia（https://cambia.org/）が運営するオープンプラットフォーム（https://www.lens.org/）

書誌情報の主要なデータソース



主要な収録出版社（収録数Top10）（数値はJournal Article）



[1] https://view.highspot.com/viewer/6551e65b86380b4ef0fb87f9
[2] https://clarivate.com/academia-government/scientific-and-academic-research/research-discovery-and-referencing/web-of-science/web-of-science-core-collection/

（1）調査のアプローチ

（補足２）検索クエリ設計｜25の検索対象について

- ノイズは後工程で省かれることを念頭に、広めに25の検査クエリを設計※１

検索対象

1．微生物を活用した農林水産業の生産性向上に資する技術開発		
（1）肥料・農薬・バイオスティミュラントの生産技術開発		
#1	微生物肥料	バイオファーティライザーや肥料成分に関与する微生物・微細藻類
#2	微生物農薬	バイオペスティサイドや生物防除に関与する微生物・微細藻類
#3	バイオスティミュラント	栄養利用率や非生物的ストレス耐性、品質特性に好影響を及ぼす微生物・微細藻類
#4	人工土壌	人工土壌の創製に関与する微生物・微細藻類
（2）（2－1）畜産｜飼料・餌料等（添加物含む）の生産技術開発		
#5	発酵飼料	発酵処理、発酵エコフィード、サイレージ発酵における微生物・微細藻類
#6	SCP/微生物たんぱく質	Single cell Proteinや微生物たんぱく質
#7	xx-biotics	プロバイオティクスやポストバイオティクス、飼料添加物、AGP代替物における微生物・微細藻類
#8	必須アミノ酸等のバイオ生産	必須栄養素（アミノ酸等）や酵素剤の生産に関わる微生物・微細藻類
#9	糞尿処理	糞尿の堆肥化やバイオガス化、臭気対策に関わる微生物・微細藻類
（2）（2－2）水産｜飼料・餌料等（添加物含む）の生産技術開発		
#10	発酵飼料	発酵処理、発酵エコフィード、サイレージ発酵における微生物・微細藻類
#11	SCP/微生物たんぱく質	Single cell Proteinや微生物たんぱく質（魚粉代替）
#12	xx-biotics	プロバイオティクスやポストバイオティクス、飼料添加物、AGP代替物における微生物・微細藻類
#13	SCO/藻油/必須脂肪酸等のバイオ生産	魚油代替としてのSCOや藻油、必須脂肪酸（DHAやEPA）の生産に関与する微生物・微細藻類
#14	水質管理	水質の維持管理、硝化・脱窒に関与する微生物・微細藻類
#15	生物防除	抗菌性を高める生物防除としての微生物・微細藻類
2．微生物を活用した食料生産技術開発（健康に資する食品を含む）		
（1）伝統発酵による高付加価値食料生産技術開発		
#16	発酵食品	発酵食品の品質安定化や風味変化、健康機能の向上に関するバイオ工学等
（2）微生物による食料生産技術開発（伝統発酵以外）		
#17	精密発酵	精密発酵や目的成分の拡張を目指したバイオ工学等
#18	SCP/代替食品	SCPや代替食品（代替肉や代替シーフード等）における微生物・微細藻類
#19	xx-biotics	プロバイオティクスやポストバイオティクス、サプリメントにおける微生物・微細藻類
#20	合成生物学や代謝工学	合成生物学による新たな機能や代謝設計に関する研究
#21	未利用資源活用や大量生産	未利用資源活用における微生物・微細藻類、大量発酵施設やB2B発酵等の産業化に関する研究
3．微生物を産業として活用することに資する研究開発		
#22	有用菌探索	ゲノミクスやシーケンシング、プロファイリング等に関する研究
#23	設計・合成・改変	ゲノムエンジニアリングや合成生物学、株開発等に関する研究
#24	培養・生産・デジタル	バイオ生産や培地、育種、産業化（大量生産やB2Bサービス）、AIやIoT等に関する研究
#25	環境・資源	環境配慮型、CO2削減等に資する研究開発

※１）定量分析のアウトプット自体は、報告書の章立てに沿った形式でアウトプットしている。

（１）調査のアプローチ

（補足３）検索クエリのサンプル※1

- **およその設計思想としては、「代表的な言葉」 OR 「関連語の組み合わせ」としている※2**

※「関連語の組み合わせ」をサポートクエリとして用意することで、「代表的な言葉を使っていないが、同じ目的の研究だと考えられる論文」の抽出も行うことが狙い。
※なお、検索結果に含まれ得るノイズの多くは、実施手順③AIによる整合性判断で弾かれる。

サンプル｜1（1）#1 微生物肥料

メイン

("bio fertilizer"~1 OR biofertilizer OR "bio inoculant"~1 OR bioinoculant OR "bio compost"~1 OR biocompost OR "microbial fertilizer"~1 OR "microbial inoculant"~1 OR "microbial compost"~1 OR "Plant Growth Promoting")
OR

サポート（（肥料成分）×（農業用語）×（微生物用語））

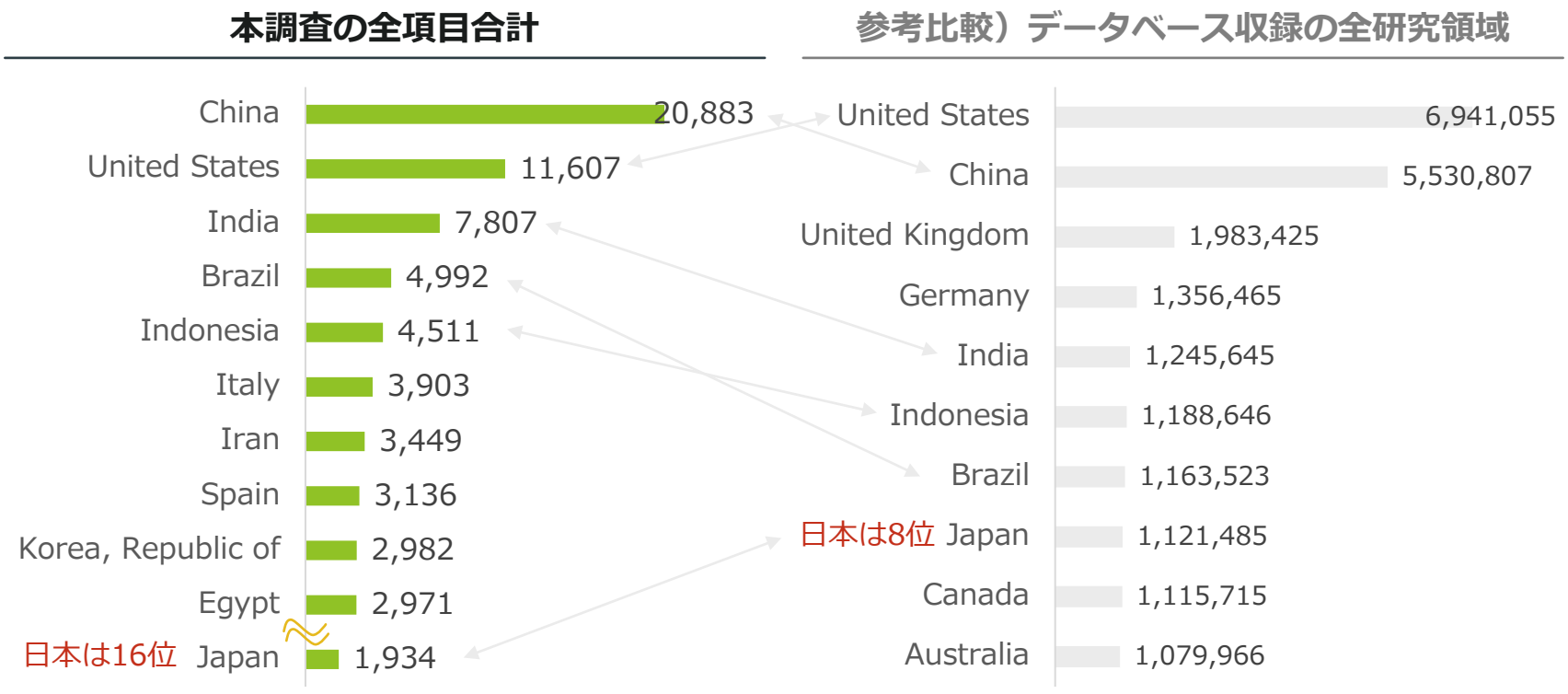
((nitrogen OR nitrogenous OR nitrate OR nitrite OR ammonia OR ammonium OR urea OR phosphate OR phosphoric OR phosphatic OR phosphorus OR phosphite OR potash OR potassium OR potassic OR kalium OR fertilizer OR inoculant OR compost OR NH3 OR NH4 OR NO3 OR NO2 OR PO4 OR P2O5 OR K2O OR KCl OR K2SO4) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

※１）本紙論文パートの末尾に全ての検索クエリを掲載
※２）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

（2）研究領域全体の論文数の動向

- 本調査の対象研究領域の全領域合計かつ対象期間累計（2015年～2025年累計）では、1位が中国、2位が米国であった。なお、全ての研究領域（本調査が対象とする研究領域も含む）においては、1位が米国、2位が中国であった。
- 3位以降は、本調査の特徴が表れており、インドやブラジル、インドネシアといった国が、全研究領域と比較して、本調査では上位に入っている。

Journal Articleの数 Top10＋日本（2015年~2025年累計）



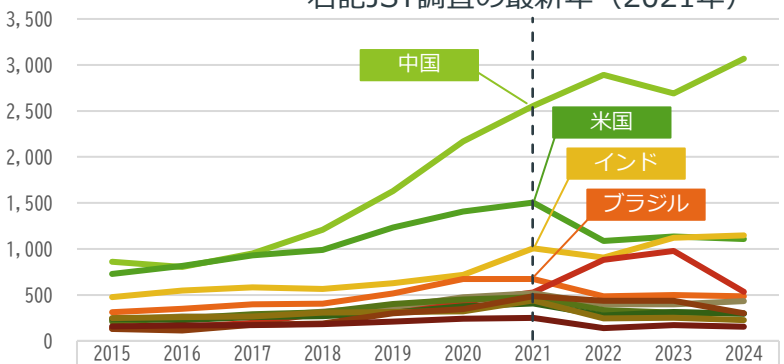
（２）研究領域全体の論文数の動向

（補足）

- 本調査結果は、JSTによる過去の調査結果と類似した傾向を示しており、本調査結果の妥当性を裏付けるものと考えられる。

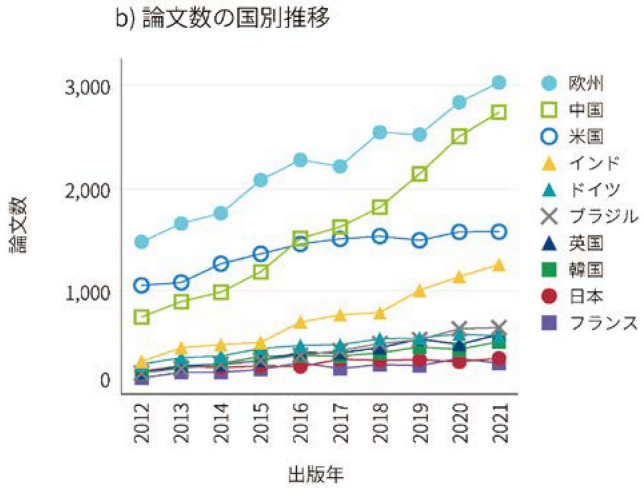
Top10＋日本（2015~2024年次推移）

右記JST調査の最新年（2021年）



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	862	804	950	1,209	1,630	2,168	2,556	2,891	2,690	3,068
United States	728	814	931	990	1,233	1,405	1,504	1,086	1,137	1,107
India	476	549	582	563	626	719	1,005	904	1,120	1,147
Brazil	312	349	399	406	516	672	673	483	497	485
Indonesia	137	151	196	302	329	427	527	882	978	535
Italy	230	266	261	316	367	473	517	399	397	432
Iran	211	245	290	311	401	450	475	334	307	297
Spain	240	226	258	268	307	376	407	276	313	297
Korea, Republic of	249	259	267	307	314	320	440	243	252	226
Egypt	131	113	175	190	300	347	486	435	435	301
Japan	157	169	170	183	210	241	250	139	170	155

参考比較）JST関連調査[1]｜微生物ものづくり



JST調査は、対象国をトップ10にしているわけではないことに注意。
つまり、日本、米国、ドイツ、英国、フランス、欧州 、中国、韓国を調査対象としつつ、それらの国・地域を除いたときに、本領域で論文数が上位 2位までに入る国（ここではインド、ブラジル）を調査対象としている。
また利用データベースはWeb of scienceである。

[1]研究開発の俯瞰報告書　論文・特許データから見る研究開発動向, 2024年, JST CRDS 研究開発戦略センター
https://www.jst.go.jp/crds/report/CRDS-FY2024-FR-01.html

（３）各研究領域の論文数の傾向

- 中国と米国は、どの研究領域においても、およそ上位（１～３位）に入っている。
- その他の上位国における、領域毎の特徴は、以下の通り。

1. インドはおよそ全分野に渡り、中位（４～７位）～上位に位置し、とくに農業領域においては、米国・中国に肩を並べるほど上位に位置している。
2. ブラジルは、人工土壌・発酵食品を除く全分野に渡り、中位である。
3. インドネシアは、畜産、水産領域において上位であり、とくに水産領域では、中国に次ぎ、２位である。
4. イタリアは、食料生産技術開発、微生物の産業活用に資する研究開発において、中位～上位である。
5. 韓国は、伝統発酵の論文数が多く、中国に次ぎ、２位である。
6. 日本は、多くの研究領域で13位以下という結果であったが、伝統発酵においては、９位に位置している。

対象分野ごとの論文数とランキング（2015年~2025年累計）

※数字は論文数とカッコ内にそのランキング

＜凡例＞ 中国、米国を除き１位　中国、米国を除き２位　中国、米国を除き３位

	全項目合計	１．微生物を活用した農林水産業の生産性向上に資する技術開発						２．微生物を活用した食料生産技術開発		３．微生物の産業活用
		微生物肥料	微生物農薬	ﾊﾞｲｵｽﾃｨﾐｭﾗﾝﾄ	人工土壌	畜産飼料等	水産飼料等	伝統発酵	伝統発酵以外	
China	20883 (1)	3167 (1)	2396 (1)	2406 (1)	54 (1)	3160 (1)	1725 (1)	2172 (1)	7712 (1)	5359 (1)
United States	11607 (2)	1593 (3)	1525 (2)	1191 (3)	47 (2)	2213 (2)	512 (3)	499 (3)	4847 (2)	2887 (2)
India	7807 (3)	3083 (2)	1343 (3)	1871 (2)	5 (12)	471 (6)	488 (4)	311 (6)	1620 (5)	834 (5)
Brazil	4992 (4)	1242 (5)	662 (4)	754 (4)	5 (12)	603 (4)	415 (5)	264 (8)	1618 (6)	834 (5)
Indonesia	4511 (5)	1278 (4)	561 (5)	431 (11)	3 (22)	1078 (3)	741 (2)	141 (14)	700 (14)	345 (18)
Italy	3903 (6)	425 (12)	416 (7)	752 (5)	19 (6)	328 (12)	98 (19)	471 (4)	1779 (3)	1174 (3)
Iran	3449 (7)	607 (7)	189 (18)	448 (10)	8 (8)	335 (11)	330 (7)	110 (20)	1693 (4)	316 (20)
Spain	3136 (8)	515 (8)	364 (8)	569 (8)	29 (3)	285 (15)	251 (8)	408 (5)	1078 (10)	866 (4)
Korea, Republic of	2982 (9)	204 (22)	249 (15)	319 (14)	2 (28)	439 (8)	161 (13)	697 (2)	1242 (8)	598 (12)
Egypt	2971 (10)	776 (6)	537 (6)	528 (9)	1 (33)	462 (7)	342 (6)	61 (35)	527 (18)	372 (15)
Japan	1934 (16)	293 (18)	139 (22)	178 (21)	2 (28)	304 (14)	135 (14)	251 (9)	779 (13)	462 (13)

※注意｜項目間で論文に重複があるため（例：１と３）、全項目の数字を足しても、全項目合計の列の数値が算出されるわけではない。

（3）各研究領域の論文数の傾向

（補足）各国の特徴語

インド：農業用語

Biofertilizer
Horticulture
Agronomy
Field experiment
Nutrient management
Vermicompost
Rhizobacteria
Yield (engineering)
Crop
Nutrient

ブラジル：およそ農業用語

Azospirillum brasilense
Inoculation
Microbial inoculant
Dry matter
Bradyrhizobium
Diazotroph
Nitrogen fixation
Nile tilapia
Cultivar
Sowing

ｲﾝﾄﾞﾈｼｱ：畜産・漁業も混ざる

Completely randomized design
Mathematics
Horticulture
Randomized block design
Animal science
Fertilizer
Agricultural science
Fishery
Fish <Actinopterygii>
Catfish

イタリア：ワイン、腸内・免疫

Wine
Winemaking
Dysbiosis
Digestate
Bioinformatics
Gut flora
Polyphenol
Intensive care medicine
Irritable bowel syndrome
Immunology

韓国：乳酸菌・発酵

Lactobacillus plantarum
Lactic acid
Fermentation
Leuconostoc mesenteroides
Weaning
Fermentation in food processing
Lactobacillus brevis
Tumor necrosis factor alpha
Lipopolysaccharide
Adipose tissue

<特徴語の抽出方法>

- Lens.orgのField of Studyを対象に特徴語を抽出。
- 以下の抽出基準を満たす語のうち、Empirical Bayes 加重対数オッズの z-score 上位10語を提示。セル色がグレーなほどグローバルで頻出語。
  - q値≦0.05
    ※Benjamini–Hochberg法でFDR制御した調整済p値
  - RCA≧1.5 (Revealed Comparative Advantage)
    ※単語AのA国の出現率÷世界での出現率
  - E≧5 (独立期待度数)
    ※A国の単語総件数×単語Aの世界での出現率
- なお、Field of StudyはMicrosoft Academic 由来の機械学習タグで、広めに付与される傾向があります。（例：韓国 Tumor necrosis factor alpha→"Multifunctional probiotic and functional properties of Lactiplantibacillus plantarum LRCC5314, isolated from kimchi."等にタグ付けされている。

（3）各研究領域の論文数の傾向

（補足）各国の特徴語

中国：バイオ産業寄り

Microbial population biology
Enzyme
Environmental chemistry
Biosynthesis
Firmicutes
Metabolic engineering
Flavor
Polysaccharide
Colitis
Denitrification

米国：腸内細菌と畜産

Microbiome
Bioinformatics
Intensive care medicine
Gut microbiome
Necrotizing enterocolitis
Genetically modified maize
Feedlot
Beef cattle
Poultry litter
Disease

日本：発酵、腸内・免疫、水田

Aspergillus oryzae
Innate immune system
Clostridium butyricum
Feces
Whole genome sequencing
Immune system
Strain (chemistry)
Propionate
Bradyrhizobium
Paddy field

イラン：ﾌﾟﾛﾊﾞｲｵﾃｨｸｽと臨床

Probiotic
Placebo
Randomized controlled trial
Clinical trial
Gastroenterology
Lactobacillus acidophilus
Rainbow trout
Internal medicine
Medicine
Essential oil

スペイン：ワインと酵母

Wine
Winemaking
Saccharomyces
Yeast
Yeast in winemaking
Fermentation in winemaking
Saccharomyces cerevisiae
Ethanol fermentation
Halophyte
Prebiotic

エジプト：ティラピアや家禽

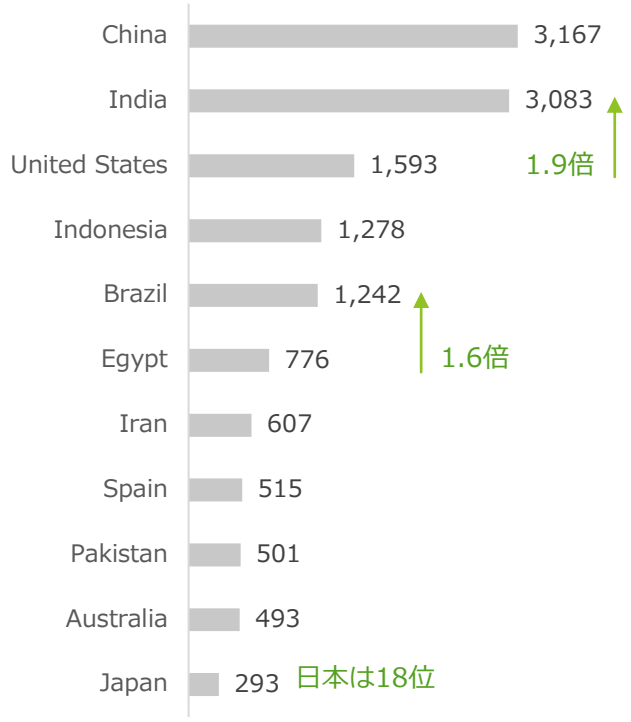
Nile tilapia
Oreochromis
Horticulture
Vegetative reproduction
Productivity
Human fertilization
Broiler
Feed conversion ratio
Spirulina (dietary supplement)
Calcareous

（３）各研究領域の論文数の傾向

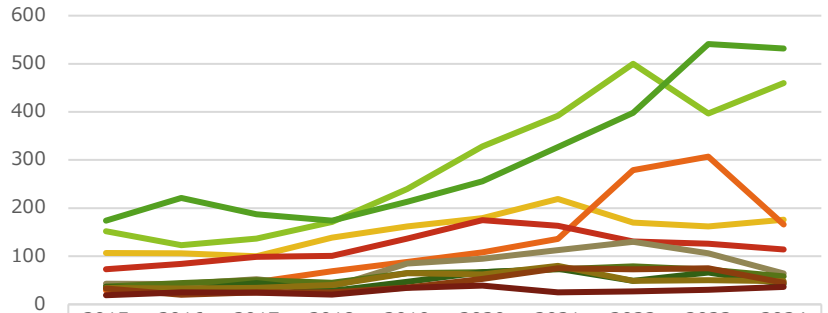
（微生物肥料）

- インドが米国を上回り2位（中国と約3%の僅差）。その後、米国、インドネシア、ブラジルと続く。
- 全項目合計から、イタリアと韓国に代わり、パキスタンとオーストラリアが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



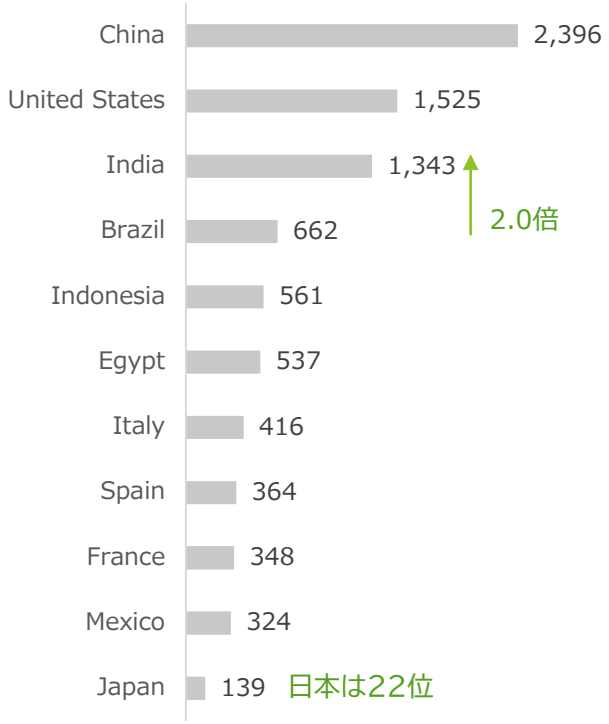
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	152	123	137	171	240	328	392	500	397	460
India	174	221	187	174	213	256	327	398	541	532
United States	107	106	100	139	162	179	219	170	162	176
Indonesia	29	32	46	69	88	108	136	279	307	166
Brazil	73	84	99	101	137	175	163	131	126	114
Egypt	43	42	52	36	85	95	113	130	106	64
Iran	37	44	50	45	65	67	73	79	72	58
Spain	36	28	44	28	47	67	74	49	66	42
Pakistan	34	33	34	40	65	62	80	49	50	48
Australia	33	20	25	25	35	53	75	73	75	45
Japan	19	25	24	20	34	39	25	27	30	36

（３）各研究領域の論文数の傾向

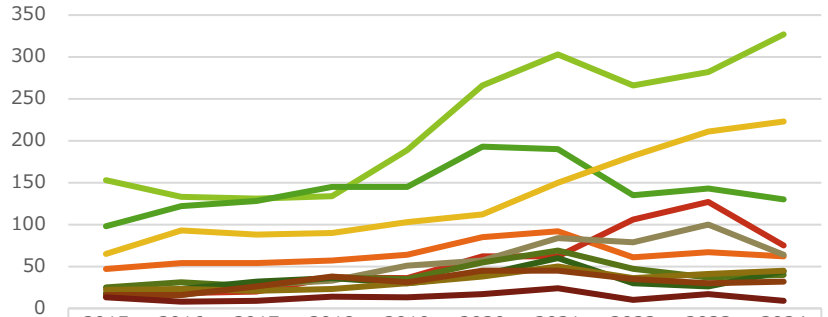
（微生物農薬）

- 中国・米国を除けば、インドがトップであり、次点のブラジルと約2倍の差がある。
- 全項目合計から、イランと韓国に代わり、フランスとメキシコが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）

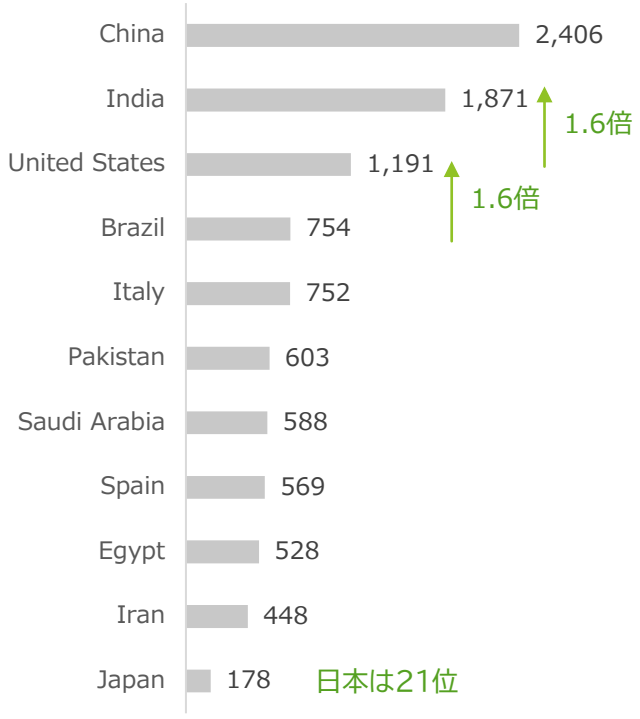


	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	153	133	131	134	189	266	303	266	282	327
United States	98	122	128	145	145	193	190	135	143	130
India	65	93	88	90	103	112	150	182	211	223
Brazil	47	54	54	57	64	85	92	61	67	62
Indonesia	14	18	20	37	36	62	62	106	127	75
Egypt	16	16	28	33	51	57	84	79	100	64
Italy	25	31	26	37	35	55	69	47	37	40
Spain	18	23	32	36	30	40	60	30	26	44
France	22	23	21	23	30	38	50	36	41	45
Mexico	16	16	26	38	31	45	45	35	30	32
Japan	13	8	9	14	13	17	24	10	17	9

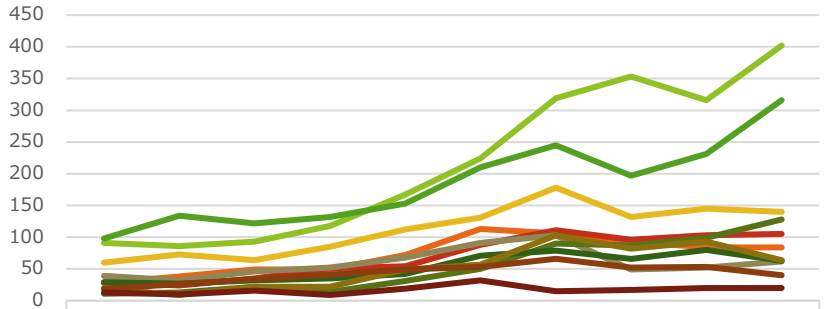
（３）各研究領域の論文数の傾向
（バイオスティミュラント）

- インドが米国の約1.6倍で2位。
- 全項目合計から、インドネシアと韓国に代わり、パキスタンとサウジアラビアが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



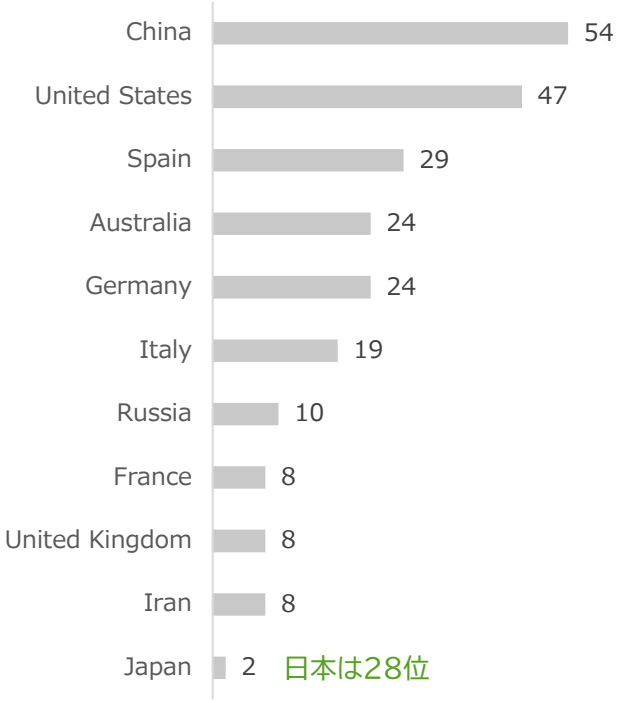
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	91	86	93	118	167	224	319	353	316	402
India	98	134	122	132	153	210	245	197	231	316
United States	60	73	64	85	112	131	178	132	145	140
Brazil	28	38	49	49	72	113	106	93	84	84
Italy	29	24	35	51	54	88	111	96	103	105
Pakistan	39	32	46	52	68	91	103	49	52	62
Saudi Arabia	11	13	22	14	31	50	90	87	99	128
Spain	29	27	32	35	42	71	79	66	80	63
Egypt	19	9	22	22	49	57	103	82	93	64
Iran	19	26	34	41	49	53	66	52	53	40
Japan	13	10	16	9	19	32	15	17	20	20

（３）各研究領域の論文数の傾向

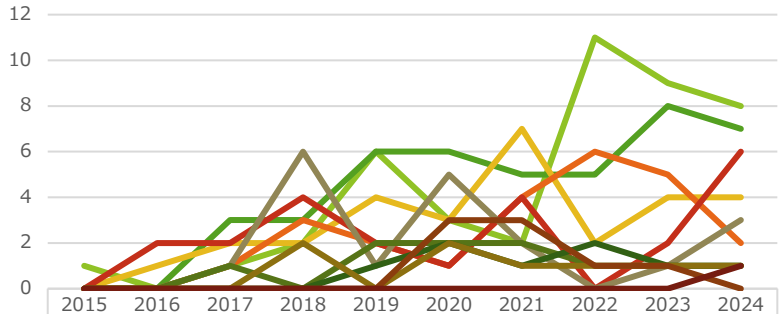
（人工土壌）

- 中国、米国を除けば、スペインがトップ。ただし、他項目よりもデータ量が不十分である。
- 全項目合計から、大きく変わり、オーストラリア、ドイツ、ロシア、フランス、英国が上位10位に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



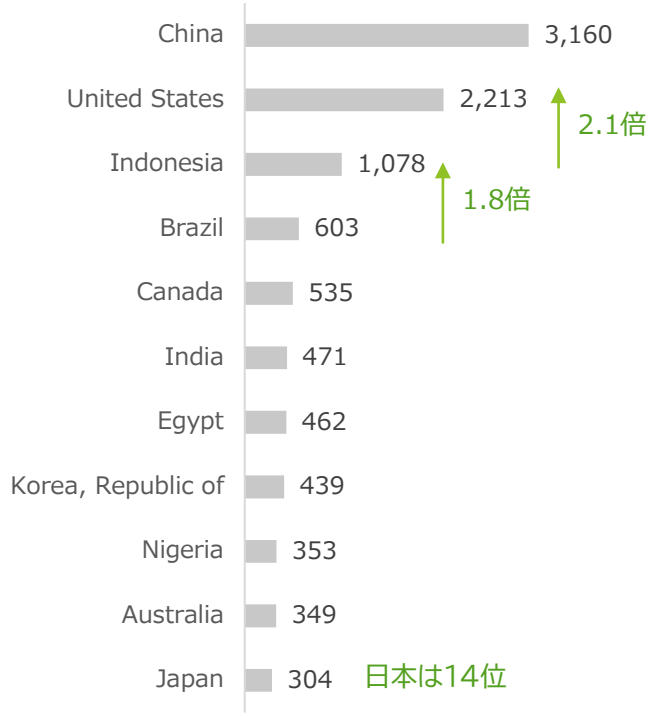
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	1	0	1	2	6	3	2	11	9	8
United States	0	0	3	3	6	6	5	5	8	7
Spain	0	1	2	2	4	3	7	2	4	4
Australia	0	0	1	3	2	1	4	6	5	2
Germany	0	2	2	4	2	1	4	0	2	6
Italy	0	0	1	6	1	5	2	0	1	3
Russia	0	0	1	0	2	2	2	1	1	1
France	0	0	0	0	1	2	1	2	1	1
United Kingdom	0	0	0	2	0	2	1	1	1	1
Iran	0	0	0	0	0	3	3	1	1	0
Japan	0	0	0	0	0	0	0	0	0	1

（３）各研究領域の論文数の傾向

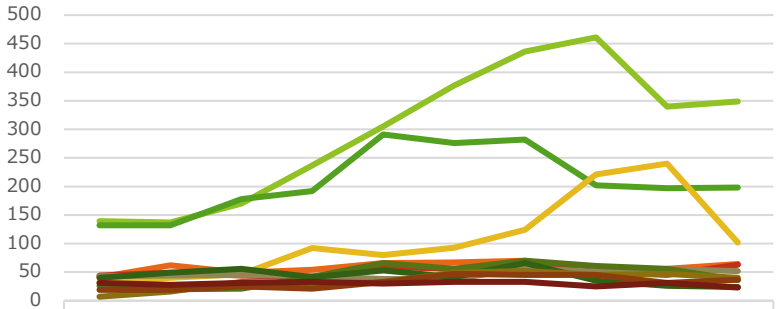
（畜産飼料等）

- 中国・米国を除けば、インドネシアがトップであり、次点のブラジルの約1.8倍である。
- 全項目合計から、イランとイタリア、スペインに代わり、カナダ、ナイジェリア、オーストラリアが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	139	137	170	237	305	377	436	461	340	349
United States	132	132	178	192	291	276	282	202	197	198
Indonesia	32	40	46	92	80	93	124	221	240	102
Brazil	41	62	49	54	66	67	70	47	56	64
Canada	44	49	44	41	59	56	62	51	45	63
India	43	44	45	43	38	38	57	51	55	52
Egypt	26	20	21	42	66	56	70	61	56	36
Korea, Republic of	40	49	56	41	53	41	66	35	26	24
Nigeria	7	16	33	30	32	49	52	45	47	40
Australia	19	19	25	21	33	47	45	45	31	37
Japan	31	28	31	33	30	33	33	25	31	23

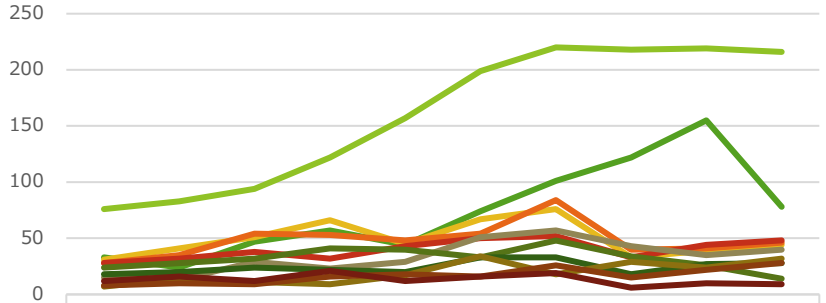
（３）各研究領域の論文数の傾向

（水産飼料等）

- インドネシアが米国を上回り、中国に次ぎ2位である。
- 全項目合計から、イタリアと韓国に代わり、オーストラリアとマレーシアが10位以内に加わる。

Top10＋日本（2015～2025年累計）

Top10＋日本（年次推移）



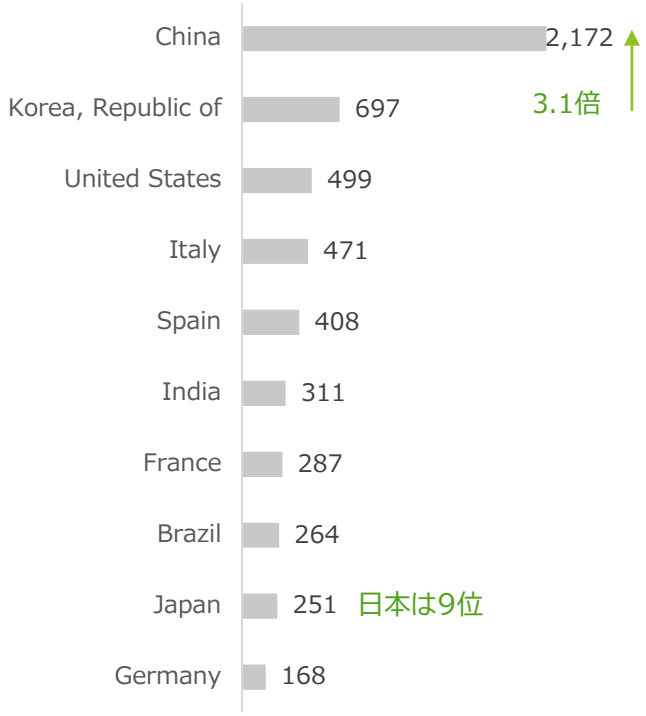
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	76	83	94	122	157	199	220	218	219	216
Indonesia	33	24	47	57	44	74	101	122	155	78
United States	31	41	51	66	45	67	76	33	39	44
India	28	35	54	53	48	54	84	40	41	46
Brazil	28	32	38	32	43	50	52	33	44	48
Egypt	15	13	29	23	29	51	57	43	35	40
Iran	24	28	32	41	40	33	48	34	26	14
Spain	18	20	24	22	20	33	33	18	27	28
Australia	7	14	11	9	17	34	18	29	24	32
Malaysia	8	10	9	16	18	16	26	15	22	28
Japan	12	16	12	21	12	16	19	6	10	9

（３）各研究領域の論文数の傾向

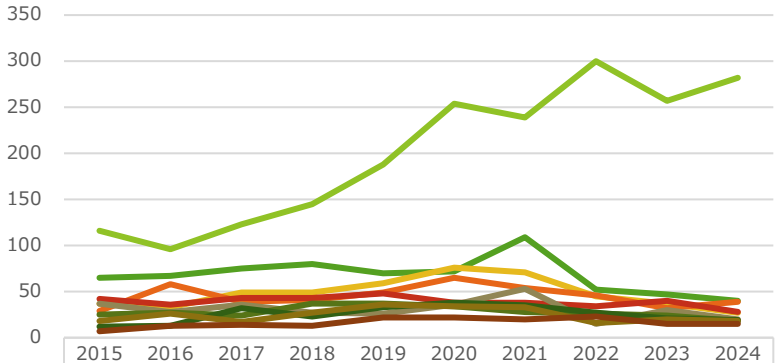
（伝統発酵）

- 韓国が米国を上回り、中国に次ぎ2位である。
- 全項目合計から、エジプト、インドネシア、イランに代わり、フランスとドイツ、日本が10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



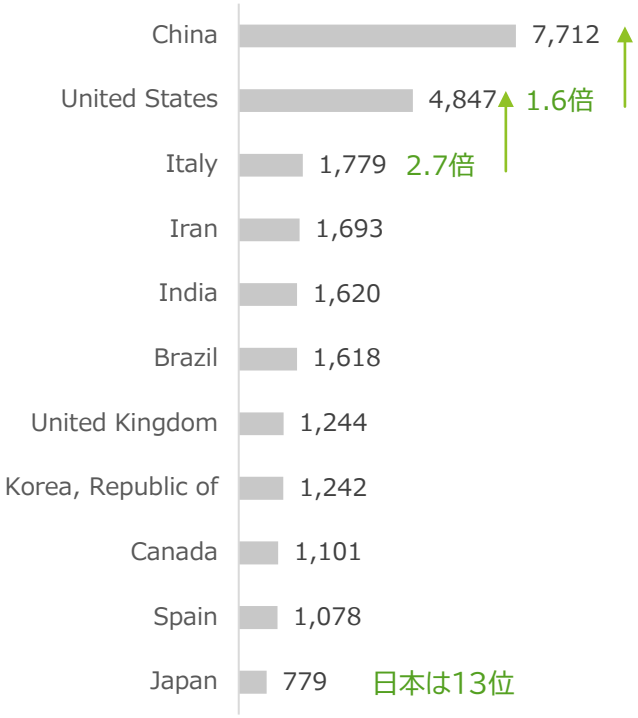
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	116	96	123	145	188	254	239	300	257	282
Korea, Republic of	65	67	75	80	70	72	109	52	47	40
United States	37	33	49	49	59	76	71	45	37	27
Italy	29	58	39	41	49	65	54	46	32	39
Spain	42	36	43	43	48	38	38	34	40	28
India	37	28	36	27	26	36	53	15	30	20
France	25	27	24	37	37	34	28	26	24	18
Brazil	12	13	32	23	33	38	35	27	21	19
Japan	18	26	17	27	36	34	33	16	20	18
Germany	7	13	14	13	22	22	20	23	15	15

（３）各研究領域の論文数の傾向

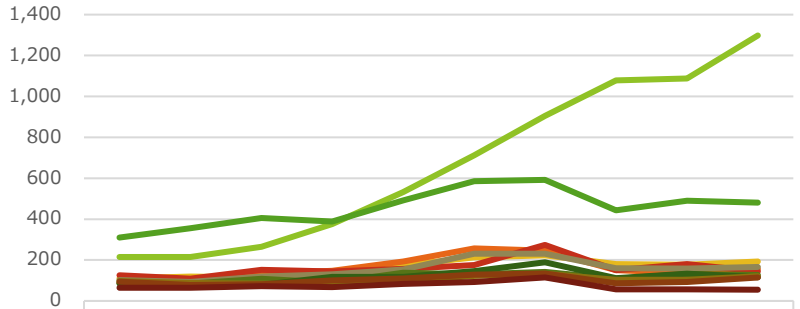
（伝統発酵以外）

- 中国・米国を除けば、イタリアがトップである。
- 全項目合計から、エジプトとインドネシアに代わり、英国とカナダが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



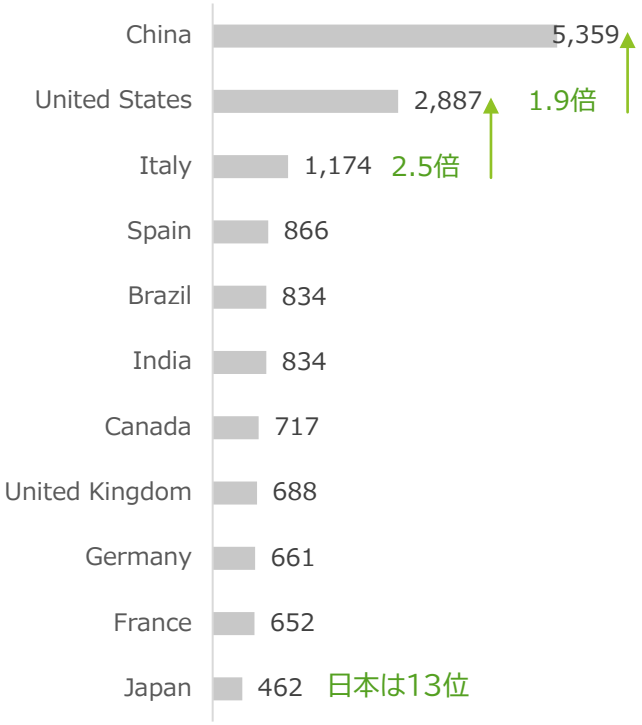
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	215	215	265	376	533	713	904	1,079	1,088	1,298
United States	310	356	405	388	491	586	592	443	490	480
Italy	110	119	115	143	174	213	223	180	177	193
Iran	89	102	133	148	193	257	246	150	136	155
India	126	109	152	145	157	176	274	151	181	144
Brazil	102	93	119	130	153	231	231	160	158	166
United Kingdom	88	85	108	89	138	131	142	108	132	127
Korea, Republic of	85	82	79	117	117	146	189	112	134	116
Canada	98	88	85	78	95	123	133	104	104	121
Spain	95	78	82	101	110	128	134	86	92	114
Japan	65	65	72	67	84	93	115	56	56	55

（３）各研究領域の論文数の傾向

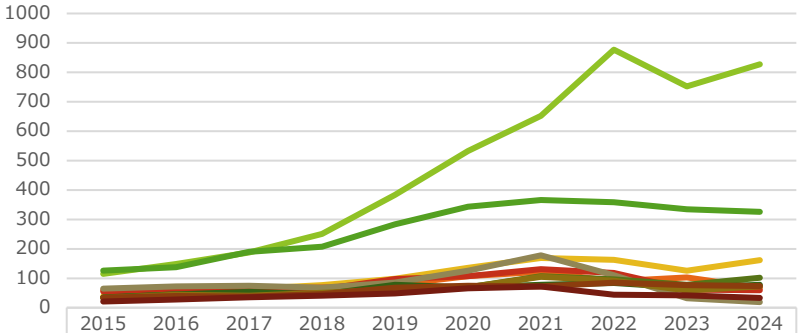
（微生物の産業活用に資する研究開発）

- 中国・米国を除けば、イタリアがトップである。
- 全項目合計から、インドネシア、イタリア、イラン、エジプトに代わり、カナダ、英国、ドイツ、フランスが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	115	149	188	251	383	532	652	877	752	827
United States	126	138	190	207	283	343	366	358	334	326
Italy	39	51	64	77	99	135	169	163	126	162
Spain	60	52	65	69	78	107	122	90	103	67
Brazil	55	59	56	63	97	107	131	118	61	59
India	65	72	75	68	85	126	178	110	32	19
Canada	34	45	41	45	59	69	107	96	78	102
United Kingdom	35	45	54	45	78	69	78	84	68	78
Germany	33	44	41	51	61	69	105	92	58	72
France	34	40	38	46	68	75	72	85	77	74
Japan	21	28	35	41	48	66	72	44	42	33

（１）調査のアプローチ

（補足４）検索クエリ　１（１）#１ 微生物肥料

("bio fertilizer"~1 OR biofertilizer OR "bio inoculant"~1 OR bioinoculant OR "bio compost"~1 OR biocompost OR "microbial fertilizer"~1 OR "microbial inoculant"~1 OR "microbial compost"~1 OR "Plant Growth Promoting")
OR
((nitrogen OR nitrogenous OR nitrate OR nitrite OR ammonia OR ammonium OR urea OR phosphate OR phosphoric OR phosphatic OR phosphorus OR phosphite OR potash OR potassium OR potassic OR kalium OR fertilizer OR inoculant OR compost OR NH3 OR NH4 OR NO3 OR NO2 OR PO4 OR P2O5 OR K2O OR KCl OR K2SO4) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（１）#2 微生物農薬

("bio pesticide"~1 OR biopesticide OR "bio insecticide"~1 OR bioinsecticide OR "bio fungicide"~1 OR biofungicide OR "bio nematicide"~1 OR bionematicide OR "bio herbicide"~1 OR bioherbicide OR "bio virucide"~1 OR biovirucide OR "microbial pesticide"~1 OR "microbial insecticide"~1 OR "microbial fungicide"~1 OR "microbial nematicide"~1 OR "microbial herbicide"~1 OR "microbial virucide"~1 OR "bio acaricide"~1 OR bioacaricide OR "microbial acaricide"~1 OR "bio bactericide"~1 OR biobactericide OR "microbial bactericide"~1 OR "bio molluscicide"~1 OR biomolluscicide OR "microbial molluscicide"~1 OR "bio larvicide"~1 OR biolarvicide OR "microbial larvicide"~1 OR "bio ovicide"~1 OR bioovicide OR "microbial ovicide"~1)
OR
((pesticide OR "pest management"~1 OR insecticide OR fungicide OR nematicide OR herbicide OR virucide OR acaricide OR bactericide OR molluscicide OR larvicide OR ovicide OR "biological control"~1 OR biocontrol OR "bio control"~1) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（１）#3 バイオスティミュラント

(biostimulant OR "bio stimulant"~1 OR "Plant Growth Promoting"~1)
OR
((bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR actinomycetes OR endophyte OR epiphyte OR fungi OR fungus OR yeast OR microalgae OR microphytes OR "arbuscular mycorrhiza"~1 OR Acaulospora OR Acetobacter OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gigaspora OR Gluconacetobacter OR Haematococcus OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanomicrobium OR Methanothrix OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR unneliformis OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria") AND (((nutrient OR nitrogen OR phosphorus OR potassium OR water) AND ("use efficiency"~1 OR availability)) OR (stress AND (tolerance OR resistance OR resilience OR adaptation) OR "quality traits"~1)) AND (improve OR enhance OR increase OR promote OR stimulate OR augment OR boost OR mitigate OR alleviate OR protect OR preserve OR maintain OR prolong OR extension OR extend OR strengthen) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere)

（１）調査のアプローチ

（補足４）検索クエリ　１（１）#4 人工土壌

(Technosol OR Technosoil OR "constructed soil"~1 OR "soil constructed"~1 OR "manufactured soil"~1 OR "soil manufactured"~1 OR "engineered soil"~1 OR "soil engineered"~1 OR "synthetic soil"~1 OR "soil synthetic"~1 OR "artificial soil"~1 OR "soil artificial"~1 OR "bio crust"~1 OR biocrust) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Acutodesmus OR Akanthomyces OR Anabaena OR Arthrobacter OR Aspergillus OR Aureobasidium OR Azotobacter OR Bacillus OR Bradyrhizobium OR Chlorella OR Claroideoglomus OR Clostridium OR Desmodesmus OR Ensifer OR Enterobacter OR Funneliformis OR Herbaspirillum OR Hydrogenophaga OR Lactiplantibacillus OR Mesorhizobium OR Metarhizium OR Methylacidimicrobium OR Methylocystis OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrospira OR Nostoc OR Paenibacillus OR Paracoccus OR Phormidium OR Pseudomonas OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Saccharomyces OR Scytonema OR Streptomyces OR Thauera OR Thermoanaerobacter OR Trichoderma)

（1）調査のアプローチ

（補足４）検索クエリ　1（2）（2-1）#5 発酵飼料

((fermented OR fermentation OR fermenting OR fermentative) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail))
OR
((silage OR haylage OR ensile) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacter OR Akanthomyces OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Brevibacterium OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leuconostoc OR Levilactobacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanocorpusculum OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methanothermobacter OR Methanothrix OR Methylococcus OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Nannochloropsis OR Nitrobacter OR Nitrososphaera OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetraselmis OR Thauera OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-1）#6 SCP/微生物たんぱく質

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)
OR
("alternative protein"~1 OR "sustainable protein"~1 OR "plant-based protein"~1 OR "animal-free protein"~1 OR "cultured protein"~1 OR "cultivated protein"~1 OR "cell-based protein"~1 OR "lab-grown protein"~1 OR "protein alternative"~1 OR "protein sustainable"~1 OR "protein plant-based"~1 OR "protein animal-free"~1 OR "protein cultured"~1 OR "protein cultivated"~1 OR "protein cell-based"~1 OR "protein lab-grown"~1 OR "protein substitute"~1 OR "protein analogue"~1) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Botryococcus OR Brevibacterium OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Megasphaera OR Methanococcus OR Methanoculleus OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrosomonas OR Nitrosospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Shewanella OR Skeletonema OR Spirulina OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR "Candidatus Brocadia" OR "lactic acid bacteria")

（1）調査のアプローチ

（補足４）検索クエリ　1（2）（2-1）#7 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR immunobiotic OR eubiotic OR phytobiotic) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)
OR ((feed OR meal OR diet OR ration OR grain) AND (("additive" OR "supplement" OR "direct fed"~1) OR ((("antimicrobial growth promoter"~1 OR "antibiotic growth promoter"~1) AND (alternative OR replacement)) OR "non antibiotic growth promoter"~1 OR "non antimicrobial growth promoter"~1))) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR "lactic acid bacteria" OR Acetobacter OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Beauveria OR Bifidobacterium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Isochrysis OR Issatchenkia OR Kazachstania OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanobacterium OR Methanobrevibacter OR Methanocorpusculum OR Methanosphaera OR Methanothermobacter OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Purpureocillium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Selenomonas OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "lactic acid bacteria")

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-1）#8 必須アミノ酸等のバイオ生産

(feed OR meal OR diet OR ration OR grain) AND (("amino acid" OR lysine OR methionine OR threonine OR tryptophan OR valine OR isoleucine OR leucine OR phenylalanine OR histidine OR arginine OR enzyme OR Phytase OR Xylanase OR "Beta-glucanase" OR "Beta-mannanase" OR "Alpha-galactosidase" OR Cellulase OR Pectinase OR Polygalacturonase OR "Alpha-amylase" OR Glucoamylase OR Pullulanase OR Protease OR "Ferulic acid esterase") AND ("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1)) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-1）#9 糞尿処理

((manure OR slurry OR litter OR dung OR feces OR faeces OR excreta OR urine) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)) AND (fertilizer OR compost OR biogas OR biomethane OR "anaerobic digestion"~1 OR "anaerobic digester"~1 OR "co-digestion"~1 OR "co-digester"~1 OR "bio filter"~1 OR biofilter OR "bio filtration"~1 OR biofiltration OR "bio trickling"~1 OR biotrickling OR "bio scrubber"~1 OR bioscrubber OR "bio remediation"~1 OR bioremediation OR "bio filtration"~1 OR biofiltration OR "phyto remediation"~1 OR phytoremediation OR "biological treatment"~1 OR bioaugmentation OR "bio augmentation"~1)

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-2）#10 発酵飼料

(fermented OR fermentation OR fermenting OR fermentative) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
(silage OR haylage OR ensile) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacter OR Actinomucor OR Acutodesmus OR Akanthomyces OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanomicrobium OR Methanothrix OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "lactic acid bacteria")

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-2）#11 SCP/微生物たんぱく質

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
("alternative protein"~1 OR "sustainable protein"~1 OR "plant-based protein"~1 OR "animal-free protein"~1 OR "cultured protein"~1 OR "cultivated protein"~1 OR "cell-based protein"~1 OR "lab-grown protein"~1 OR "protein alternative"~1 OR "protein sustainable"~1 OR "protein plant-based"~1 OR "protein animal-free"~1 OR "protein cultured"~1 OR "protein cultivated"~1 OR "protein cell-based"~1 OR "protein lab-grown"~1 OR "protein substitute"~1 OR "protein analogue"~1) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Botryococcus OR Brevibacterium OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Enterobacter OR Euglena OR Galdieria OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanococcus OR Methanosaeta OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Shewanella OR Skeletonema OR Spirulina OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thauera OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium)

（１）調査のアプローチ

（補足４）検索クエリ　1（2）（2-2）#12 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR immunobiotic OR eubiotic OR phytobiotic) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
((feed OR meal OR diet OR ration OR grain) AND (("additive" OR "supplement" OR "direct fed"~1) OR ((("antimicrobial growth promoter"~1 OR "antibiotic growth promoter"~1) AND (alternative OR replacement)) OR "non antibiotic growth promoter"~1 OR "non antimicrobial growth promoter"~1))) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR cyanobacteria OR "lactic acid bacteria" OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Hanseniaspora OR Isochrysis OR Kazachstania OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanomassiliicoccus OR Methanosarcina OR Methylococcus OR Methylocystis OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrosospira OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "lactic acid bacteria")

（1）調査のアプローチ

（補足4）検索クエリ　1（2）（2-2）#13 SCO/藻油/必須脂肪酸等のバイオ生産

(("single cell oil"~1 OR "microbial oil"~1 OR "fungal oil"~1 OR "bacterial oil"~1 OR "yeast oil"~1 OR "microalgal oil"~1 OR "oleaginous bacteria"~1 OR "oleaginous yeast"~1 OR "oleaginous fungus"~1 OR "oleaginous fungi"~1 OR "oleaginous microalgae"~1) AND ("eicosapentaenoic acid" OR "docosahexaenoic acid" OR "arachidonic acid" OR "omega-3 fatty acids" OR "essential fatty acid" OR "long-chain polyunsaturated fatty acids" OR "unsaturated fatty acid" OR astaxanthin))
OR
(("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1) AND ("eicosapentaenoic acid" OR "docosahexaenoic acid" OR "arachidonic acid" OR "omega-3 fatty acids" OR "essential fatty acid" OR "long-chain polyunsaturated fatty acids" OR "unsaturated fatty acid" OR astaxanthin) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clonostachys OR Clostridium OR Corynebacterium OR Crypthecodinium OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconobacter OR Haematococcus OR Halanaerobium OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lactiplantibacillus OR Leptolyngbya OR Leuconostoc OR Lysinibacillus OR Metarhizium OR Methanobrevibacter OR Methanococcus OR Methylacidimicrobium OR Methylocaldum OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrospira OR Nitzschia OR Nostoc OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Staphylococcus OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-2）#14 水質管理

((biofilter OR "bio filter"~1 OR biofiltration OR "bio filtration"~1 OR "bio trickling"~1 OR biotrickling OR "biological filter"~1 OR bioreactor OR "bio reactor"~1 OR biofloc OR "bio floc"~1 OR bioremediation OR "bio remediation"~1 OR bioaugmentation OR "bio augmentation"~1 OR phytoremediation OR "biological treatment"~1 OR anammox) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus"))
OR
((nitrification OR denitrification) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clostridium OR Corynebacterium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Haematococcus OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isochrysis OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanocaldococcus OR Methanococcus OR Methanosaeta OR Methanosarcina OR Methanothrix OR Methylacidimicrobium OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Microchloropsis OR Moorella OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Rhizobium OR Rhizophagus OR Rhodobacter OR Rhodopseudomonas OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Selenomonas OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thauera OR Thiobacillus OR Tisochrysis OR Trichoderma OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR "Candidatus Brocadia" OR "Candidatus Jettenia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-2）#15 生物防除

(biocontrol OR "biological control" OR "antagonistic bacteria"~1 OR "bacterial antagonist"~1 OR "quorum quenching"~1 OR bacteriocin) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanopyrus OR Methanosarcina OR Methanothrix OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrosospira OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Skeletonema OR Spirulina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "Candidatus Kuenenia" OR "lactic acid bacteria")

（1）調査のアプローチ

（補足４）検索クエリ　2（1）#16 発酵食品

((fermented OR fermentation OR fermenting OR fermentative) AND ("food" OR "ready to eat" OR "beverage" OR "drink" OR "alcoholic beverage" OR "dairy product" OR "milk product") OR (miso OR "soy sauce" OR sake OR shochu OR amazake OR vinegar OR nukazuke OR pickles OR kimchi OR sauerkraut OR natto OR tempeh OR sourdough OR yogurt OR cheese OR kefir OR buttermilk OR katsuobushi OR narezushi OR "fish sauce" OR "nam pla" OR "nuoc mam" OR shiokara OR wine OR beer OR cider OR kombucha)) AND (Acetobacter OR Actinomucor OR Acutodesmus OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Bifidobacterium OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Jettenia" OR "lactic acid bacteria" OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)
AND
(safety OR "shelf life" OR "freshness" OR "preservation" OR "clean label" OR quality OR stability OR consistency OR "batch-to-batch" OR "standardized" OR "spoilage control" OR "mold control" OR "yeast control" OR contamination OR poisoning OR "flavor" OR "aroma" OR "smell" OR "taste" OR "aftertaste" OR "mouthfeel" OR "texture" OR "thickness" OR "creaminess" OR "smoothness" OR "crispiness" OR "springiness" OR "chewiness" OR "crumb structure" OR "richness" OR "balance" OR "sweetness" OR "sourness" OR "bitterness" OR "saltiness" OR "umami" OR "savory" OR "off odor" OR health OR digestion OR immunity OR antioxidant OR anti-inflammatory OR "blood sugar" OR "blood pressure" OR cholesterol)
AND
("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1)

（1）調査のアプローチ

（補足４）検索クエリ　2（2）#17 精密発酵

"precision fermentation"
OR
((("genetic engineering"~1 OR "genome engineering"~1 OR "engineering genome"~1 OR "genetically engineered"~1 OR "engineered genetically"~1 OR "genetic modification"~1 OR "genetically modified"~1 OR "modified genetically"~1 OR "protein engineering"~1 OR "engineering protein"~1 OR "enzyme engineering"~1 OR "engineering enzyme"~1 OR "metabolic engineering"~1 OR "peptide engineering"~1 OR "pathway engineering"~1 OR "engineering pathway"~1 OR "strain engineering"~1 OR "engineering strain"~1 OR "host engineering"~1 OR "engineering host"~1 OR "chassis engineering"~1 OR ("bio engineering"~1 OR bioengineering) OR "biological engineering"~1 OR "tissue engineering"~1 OR "cell engineering"~1 OR "cellular engineering"~1 OR "synthetic biology"~1 OR "DNA synthesis"~1 OR "RNA synthesis"~1 OR "gene synthesis"~1 OR "oligonucleotide synthesis"~1 OR "protein synthesis"~1 OR "peptide synthesis"~1 OR ("bio synthesis"~1 OR biosynthesis) OR "biological synthesis"~1 OR "gene editing"~1 OR "genome editing"~1 OR "editing genome"~1 OR "genetic editing"~1 OR "genetically edited"~1 OR "edited genetically"~1 OR CRISPR OR recombinant OR "heterologous expression"~1 OR overexpression OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1) AND (food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acetobacter OR Acetobacterium OR Acidithiobacillus OR Alcaligenes OR Anabaena OR Arthrobacter OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Bifidobacterium OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR enococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gallionella OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Metarhizium OR Methanococcus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella))

（1）調査のアプローチ

（補足４）検索クエリ　2（2）#18 SCP/代替食品

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken OR human)
OR
("alternative food"~1 OR "alternative groceries"~1 OR "alternative beverage"~1 OR "alternative drink"~1 OR "alternative dairy"~1 OR "alternative milk"~1 OR "alternative meat"~1 OR "alternative beef"~1 OR "alternative seafood"~1 OR "alternative pork"~1 OR "alternative chicken"~1 OR "sustainable food"~1 OR "sustainable groceries"~1 OR "sustainable beverage"~1 OR "sustainable drink"~1 OR "sustainable dairy"~1 OR "sustainable milk"~1 OR "sustainable meat"~1 OR "sustainable beef"~1 OR "sustainable seafood"~1 OR "sustainable pork"~1 OR "sustainable chicken"~1 OR "plant-based food"~1 OR "plant-based groceries"~1 OR "plant-based beverage"~1 OR "plant-based drink"~1 OR "plant-based dairy"~1 OR "plant-based milk"~1 OR "plant-based meat"~1 OR "plant-based beef"~1 OR "plant-based seafood"~1 OR "plant-based pork"~1 OR "plant-based chicken"~1 OR "animal free food"~1 OR "animal free groceries"~1 OR "animal free beverage"~1 OR "animal free drink"~1 OR "animal free dairy"~1 OR "animal free milk"~1 OR "animal free meat"~1 OR "animal free beef"~1 OR "animal free seafood"~1 OR "animal free pork"~1 OR "animal free chicken"~1 OR "cultured food"~1 OR "cultured groceries"~1 OR "cultured beverage"~1 OR "cultured drink"~1 OR "cultured dairy"~1 OR "cultured milk"~1 OR "cultured meat"~1 OR "cultured beef"~1 OR "cultured seafood"~1 OR "cultured pork"~1 OR "cultured chicken"~1 OR "cultivated food"~1 OR "cultivated groceries"~1 OR "cultivated beverage"~1 OR "cultivated drink"~1 OR "cultivated dairy"~1 OR "cultivated milk"~1 OR "cultivated meat"~1 OR "cultivated beef"~1 OR "cultivated seafood"~1 OR "cultivated pork"~1 OR "cultivated chicken"~1 OR "cell based food"~1 OR "cell based groceries"~1 OR "cell based beverage"~1 OR "cell based drink"~1 OR "cell based dairy"~1 OR "cell based milk"~1 OR "cell based meat"~1 OR "cell based beef"~1 OR "cell based seafood"~1 OR "cell based pork"~1 OR "cell based chicken"~1 OR "lab grown food"~1 OR "lab grown groceries"~1 OR "lab grown beverage"~1 OR "lab grown drink"~1 OR "lab grown dairy"~1 OR "lab grown milk"~1 OR "lab grown meat"~1 OR "lab grown beef"~1 OR "lab grown seafood"~1 OR "lab grown pork"~1 OR "lab grown chicken"~1 OR "food substitute"~1 OR "food alternative"~1 OR "food analogue"~1 OR "groceries substitute"~1 OR "groceries alternative"~1 OR "groceries analogue"~1 OR "beverage substitute"~1 OR "beverage alternative"~1 OR "beverage analogue"~1 OR "drink substitute"~1 OR "drink alternative"~1 OR "drink analogue"~1 OR "dairy substitute"~1 OR "dairy alternative"~1 OR "dairy analogue"~1 OR "milk substitute"~1 OR "milk alternative"~1 OR "milk analogue"~1 OR "meat substitute"~1 OR "meat alternative"~1 OR "meat analogue"~1 OR "beef substitute"~1 OR "beef alternative"~1 OR "beef analogue"~1 OR "seafood substitute"~1 OR "seafood alternative"~1 OR "seafood analogue"~1 OR "pork substitute"~1 OR "pork alternative"~1 OR "pork analogue"~1 OR "chicken substitute"~1 OR "chicken alternative"~1 OR "chicken analogue"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Candida OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconobacter OR Haematococcus OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Methanococcus OR Methylacidiphilum OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Propionibacterium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella)

（１）調査のアプローチ

（補足４）検索クエリ　２（２）#19 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR psychobiotic OR immunobiotic OR eubiotic) AND NOT (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail OR aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")

（1）調査のアプローチ

（補足４）検索クエリ　2（2）#20 合成生物学や代謝工学

(food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken) AND ("synthetic biology"~1 OR "DNA synthesis"~1 OR "RNA synthesis"~1 OR "gene synthesis"~1 OR "oligonucleotide synthesis"~1 OR "protein synthesis"~1 OR "peptide synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "metabolic engineering"~1 OR "peptide engineering"~1 OR "pathway engineering"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acetobacter OR Acetobacterium OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanocaldococcus OR Methanococcus OR Methanosarcina OR Methanothrix OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)

（1）調査のアプローチ

（補足４）検索クエリ　2（2）#21 未利用資源活用や大量生産

(food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken) AND ("biomass fermentation"~1 OR "biomass valorization"~1 OR "biomass upcycling"~1 OR "circular bioeconomy"~1 OR byproducts OR "non-edible part"~1 OR "non-edible fraction"~1 OR "inedible part"~1 OR "inedible fraction"~1 OR "non food part"~1 OR "non food fraction"~1 OR "underutilized biomass"~1 OR "underutilised biomass"~1 OR "underused biomass"~1 OR "unused biomass"~1 OR "untapped biomass"~1 OR "residual biomass"~1 OR "waste biomass"~1 OR lignocellulose OR "lignocellulosic biomass"~1 OR "lignocellulosic material"~1 OR "lignocellulosic feedstock"~1 OR "cellulosic biomass"~1 OR "cellulosic feedstock"~1 OR "cellulosic material"~1 OR "woody biomass"~1 OR "plant biomass"~1 OR "lignocellulosic hydrolysate"~1 OR "cellulosic hydrolysate"~1 OR "hemicellulose hydrolysate"~1 OR biomanufacturing OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1 OR "scale up"~1 OR "large scale"~1 OR "high throughput"~1 OR "Contract Manufacturing Organization"~1 OR "Contract Development and Manufacturing Organization"~1 OR "Fermentation-as-a-Service"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acaulospora OR Acetobacter OR Acetobacterium OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Methanococcus OR Methanoculleus OR Methanomicrobium OR Methanothermobacter OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrosospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Selenomonas OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #22 有用菌探索

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(genomics OR proteomics OR transcriptomics OR metabolomics OR "DNA sequencing"~1 OR "sequencing DNA"~1 OR "RNA sequencing"~1 OR "sequencing RNA"~1 OR "single cell sequencing"~1 OR "amplicon sequencing"~1 OR "protein sequencing"~1 OR "peptide sequencing"~1 OR "DNA amplification"~1 OR "RNA amplification"~1 OR PCR OR "gene probes"~1 OR "DNA probes"~1 OR "DNA markers"~1 OR "molecular marker"~1 OR "gene chip"~1 OR bioinformatics OR "computational biology"~1 OR "resource mining"~1 OR "gene profiling"~1 OR "RNA profiling"~1 OR "protein profiling"~1 OR "proteome profiling"~1 OR "peptide profiling"~1 OR "metabolic profiling"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #23 設計・合成・改変

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

("genetic engineering"~1 OR "engineering genetic"~1 OR "genome engineering"~1 OR "engineering genome"~1 OR "genetically engineered"~1 OR "engineered genetically"~1 OR "genetic modification"~1 OR "modification genetic"~1 OR "genetically modified"~1 OR "modified genetically"~1 OR "protein engineering"~1 OR "engineering protein"~1 OR "enzyme engineering"~1 OR "engineering enzyme"~1 OR "metabolic engineering"~1 OR "engineering metabolic"~1 OR "peptide engineering"~1 OR "engineering peptide"~1 OR "pathway engineering"~1 OR "engineering pathway"~1 OR "strain engineering"~1 OR "engineering strain"~1 OR "host engineering"~1 OR "engineering host"~1 OR "chassis engineering"~1 OR "engineering chassis"~1 OR bioengineering OR "bio engineering"~1 OR "biological engineering"~1 OR "engineering biological"~1 OR "tissue engineering"~1 OR "engineering tissue"~1 OR "cell engineering"~1 OR "engineering cell"~1 OR "cellular engineering"~1 OR "engineering cellular"~1 OR "synthetic biology"~1 OR "biology synthetic"~1 OR "DNA synthesis"~1 OR "synthesis DNA"~1 OR "RNA synthesis"~1 OR "synthesis RNA"~1 OR "gene synthesis"~1 OR "synthesis gene"~1 OR "oligonucleotide synthesis"~1 OR "synthesis oligonucleotide"~1 OR "protein synthesis"~1 OR "synthesis protein"~1 OR "peptide synthesis"~1 OR "synthesis peptide"~1 OR biosynthesis OR "bio synthesis"~1 OR "biological synthesis"~1 OR "synthesis biological"~1 OR "gene editing"~1 OR "editing gene"~1 OR "genome editing"~1 OR "editing genome"~1 OR "genetic editing"~1 OR "editing genetic"~1 OR "genetically edited"~1 OR "edited genetically"~1 OR CRISPR OR recombinant OR "heterologous expression"~1 OR "expression heterologous"~1 OR overexpression OR "strain improvement"~1 OR "improvement strain"~1 OR "strain development"~1 OR "development strain"~1 OR "strain optimization"~1 OR "optimization strain"~1 OR "strain selection"~1 OR "selection strain"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #24 培養・生産・デジタル

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(bioprocess OR "bio process"~1 OR "biological process"~1 OR "process biological"~1 OR biorefining OR "bio refining"~1 OR bioreactor OR "bio reactor"~1 OR biofoundry OR "bio foundry"~1 OR "fed batch"~1 OR "batch fed"~1 OR "perfusion culture"~1 OR "culture perfusion"~1 OR chemostat OR "cell culture"~1 OR "culture cell"~1 OR "tissue culture"~1 OR "culture tissue"~1 OR "embryo culture"~1 OR "culture embryo"~1 OR biocatalysis OR "bio catalysis"~1 OR biotechnology OR "bio technology"~1 OR biomanufacturing OR "bio manufacturing"~1 OR "precision fermentation"~1 OR "fermentation precision"~1 OR "microbial breeding"~1 OR "breeding microbial"~1 OR "industrial microbiology"~1 OR "microbiology industrial"~1 OR "applied microbiology"~1 OR "microbiology applied"~1 OR "scale up"~1 OR "up scale"~1 OR "large scale"~1 OR "scale large"~1 OR "high throughput"~1 OR "throughput high"~1 OR "Contract Manufacturing Organization"~1 OR "Manufacturing Organization Contract"~1 OR "Contract Development and Manufacturing Organization"~1 OR "Development and Manufacturing Organization Contract"~1 OR "Fermentation-as-a-Service" OR "digital twin"~1 OR "twin digital"~1 OR "process analytical technology"~1 OR "analytical technology process"~1 OR "quality by design"~1 OR "design quality"~1 OR "soft sensor"~1 OR "sensor soft"~1 OR "virtual sensor"~1 OR "sensor virtual"~1 OR chemometrics OR "model predictive control"~1 OR "predictive control model"~1 OR "state estimation"~1 OR "estimation state"~1 OR "digital thread"~1 OR "thread digital"~1 OR "big data"~1 OR "data big"~1 OR "machine learning"~1 OR "learning machine"~1 OR "deep learning"~1 OR "learning deep"~1 OR "neural network"~1 OR "network neural"~1 OR "random forest"~1 OR "forest random"~1 OR "gradient boosting"~1 OR "boosting gradient"~1 OR "support vector"~1 OR "vector support"~1 OR "Gaussian process"~1 OR "process Gaussian"~1 OR "Bayesian optimization"~1 OR "optimization Bayesian"~1 OR "reinforcement learning"~1 OR "learning reinforcement"~1 OR "active learning"~1 OR "learning active"~1 OR "transfer learning"~1 OR "learning transfer"~1 OR "semi-supervised"~1 OR "self-supervised"~1 OR "anomaly detection"~1 OR "detection anomaly"~1 OR "computer vision"~1 OR "vision computer"~1 OR "image analysis"~1 OR "analysis image"~1 OR "object detection"~1 OR "detection object"~1 OR IoT OR "edge computing"~1 OR "computing edge"~1 OR "fog computing"~1 OR "computing fog"~1 OR "cloud computing"~1 OR "computing cloud"~1 OR "wireless sensor"~1 OR "sensor wireless"~1 OR "sensor network"~1 OR "network sensor"~1 OR SCADA OR biofoundry OR "bio foundry"~1 OR automation OR autonomous OR robot OR autosampler OR "auto sampler"~1 OR "microplate handler"~1 OR "handler microplate"~1 OR "liquid handling"~1 OR "handling liquid"~1 OR "colony picker"~1 OR "picker colony"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #25 環境・資源

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(bioremediation OR "bio remediation"~1 OR biofiltration OR "bio filtration"~1 OR phytoremediation OR "phyto remediation"~1 OR "biological treatment"~1 OR "treatment biological"~1 OR bioaugmentation OR "bio augmentation"~1 OR "life cycle assessment"~1 OR "cycle assessment life"~1 OR environment OR sustainability OR "climate change"~1 OR "change climate"~1 OR "global warming"~1 OR "warming global"~1 OR decarbonization OR decarbonisation OR "net zero"~1 OR "zero net"~1 OR "carbon neutrality"~1 OR "neutrality carbon"~1 OR "carbon capture"~1 OR "capture carbon"~1 OR "carbon utilization"~1 OR "utilization carbon"~1 OR "carbon storage"~1 OR "storage carbon"~1 OR "carbon footprint"~1 OR "footprint carbon"~1 OR "greenhouse gas"~1 OR "gas greenhouse"~1 OR CO2 OR "carbon dioxide"~1 OR "dioxide carbon"~1 OR methane OR CH4 OR "nitrous oxide"~1 OR "oxide nitrous"~1 OR N2O OR syngas OR "circular economy"~1 OR "economy circular"~1 OR "water footprint"~1 OR "footprint water"~1 OR wastewater OR "waste water"~1 OR effluent)

付属資料１　論文の分析（被引用数）

（1）調査のアプローチ

- **論文データベースとしてLens.orgを用い、対象期間は2015年1月～2025年9月とし、本調査が対象とする研究領域に該当する論文数を調査した。**

実施手順

1．検索クエリ設計	- 対象研究領域に対して、25の検索クエリを策定。
2．初期データセット作成	- Lens.org（https://www.lens.org/）に検索クエリを入力し、初期的なデータセットを作成（検索期間は2015年1月～2025年9月）。
3．AIによる整合性判断	- 本プロジェクトの制約条件や、検索クエリの設計意図をAIに入力し、初期データセットの各論文に対して、その対象項目との整合性をAIが判断。
4．人間によるデータセット最終化	- AIの判断を人間がサンプルチェックし、その対象項目に含まれるべき論文を最終化（データセット最終化）。
5-1.国別年次別の定量分析（付属資料１ 論文の分析（論文数））	- 最終化されたデータセットの書誌情報（出版年、著者所属機関の国名）を用いて、国別・年次別の論文数を分析。
5-2.被引用数Top10%の定量分析（付属資料１ 論文の分析（被引用数））	- 最終化されたデータセットから、年毎の被引用数Top10%の論文（整数カウント法, 境界同率は全件含む）を抽出。その被引用数Top10%の論文データセットにおいて、国別の論文数を分析。
5-3.キーワードの定量分析（付属資料１ 論文の分析（キーワード））	- 最終化されたデータセットの書誌情報（キーワードタグ）を用いて、国別（中国とそれ以外）・年次別・キーワード別の論文数を分析

（１）調査のアプローチ

（補足１）Lens.orgについて

- **Journal Articleを約1.4億件収録するデータベース**

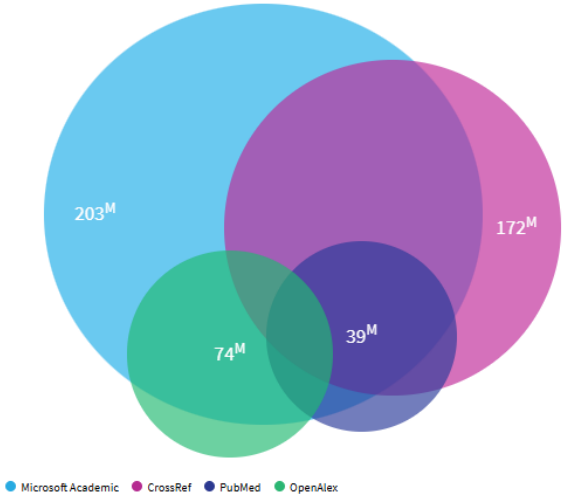
参考比較）Scopus（Elsevier）：9,060万件の文献[1]

参考比較）Web of Science Core Collection（Clarivate）：9700万件の文献[2]

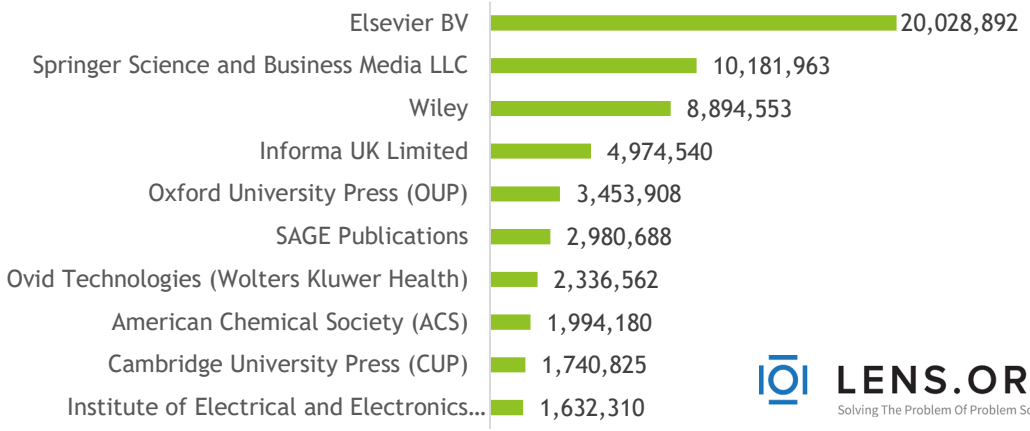
Lens.org概要

Lens.orgは世界的な非営利の社会的企業であるCambia（https://cambia.org/）が運営するオープンプラットフォーム（https://www.lens.org/）

書誌情報の主要なデータソース



主要な収録出版社（収録数Top10）（数値はJournal Article）



[1] https://view.highspot.com/viewer/6551e65b86380b4ef0fb87f9
[2] https://clarivate.com/academia-government/scientific-and-academic-research/research-discovery-and-referencing/web-of-science/web-of-science-core-collection/

2．論文等の動向｜論文（被引用数Top10%）

（1）調査のアプローチ

（補足２）検索クエリ設計｜25の検索対象について

- ノイズは後工程で省かれることを念頭に、広めに25の検査クエリを設計※１

検索対象

1．微生物を活用した農林水産業の生産性向上に資する技術開発		
（1）肥料・農薬・バイオスティミュラントの生産技術開発		
#1	微生物肥料	バイオファーティライザーや肥料成分に関与する微生物・微細藻類
#2	微生物農薬	バイオペスティサイドや生物防除に関与する微生物・微細藻類
#3	バイオスティミュラント	栄養利用率や非生物的ストレス耐性、品質特性に好影響を及ぼす微生物・微細藻類
#4	人工土壌	人工土壌の創製に関与する微生物・微細藻類
（2）（2－1）畜産｜飼料・餌料等（添加物含む）の生産技術開発		
#5	発酵飼料	発酵処理、発酵エコフィード、サイレージ発酵における微生物・微細藻類
#6	SCP/微生物たんぱく質	Single cell Proteinや微生物たんぱく質
#7	xx-biotics	プロバイオティクスやポストバイオティクス、飼料添加物、AGP代替物における微生物・微細藻類
#8	必須アミノ酸等のバイオ生産	必須栄養素（アミノ酸等）や酵素剤の生産に関わる微生物・微細藻類
#9	糞尿処理	糞尿の堆肥化やバイオガス化、臭気対策に関わる微生物・微細藻類
（2）（2－2）水産｜飼料・餌料等（添加物含む）の生産技術開発		
#10	発酵飼料	発酵処理、発酵エコフィード、サイレージ発酵における微生物・微細藻類
#11	SCP/微生物たんぱく質	Single cell Proteinや微生物たんぱく質（魚粉代替）
#12	xx-biotics	プロバイオティクスやポストバイオティクス、飼料添加物、AGP代替物における微生物・微細藻類
#13	SCO/藻油/必須脂肪酸等のバイオ生産	魚油代替としてのSCOや藻油、必須脂肪酸（DHAやEPA）の生産に関与する微生物・微細藻類
#14	水質管理	水質の維持管理、硝化・脱窒に関与する微生物・微細藻類
#15	生物防除	抗菌性を高める生物防除としての微生物・微細藻類
2．微生物を活用した食料生産技術開発（健康に資する食品を含む）		
（1）伝統発酵による高付加価値食料生産技術開発		
#16	発酵食品	発酵食品の品質安定化や風味変化、健康機能の向上に関するバイオ工学等
（2）微生物による食料生産技術開発（伝統発酵以外）		
#17	精密発酵	精密発酵や目的成分の拡張を目指したバイオ工学等
#18	SCP/代替食品	SCPや代替食品（代替肉や代替シーフード等）における微生物・微細藻類
#19	xx-biotics	プロバイオティクスやポストバイオティクス、サプリメントにおける微生物・微細藻類
#20	合成生物学や代謝工学	合成生物学による新たな機能や代謝設計に関する研究
#21	未利用資源活用や大量生産	未利用資源活用における微生物・微細藻類、大量発酵施設やB2B発酵等の産業化に関する研究
3．微生物を産業として活用することに資する研究開発		
#22	有用菌探索	ゲノミクスやシーケンシング、プロファイリング等に関する研究
#23	設計・合成・改変	ゲノムエンジニアリングや合成生物学、株開発等に関する研究
#24	培養・生産・デジタル	バイオ生産や培地、育種、産業化（大量生産やB2Bサービス）、AIやIoT等に関する研究
#25	環境・資源	環境配慮型、CO2削減等に資する研究開発

※１）定量分析のアウトプット自体は、報告書の章立てに沿った形式でアウトプットしている。

（１）調査のアプローチ

（補足３）検索クエリのサンプル※1

- **およその設計思想としては、「代表的な言葉」 OR 「関連語の組み合わせ」としている※2**

※「関連語の組み合わせ」をサポートクエリとして用意することで、「代表的な言葉を使っていないが、同じ目的の研究だと考えられる論文」の抽出も行うことが狙い。
※なお、検索結果に含まれ得るノイズの多くは、実施手順③AIによる整合性判断で弾かれる。

サンプル｜1（1）#1 微生物肥料

メイン

("bio fertilizer"~1 OR biofertilizer OR "bio inoculant"~1 OR bioinoculant OR "bio compost"~1 OR biocompost OR "microbial fertilizer"~1 OR "microbial inoculant"~1 OR "microbial compost"~1 OR "Plant Growth Promoting")
OR

サポート（（肥料成分）×（農業用語）×（微生物用語））

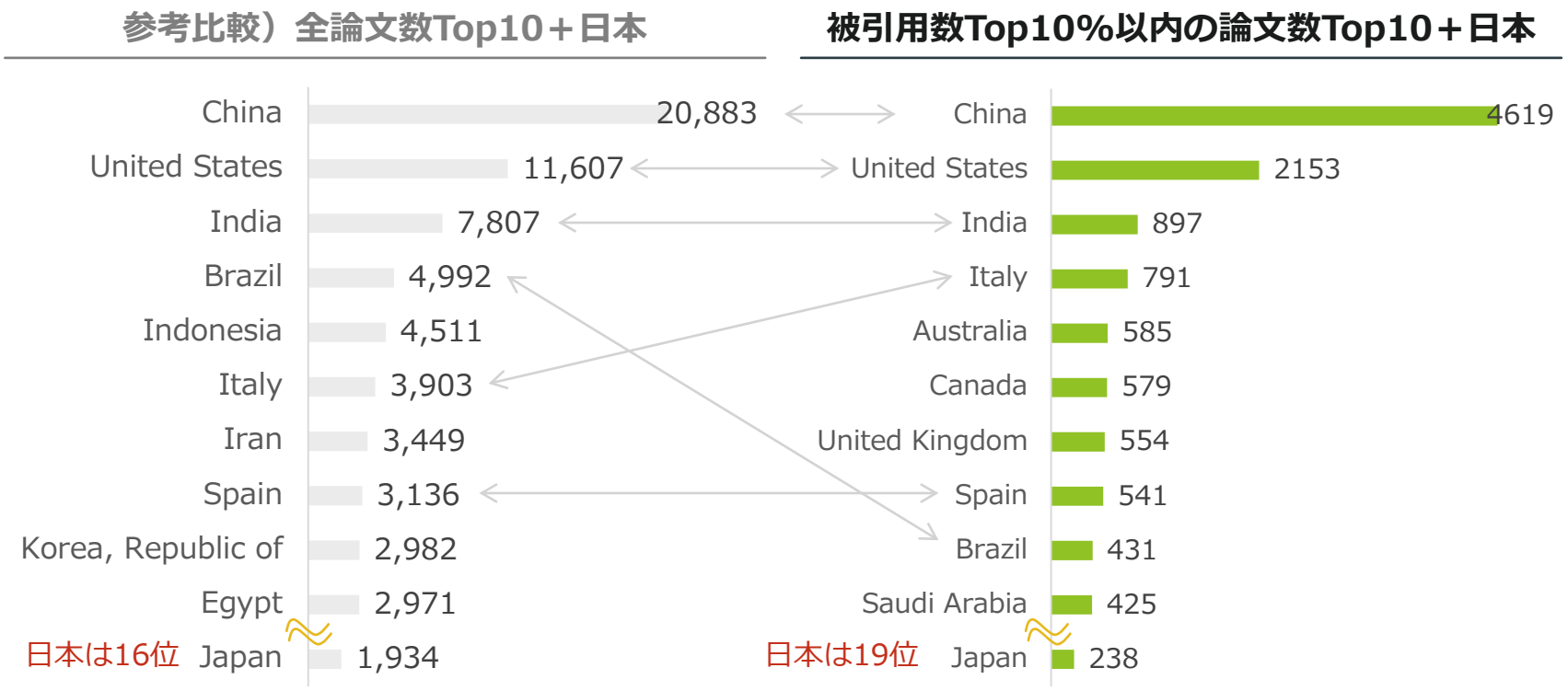
((nitrogen OR nitrogenous OR nitrate OR nitrite OR ammonia OR ammonium OR urea OR phosphate OR phosphoric OR phosphatic OR phosphorus OR phosphite OR potash OR potassium OR potassic OR kalium OR fertilizer OR inoculant OR compost OR NH3 OR NH4 OR NO3 OR NO2 OR PO4 OR P2O5 OR K2O OR KCl OR K2SO4) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

※１）本紙末尾に全ての検索クエリを掲載
※２）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

（2）研究領域全体の論文数（被引用数Top10%）の動向

- 被引用数Top10%以内の論文数を比較すると、1位が中国、2位が米国、3位がインドであり、（被引用数を踏まえない）全論文の集計結果と同様の傾向であった。
- 4位以降は、本調査の特徴が表れており、全論文の集計結果と比較して、イタリア、オーストラリア、カナダ、英国、サウジアラビアといった国が上位に現れている。

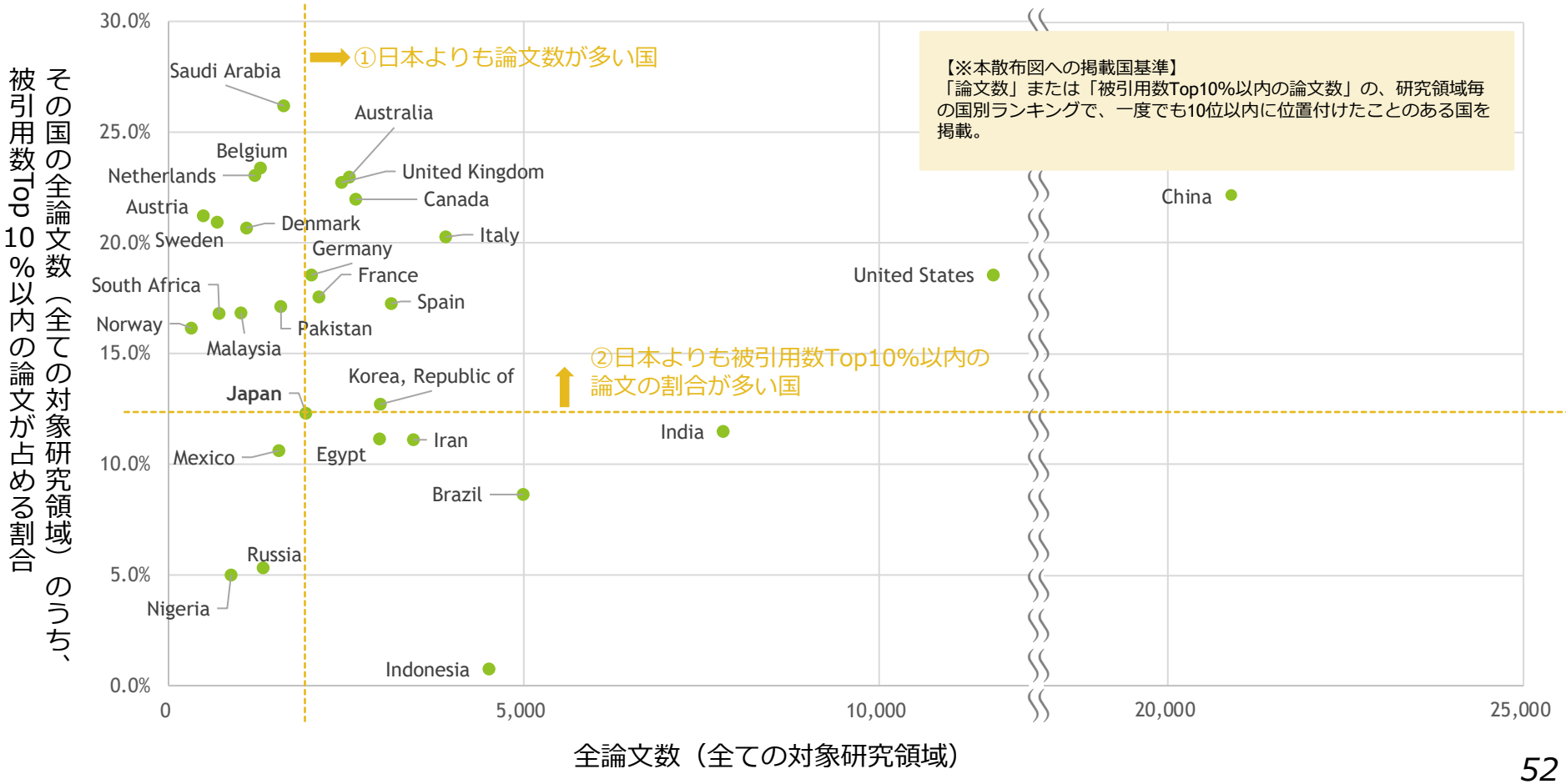
対象研究領域の論文（Journal Article）の数（対象期間｜2015年1月～2025年9月）



（２）研究領域全体の論文数（被引用数Top10%）の動向

（補足）全論文数と被引用数Top10%以内の論文が占める割合の散布図

- 日本以外の28か国（※掲載国基準は表中に記載）の中で、「①対象研究領域に関する論文を、日本よりも多く報告しており」、「②それら論文のうち被引用数Top10%以内の論文の割合が、日本よりも高い国」は、10か国であった。



（３）各研究領域の論文数（被引用数Top10%）の傾向

- 中国と米国は、どの研究領域においても、およそ上位（１～３位）に入っている。
- その他の上位国における、領域毎の特徴は、以下の通り。

1. インドは、とくに農業領域においては、中国・米国に肩を並べるほど上位に位置している。その他、農業領域では、イタリア、オーストラリア、スペイン、サウジアラビアも中位に位置付けている。
2. イタリアは、食料生産技術開発、微生物の産業活用に資する研究開発において、上位である。その他、食料生産技術開発では、英国、スペイン、カナダも中位に位置付けている。
3. 畜産領域は、中国・米国に次いで、カナダ、オーストラリアが上位である。

対象分野ごとの論文数（被引用数Top10%）とランキング（2015年~2025年累計）

※数字は論文数とカッコ内にそのランキング

＜凡例＞ 中国、米国を除き１位　中国、米国を除き２位　中国、米国を除き３位

	全項目合計	１．微生物を活用した農林水産業の生産性向上に資する技術開発						２．微生物を活用した食料生産技術開発		３．微生物の産業活用
		微生物肥料	微生物農薬	ﾊﾞｲｵｽﾃｨﾐｭﾗﾝﾄ	人工土壌	畜産飼料等	水産飼料等	伝統発酵	伝統発酵以外	
China	4619 (1)	911 (1)	489 (1)	431 (1)	11 (1)	968 (1)	324 (1)	367 (1)	1456 (1)	698 (1)
United States	2153 (2)	390 (2)	263 (2)	201 (3)	11 (1)	427 (2)	80 (3)	69 (3)	859 (2)	447 (2)
India	897 (3)	345 (3)	144 (3)	245 (2)	-	59 (9)	74 (4)	43 (6)	152 (10)	141 (4)
Italy	791 (4)	125 (8)	105 (4)	135 (5)	2 (7)	68 (6)	25 (14)	82 (2)	311 (3)	187 (3)
Australia	585 (5)	157 (4)	56 (11)	79 (8)	1 (12)	86 (4)	49 (6)	32 (8)	186 (6)	125 (7)
Canada	579 (6)	120 (9)	68 (8)	98 (7)	-	97 (3)	12 (23)	26 (11)	223 (5)	133 (5)
United Kingdom	554 (7)	126 (7)	66 (9)	50 (14)	1 (12)	52 (12)	31 (8)	14 (21)	247 (4)	126 (6)
Spain	541 (8)	100 (12)	87 (5)	62 (11)	4 (3)	60 (8)	27 (13)	61 (4)	174 (7)	108 (8)
Brazil	431 (9)	117 (10)	53 (12)	64 (10)	-	41 (16)	24 (15)	18 (14)	173 (8)	59 (12)
Saudi Arabia	425 (10)	141 (5)	80 (6)	151 (4)	1 (12)	61 (7)	30 (9)	11 (22)	30 (31)	56 (13)
Japan	238 (19)	44 (20)	19 (24)	13 (33)	-	33 (18)	28 (11)	18 (14)	95 (16)	39 (19)

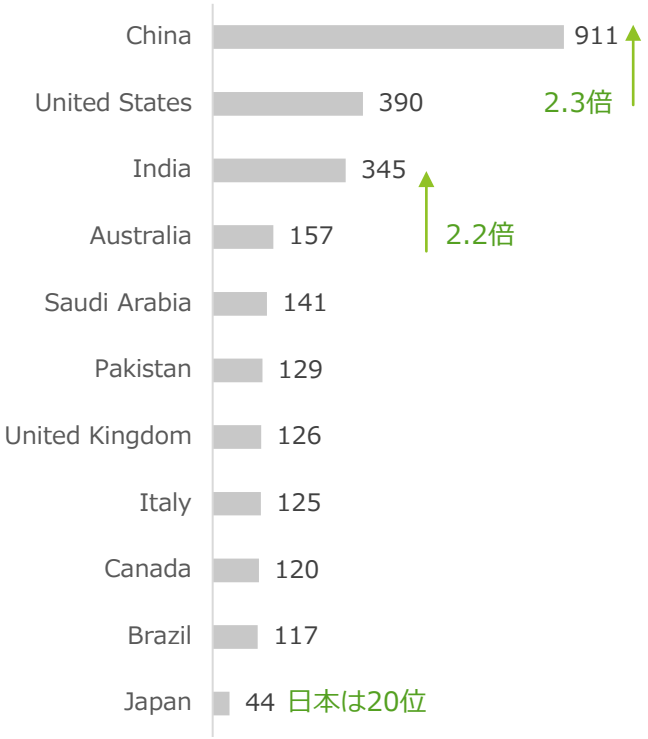
※注意｜項目間で論文に重複があるため（例：１と３）、全項目の数字を足しても、全項目合計の列の数値が算出されるわけではない。

（３）各研究領域の論文数（被引用数Top10%）の傾向

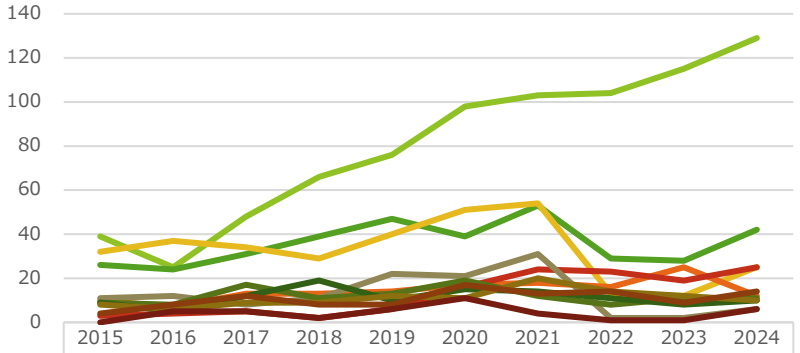
（微生物肥料）

- 中国・米国を除けば、インドがトップであり、次点のオーストラリアと約2倍の差がある。
- 全項目合計から、スペインに代わり、パキスタンが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



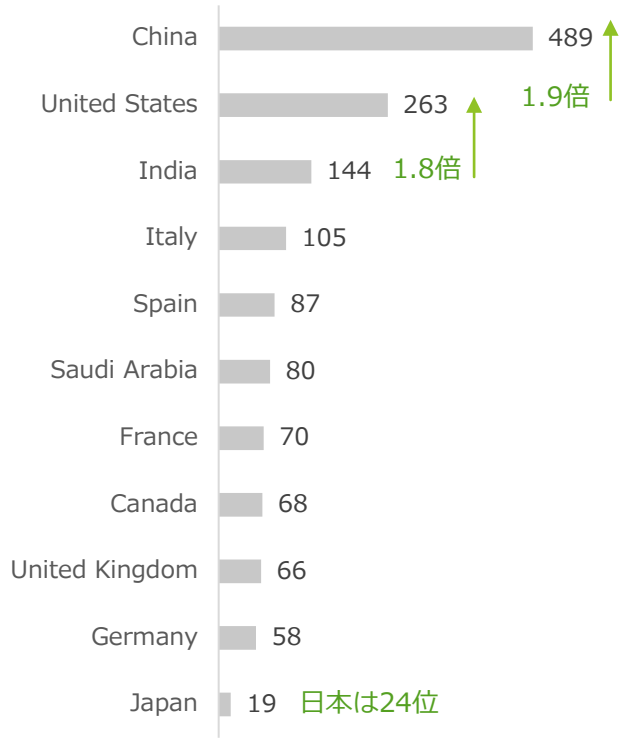
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	39	25	48	66	76	98	103	104	115	129
United States	26	24	31	39	47	39	53	29	28	42
India	32	37	34	29	40	51	54	13	12	25
Australia	10	7	13	13	14	17	18	16	25	12
Saudi Arabia	3	4	5	2	6	16	24	23	19	25
Pakistan	11	12	8	11	22	21	31	2	2	6
United Kingdom	9	8	17	11	13	19	12	8	11	11
Italy	9	5	12	19	10	15	14	11	8	10
Canada	8	6	9	9	12	11	20	14	12	10
Brazil	4	8	12	8	8	17	13	14	9	14
Japan	0	5	5	2	6	11	4	1	1	6

（３）各研究領域の論文数（被引用数Top10%）の傾向

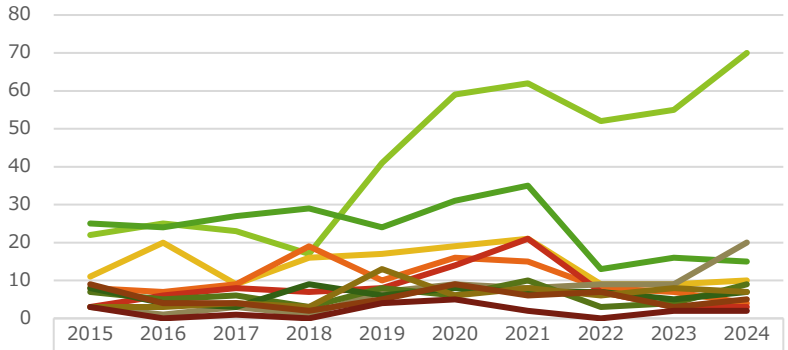
（微生物農薬）

- 中国・米国を除けば、インドがトップである。
- 全項目合計から、オーストラリア、ブラジルに代わり、フランス、ドイツが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）

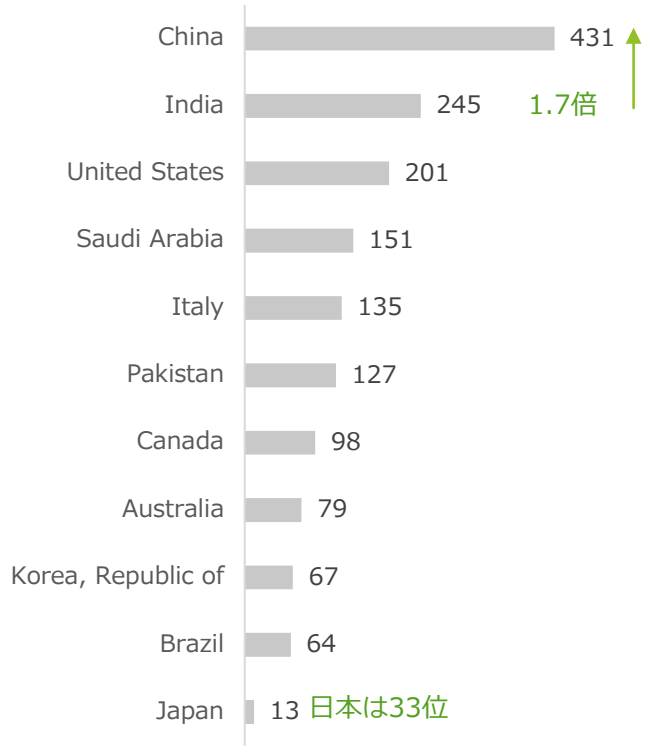


	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	22	25	23	17	41	59	62	52	55	70
United States	25	24	27	29	24	31	35	13	16	15
India	11	20	9	16	17	19	21	9	9	10
Italy	8	7	9	19	10	16	15	8	7	4
Spain	3	6	8	7	8	14	21	7	3	3
Saudi Arabia	3	1	3	1	7	9	8	9	9	20
France	7	5	6	3	8	6	10	3	4	9
Canada	8	4	3	9	6	8	7	7	5	7
United Kingdom	3	3	4	3	13	6	8	6	8	7
Germany	9	4	4	2	5	9	6	7	3	5
Japan	3	0	1	0	4	5	2	0	2	2

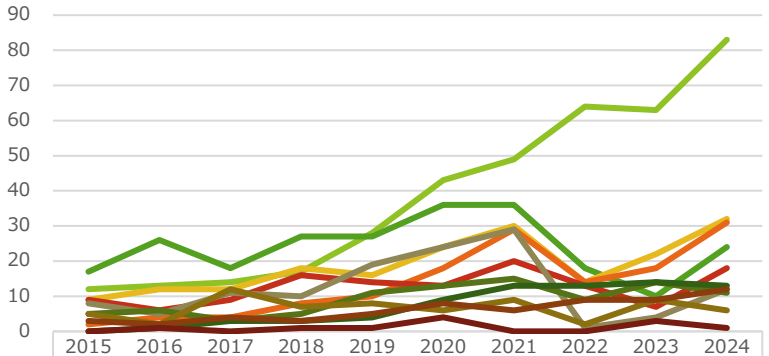
（３）各研究領域の論文数（被引用数Top10%）の傾向
（バイオスティミュラント）

- インドが、米国を上回り、2位である。
- 全項目合計から、英国とスペインに代わり、パキスタンと韓国が10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



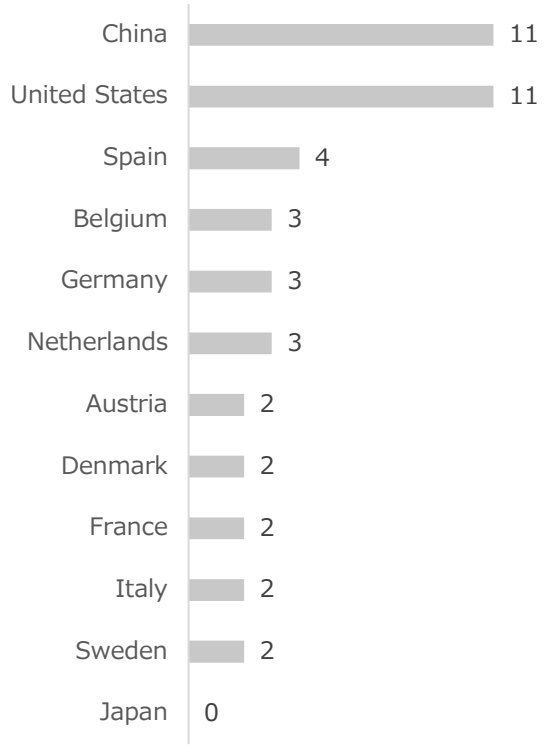
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	12	13	14	17	28	43	49	64	63	83
India	17	26	18	27	27	36	36	18	10	24
United States	9	12	12	18	16	24	30	14	22	32
Saudi Arabia	2	4	4	8	10	18	29	14	18	31
Italy	9	6	9	16	14	13	20	13	7	18
Pakistan	8	5	11	10	19	24	29	1	4	12
Canada	5	6	3	5	11	13	15	9	14	11
Australia	0	1	3	3	4	9	13	13	14	13
Korea, Republic of	5	2	12	7	8	6	9	2	9	6
Brazil	3	2	4	3	5	8	6	9	9	12
Japan	0	1	0	1	1	4	0	0	3	1

（３）各研究領域の論文数（被引用数Top10%）の傾向

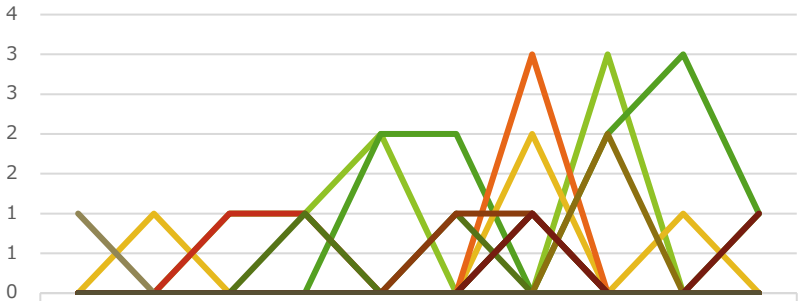
（人工土壌）

- 中国、米国を除けば、スペインがトップ。ただし、他項目よりもデータ量が不十分である。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



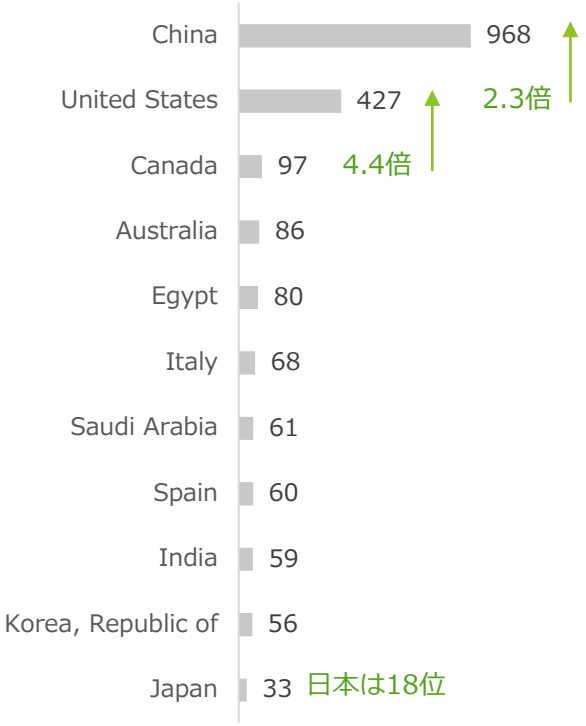
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	0	0	1	1	2	0	0	3	0	1
United States	0	0	0	0	2	2	0	2	3	1
Spain	0	1	0	0	0	0	2	0	1	0
Belgium	0	0	0	0	0	0	3	0	0	0
Germany	0	0	1	1	0	0	1	0	0	0
Netherlands	1	0	0	0	0	0	0	0	0	1
Austria	0	0	0	1	0	1	0	0	0	0
Denmark	0	0	0	0	0	0	1	0	0	0
France	0	0	0	0	0	0	0	2	0	0
Italy	0	0	0	0	0	1	1	0	0	0
Sweden	0	0	0	0	0	0	1	0	0	1
Japan	0	0	0	0	0	0	0	0	0	0

（３）各研究領域の論文数（被引用数Top10%）の傾向

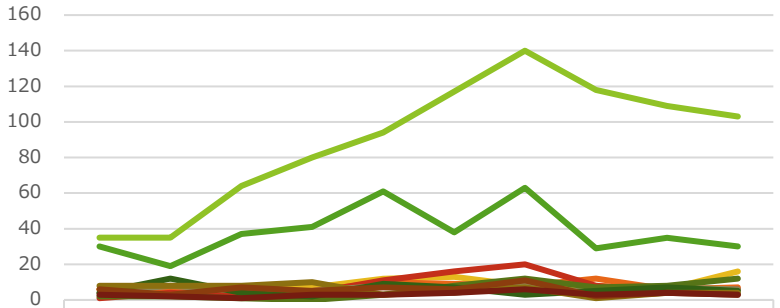
（畜産飼料等）

- 中国・米国を除けば、カナダがトップである。
- 全項目合計から、英国、ブラジルに代わり、エジプト、韓国が10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



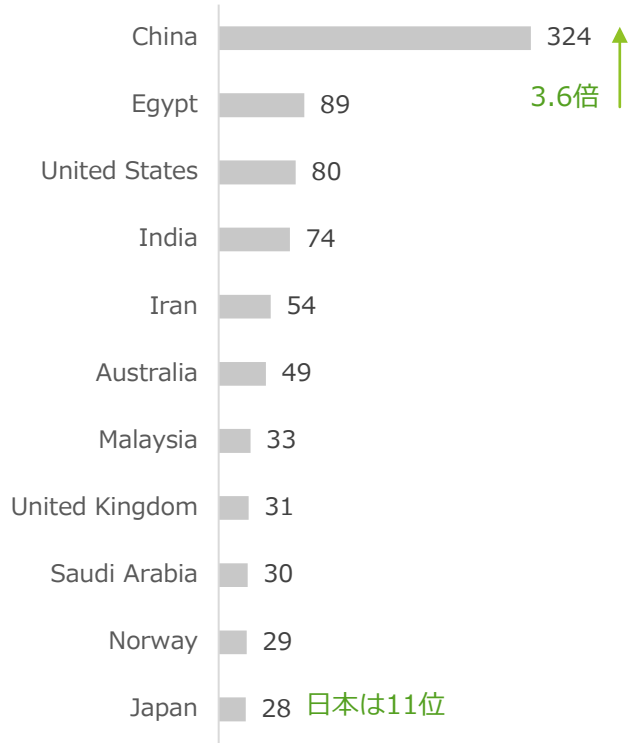
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	35	35	64	80	94	117	140	118	109	103
United States	30	19	37	41	61	38	63	29	35	30
Canada	6	5	7	7	12	13	8	8	6	16
Australia	6	6	3	5	10	9	8	12	6	7
Egypt	1	4	2	4	11	16	20	8	5	6
Italy	4	8	5	5	8	4	8	4	7	6
Saudi Arabia	2	2	1	0	3	8	12	7	8	12
Spain	4	12	4	2	9	7	3	5	7	5
India	8	8	8	10	3	5	7	1	4	4
Korea, Republic of	6	3	7	5	7	6	11	2	4	3
Japan	3	2	1	3	3	4	6	3	4	3

（３）各研究領域の論文数（被引用数Top10%）の傾向

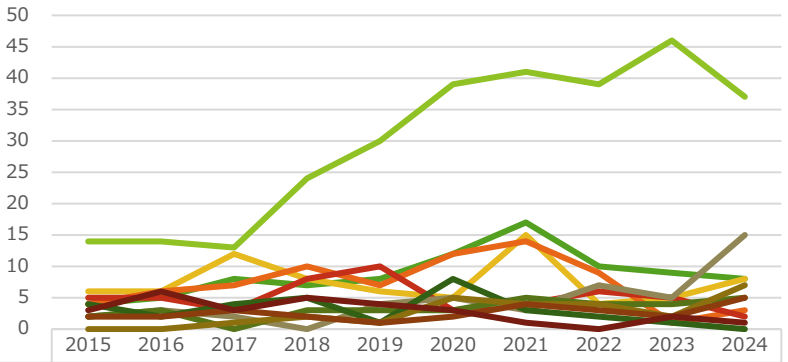
（水産飼料等）

- エジプトが、米国を上回り、中国に次ぎ2位である。
- 全項目合計から、イタリアとカナダ、スペイン、ブラジルに代わり、エジプトとイラン、マレーシア、ノルウェーが10位以内に加わっている。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



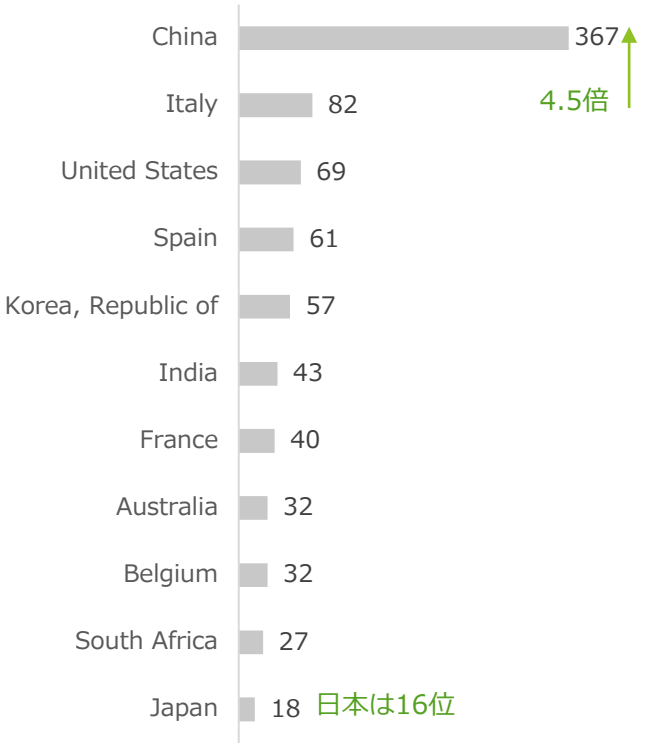
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	14	14	13	24	30	39	41	39	46	37
Egypt	4	5	8	7	8	12	17	10	9	8
United States	6	6	12	8	6	5	15	4	5	8
India	4	6	7	10	7	12	14	9	1	3
Iran	5	5	3	8	10	3	4	6	5	2
Australia	2	3	2	0	4	5	3	7	5	15
Malaysia	2	3	0	3	3	3	5	4	4	5
United Kingdom	4	2	4	5	1	8	3	2	1	0
Saudi Arabia	0	0	1	2	1	5	4	4	2	7
Norway	2	2	3	2	1	2	4	3	2	5
Japan	3	6	3	5	4	3	1	0	2	1

（３）各研究領域の論文数（被引用数Top10%）の傾向

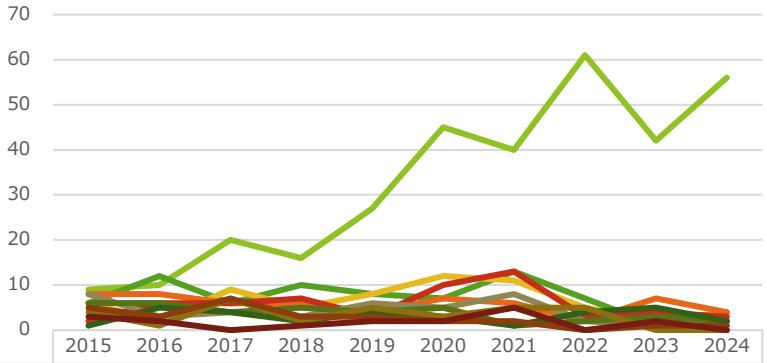
（伝統発酵）

- イタリアが、米国を上回り、中国に次ぎ2位である。
- 全項目合計から、カナダ、英国、ブラジル、サウジアラビアに代わり、韓国、フランス、ベルギー、南アフリカが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）

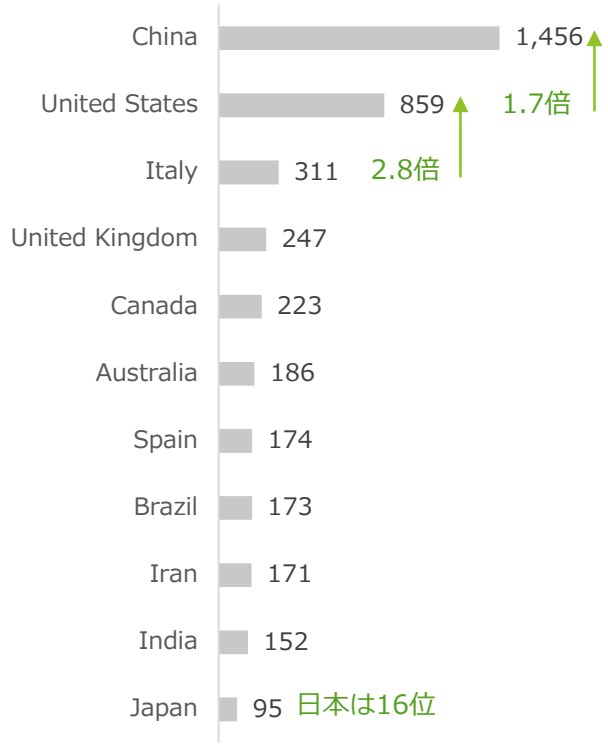


	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	9	10	20	16	27	45	40	61	42	56
Italy	6	12	6	10	8	7	13	7	1	4
United States	6	2	9	5	8	12	11	5	2	4
Spain	8	8	6	6	4	7	6	2	7	4
Korea, Republic of	2	6	6	7	3	10	13	3	4	3
India	8	3	4	3	6	5	8	2	1	2
France	6	6	4	5	4	5	1	2	3	2
Australia	1	5	4	2	4	3	1	4	5	2
Belgium	4	1	7	2	5	3	5	5	0	0
South Africa	5	3	7	3	3	2	2	0	1	1
Japan	3	2	0	1	2	2	5	0	2	0

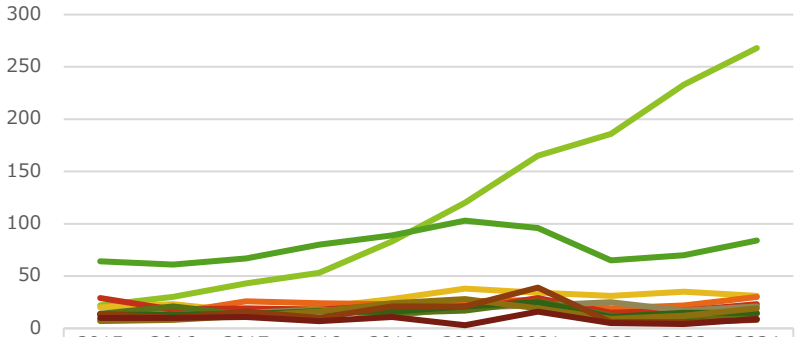
（３）各研究領域の論文数（被引用数Top10%）の傾向（伝統発酵以外）

- 中国・米国を除けば、イタリアがトップである。
- 全項目合計から、サウジアラビアに代わり、イランが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



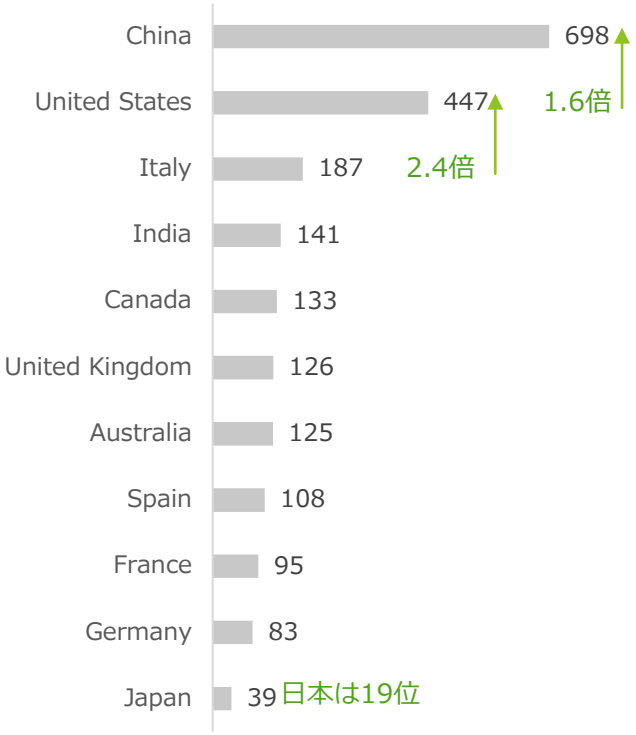
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	22	30	43	53	83	120	165	186	233	268
United States	64	61	67	80	89	103	96	65	70	84
Italy	20	23	16	20	28	38	34	31	35	31
United Kingdom	13	15	26	24	23	26	27	19	22	30
Canada	29	18	19	18	22	18	29	15	17	23
Australia	8	13	15	18	12	20	22	25	17	21
Spain	14	21	13	17	15	17	26	12	11	14
Brazil	13	13	14	16	16	21	25	11	15	15
Iran	7	8	12	16	24	28	19	9	12	19
India	14	10	16	10	21	21	39	6	6	8
Japan	10	10	11	7	11	3	16	5	4	9

（３）各研究領域の論文数（被引用数Top10%）の傾向

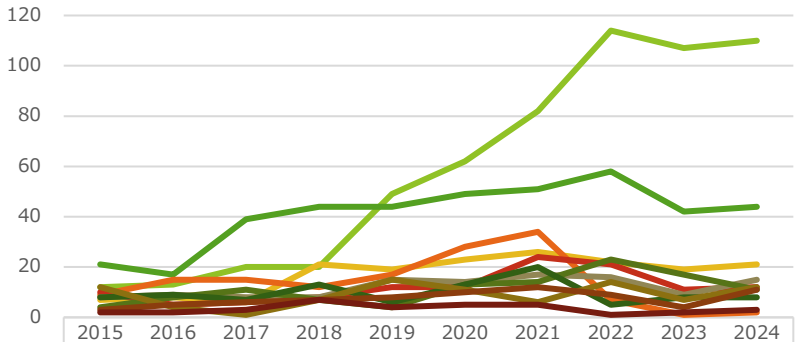
（微生物の産業活用）

- 中国・米国を除けば、イタリアがトップである。
- 全項目合計から、ブラジル、サウジアラビアに代わり、フランス、ドイツが10位以内に加わる。

Top10＋日本（2015～2025年累計）



Top10＋日本（年次推移）



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
China	12	13	20	20	49	62	82	114	107	110
United States	21	17	39	44	44	49	51	58	42	44
Italy	7	8	6	21	19	23	26	22	19	21
India	9	15	15	12	17	28	34	7	1	2
Canada	10	5	6	8	12	12	24	21	11	12
United Kingdom	8	9	8	8	15	14	17	16	9	15
Australia	4	8	11	7	4	13	14	23	17	11
Spain	8	9	7	13	6	13	20	5	8	8
France	12	4	1	7	15	11	6	14	7	12
Germany	3	5	6	7	8	10	12	9	4	11
Japan	2	2	3	7	4	5	5	1	2	3

2．論文等の動向｜論文（被引用数Top10%）

（１）調査のアプローチ

（補足４）検索クエリ　１（１）#１ 微生物肥料

("bio fertilizer"~1 OR biofertilizer OR "bio inoculant"~1 OR bioinoculant OR "bio compost"~1 OR biocompost OR "microbial fertilizer"~1 OR "microbial inoculant"~1 OR "microbial compost"~1 OR "Plant Growth Promoting")
OR
((nitrogen OR nitrogenous OR nitrate OR nitrite OR ammonia OR ammonium OR urea OR phosphate OR phosphoric OR phosphatic OR phosphorus OR phosphite OR potash OR potassium OR potassic OR kalium OR fertilizer OR inoculant OR compost OR NH3 OR NH4 OR NO3 OR NO2 OR PO4 OR P2O5 OR K2O OR KCl OR K2SO4) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（１）#2 微生物農薬

("bio pesticide"~1 OR biopesticide OR "bio insecticide"~1 OR bioinsecticide OR "bio fungicide"~1 OR biofungicide OR "bio nematicide"~1 OR bionematicide OR "bio herbicide"~1 OR bioherbicide OR "bio virucide"~1 OR biovirucide OR "microbial pesticide"~1 OR "microbial insecticide"~1 OR "microbial fungicide"~1 OR "microbial nematicide"~1 OR "microbial herbicide"~1 OR "microbial virucide"~1 OR "bio acaricide"~1 OR bioacaricide OR "microbial acaricide"~1 OR "bio bactericide"~1 OR biobactericide OR "microbial bactericide"~1 OR "bio molluscicide"~1 OR biomolluscicide OR "microbial molluscicide"~1 OR "bio larvicide"~1 OR biolarvicide OR "microbial larvicide"~1 OR "bio ovicide"~1 OR bioovicide OR "microbial ovicide"~1)
OR
((pesticide OR "pest management"~1 OR insecticide OR fungicide OR nematicide OR herbicide OR virucide OR acaricide OR bactericide OR molluscicide OR larvicide OR ovicide OR "biological control"~1 OR biocontrol OR "bio control"~1) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（1）#3 バイオスティミュラント

(biostimulant OR "bio stimulant"~1 OR "Plant Growth Promoting"~1)
OR
((bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR actinomycetes OR endophyte OR epiphyte OR fungi OR fungus OR yeast OR microalgae OR microphytes OR "arbuscular mycorrhiza"~1 OR Acaulospora OR Acetobacter OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gigaspora OR Gluconacetobacter OR Haematococcus OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanomicrobium OR Methanothrix OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR unneliformis OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria") AND (((nutrient OR nitrogen OR phosphorus OR potassium OR water) AND ("use efficiency"~1 OR availability)) OR (stress AND (tolerance OR resistance OR resilience OR adaptation) OR "quality traits"~1)) AND (improve OR enhance OR increase OR promote OR stimulate OR augment OR boost OR mitigate OR alleviate OR protect OR preserve OR maintain OR prolong OR extension OR extend OR strengthen) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere)

（１）調査のアプローチ

（補足４）検索クエリ　１（1）#4 人工土壌

(Technosol OR Technosoil OR "constructed soil"~1 OR "soil constructed"~1 OR "manufactured soil"~1 OR "soil manufactured"~1 OR "engineered soil"~1 OR "soil engineered"~1 OR "synthetic soil"~1 OR "soil synthetic"~1 OR "artificial soil"~1 OR "soil artificial"~1 OR "bio crust"~1 OR biocrust) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Acutodesmus OR Akanthomyces OR Anabaena OR Arthrobacter OR Aspergillus OR Aureobasidium OR Azotobacter OR Bacillus OR Bradyrhizobium OR Chlorella OR Claroideoglomus OR Clostridium OR Desmodesmus OR Ensifer OR Enterobacter OR Funneliformis OR Herbaspirillum OR Hydrogenophaga OR Lactiplantibacillus OR Mesorhizobium OR Metarhizium OR Methylacidimicrobium OR Methylocystis OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrospira OR Nostoc OR Paenibacillus OR Paracoccus OR Phormidium OR Pseudomonas OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Saccharomyces OR Scytonema OR Streptomyces OR Thauera OR Thermoanaerobacter OR Trichoderma)

（1）調査のアプローチ

（補足4）検索クエリ　1（2）（2-1）#5 発酵飼料

((fermented OR fermentation OR fermenting OR fermentative) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail))
OR
((silage OR haylage OR ensile) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacter OR Akanthomyces OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Brevibacterium OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leuconostoc OR Levilactobacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanocorpusculum OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methanothermobacter OR Methanothrix OR Methylococcus OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Nannochloropsis OR Nitrobacter OR Nitrososphaera OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetraselmis OR Thauera OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　1（2）（2-1）#6 SCP/微生物たんぱく質

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)
OR
("alternative protein"~1 OR "sustainable protein"~1 OR "plant-based protein"~1 OR "animal-free protein"~1 OR "cultured protein"~1 OR "cultivated protein"~1 OR "cell-based protein"~1 OR "lab-grown protein"~1 OR "protein alternative"~1 OR "protein sustainable"~1 OR "protein plant-based"~1 OR "protein animal-free"~1 OR "protein cultured"~1 OR "protein cultivated"~1 OR "protein cell-based"~1 OR "protein lab-grown"~1 OR "protein substitute"~1 OR "protein analogue"~1) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Botryococcus OR Brevibacterium OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Megasphaera OR Methanococcus OR Methanoculleus OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrosomonas OR Nitrosospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Shewanella OR Skeletonema OR Spirulina OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR "Candidatus Brocadia" OR "lactic acid bacteria")

（１）調査のアプローチ

（補足４）検索クエリ　1（2）（2-1）#7 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR immunobiotic OR eubiotic OR phytobiotic) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)
OR ((feed OR meal OR diet OR ration OR grain) AND (("additive" OR "supplement" OR "direct fed"~1) OR ((("antimicrobial growth promoter"~1 OR "antibiotic growth promoter"~1) AND (alternative OR replacement)) OR "non antibiotic growth promoter"~1 OR "non antimicrobial growth promoter"~1))) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR "lactic acid bacteria" OR Acetobacter OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Beauveria OR Bifidobacterium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Isochrysis OR Issatchenkia OR Kazachstania OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanobacterium OR Methanobrevibacter OR Methanocorpusculum OR Methanosphaera OR Methanothermobacter OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Purpureocillium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Selenomonas OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "lactic acid bacteria")

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-1）#8 必須アミノ酸等のバイオ生産

(feed OR meal OR diet OR ration OR grain) AND (("amino acid" OR lysine OR methionine OR threonine OR tryptophan OR valine OR isoleucine OR leucine OR phenylalanine OR histidine OR arginine OR enzyme OR Phytase OR Xylanase OR "Beta-glucanase" OR "Beta-mannanase" OR "Alpha-galactosidase" OR Cellulase OR Pectinase OR Polygalacturonase OR "Alpha-amylase" OR Glucoamylase OR Pullulanase OR Protease OR "Ferulic acid esterase") AND ("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1)) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-1）#9 糞尿処理

((manure OR slurry OR litter OR dung OR feces OR faeces OR excreta OR urine) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)) AND (fertilizer OR compost OR biogas OR biomethane OR "anaerobic digestion"~1 OR "anaerobic digester"~1 OR "co-digestion"~1 OR "co-digester"~1 OR "bio filter"~1 OR biofilter OR "bio filtration"~1 OR biofiltration OR "bio trickling"~1 OR biotrickling OR "bio scrubber"~1 OR bioscrubber OR "bio remediation"~1 OR bioremediation OR "bio filtration"~1 OR biofiltration OR "phyto remediation"~1 OR phytoremediation OR "biological treatment"~1 OR bioaugmentation OR "bio augmentation"~1)

2．論文等の動向｜論文（被引用数Top10%）

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-2）#10 発酵飼料

(fermented OR fermentation OR fermenting OR fermentative) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
(silage OR haylage OR ensile) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacter OR Actinomucor OR Acutodesmus OR Akanthomyces OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanomicrobium OR Methanothrix OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "lactic acid bacteria")

2．論文等の動向｜論文（被引用数Top10%）

（1）調査のアプローチ

（補足4）検索クエリ　1（2）（2-2）#11 SCP/微生物たんぱく質

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
("alternative protein"~1 OR "sustainable protein"~1 OR "plant-based protein"~1 OR "animal-free protein"~1 OR "cultured protein"~1 OR "cultivated protein"~1 OR "cell-based protein"~1 OR "lab-grown protein"~1 OR "protein alternative"~1 OR "protein sustainable"~1 OR "protein plant-based"~1 OR "protein animal-free"~1 OR "protein cultured"~1 OR "protein cultivated"~1 OR "protein cell-based"~1 OR "protein lab-grown"~1 OR "protein substitute"~1 OR "protein analogue"~1) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Botryococcus OR Brevibacterium OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Enterobacter OR Euglena OR Galdieria OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanococcus OR Methanosaeta OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Shewanella OR Skeletonema OR Spirulina OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thauera OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium)

（１）調査のアプローチ

（補足４）検索クエリ　1（2）（2-2）#12 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR immunobiotic OR eubiotic OR phytobiotic) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
((feed OR meal OR diet OR ration OR grain) AND (("additive" OR "supplement" OR "direct fed"~1) OR ((("antimicrobial growth promoter"~1 OR "antibiotic growth promoter"~1) AND (alternative OR replacement)) OR "non antibiotic growth promoter"~1 OR "non antimicrobial growth promoter"~1))) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR cyanobacteria OR "lactic acid bacteria" OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Hanseniaspora OR Isochrysis OR Kazachstania OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanomassiliicoccus OR Methanosarcina OR Methylococcus OR Methylocystis OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrosospira OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "lactic acid bacteria")

（1）調査のアプローチ

（補足4）検索クエリ　1（2）（2-2）#13 SCO/藻油/必須脂肪酸等のバイオ生産

((“single cell oil”~1 OR “microbial oil”~1 OR “fungal oil”~1 OR “bacterial oil”~1 OR “yeast oil”~1 OR “microalgal oil”~1 OR “oleaginous bacteria”~1 OR “oleaginous yeast”~1 OR “oleaginous fungus”~1 OR “oleaginous fungi”~1 OR “oleaginous microalgae”~1) AND (“eicosapentaenoic acid” OR “docosahexaenoic acid” OR “arachidonic acid” OR “omega-3 fatty acids” OR “essential fatty acid” OR “long-chain polyunsaturated fatty acids” OR “unsaturated fatty acid” OR astaxanthin))
OR
((“bio engineering”~1 OR bioengineering OR “biological engineering”~1 OR “bio manufacturing”~1 OR biomanufacturing OR “synthetic biology”~1 OR “bio synthesis”~1 OR biosynthesis OR “biological synthesis”~1 OR “strain improvement”~1 OR “strain development”~1 OR “strain optimization”~1 OR “strain selection”~1 OR “bio process”~1 OR bioprocess OR “biological process”~1 OR “bio refining”~1 OR biorefining OR “bio reactor”~1 OR bioreactor OR “bio foundry”~1 OR biofoundry OR “fed batch”~1 OR fedbatch OR “perfusion culture”~1 OR chemostat OR “cell culture”~1 OR “tissue culture”~1 OR “embryo culture”~1 OR “bio catalysis”~1 OR biocatalysis OR “bio technology”~1 OR biotechnology OR “precision fermentation”~1 OR “microbial breeding”~1 OR “industrial microbiology”~1 OR “applied microbiology”~1) AND (“eicosapentaenoic acid” OR “docosahexaenoic acid” OR “arachidonic acid” OR “omega-3 fatty acids” OR “essential fatty acid” OR “long-chain polyunsaturated fatty acids” OR “unsaturated fatty acid” OR astaxanthin) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clonostachys OR Clostridium OR Corynebacterium OR Crypthecodinium OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconobacter OR Haematococcus OR Halanaerobium OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lactiplantibacillus OR Leptolyngbya OR Leuconostoc OR Lysinibacillus OR Metarhizium OR Methanobrevibacter OR Methanococcus OR Methylacidimicrobium OR Methylocaldum OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrospira OR Nitzschia OR Nostoc OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Staphylococcus OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR “Candidatus Kuenenia” OR “lactic acid bacteria”))

（１）調査のアプローチ

（補足４）検索クエリ　1（2）（2-2）#14 水質管理

((biofilter OR "bio filter"~1 OR biofiltration OR "bio filtration"~1 OR "bio trickling"~1 OR biotrickling OR "biological filter"~1 OR bioreactor OR "bio reactor"~1 OR biofloc OR "bio floc"~1 OR bioremediation OR "bio remediation"~1 OR bioaugmentation OR "bio augmentation"~1 OR phytoremediation OR "biological treatment"~1 OR anammox) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus"))
OR
((nitrification OR denitrification) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clostridium OR Corynebacterium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Haematococcus OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isochrysis OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanocaldococcus OR Methanococcus OR Methanosaeta OR Methanosarcina OR Methanothrix OR Methylacidimicrobium OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Microchloropsis OR Moorella OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Rhizobium OR Rhizophagus OR Rhodobacter OR Rhodopseudomonas OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Selenomonas OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thauera OR Thiobacillus OR Tisochrysis OR Trichoderma OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR "Candidatus Brocadia" OR "Candidatus Jettenia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足４）検索クエリ　１（２）（2-2）#15 生物防除

(biocontrol OR "biological control" OR "antagonistic bacteria"~1 OR "bacterial antagonist"~1 OR "quorum quenching"~1 OR bacteriocin) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanopyrus OR Methanosarcina OR Methanothrix OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrosospira OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Skeletonema OR Spirulina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "Candidatus Kuenenia" OR "lactic acid bacteria")

（１）調査のアプローチ

（補足４）検索クエリ　２（１）#16 発酵食品

((fermented OR fermentation OR fermenting OR fermentative) AND ("food" OR "ready to eat" OR "beverage" OR "drink" OR "alcoholic beverage" OR "dairy product" OR "milk product") OR (miso OR "soy sauce" OR sake OR shochu OR amazake OR vinegar OR nukazuke OR pickles OR kimchi OR sauerkraut OR natto OR tempeh OR sourdough OR yogurt OR cheese OR kefir OR buttermilk OR katsuobushi OR narezushi OR "fish sauce" OR "nam pla" OR "nuoc mam" OR shiokara OR wine OR beer OR cider OR kombucha)) AND (Acetobacter OR Actinomucor OR Acutodesmus OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Bifidobacterium OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Jettenia" OR "lactic acid bacteria" OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)
AND
(safety OR "shelf life" OR "freshness" OR "preservation" OR "clean label" OR quality OR stability OR consistency OR "batch-to-batch" OR "standardized" OR "spoilage control" OR "mold control" OR "yeast control" OR contamination OR poisoning OR "flavor" OR "aroma" OR "smell" OR "taste" OR "aftertaste" OR "mouthfeel" OR "texture" OR "thickness" OR "creaminess" OR "smoothness" OR "crispiness" OR "springiness" OR "chewiness" OR "crumb structure" OR "richness" OR "balance" OR "sweetness" OR "sourness" OR "bitterness" OR "saltiness" OR "umami" OR "savory" OR "off odor" OR health OR digestion OR immunity OR antioxidant OR anti-inflammatory OR "blood sugar" OR "blood pressure" OR cholesterol)
AND
("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1)

（１）調査のアプローチ

（補足４）検索クエリ　２（２）#17 精密発酵

"precision fermentation"
OR
((("genetic engineering"~1 OR "genome engineering"~1 OR "engineering genome"~1 OR "genetically engineered"~1 OR "engineered genetically"~1 OR "genetic modification"~1 OR "genetically modified"~1 OR "modified genetically"~1 OR "protein engineering"~1 OR "engineering protein"~1 OR "enzyme engineering"~1 OR "engineering enzyme"~1 OR "metabolic engineering"~1 OR "peptide engineering"~1 OR "pathway engineering"~1 OR "engineering pathway"~1 OR "strain engineering"~1 OR "engineering strain"~1 OR "host engineering"~1 OR "engineering host"~1 OR "chassis engineering"~1 OR ("bio engineering"~1 OR bioengineering) OR "biological engineering"~1 OR "tissue engineering"~1 OR "cell engineering"~1 OR "cellular engineering"~1 OR "synthetic biology"~1 OR "DNA synthesis"~1 OR "RNA synthesis"~1 OR "gene synthesis"~1 OR "oligonucleotide synthesis"~1 OR "protein synthesis"~1 OR "peptide synthesis"~1 OR ("bio synthesis"~1 OR biosynthesis) OR "biological synthesis"~1 OR "gene editing"~1 OR "genome editing"~1 OR "editing genome"~1 OR "genetic editing"~1 OR "genetically edited"~1 OR "edited genetically"~1 OR CRISPR OR recombinant OR "heterologous expression"~1 OR overexpression OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1) AND (food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acetobacter OR Acetobacterium OR Acidithiobacillus OR Alcaligenes OR Anabaena OR Arthrobacter OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Bifidobacterium OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR enococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gallionella OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Metarhizium OR Methanococcus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella))

2．論文等の動向｜論文（被引用数Top10%）

（1）調査のアプローチ

（補足4）検索クエリ　2（2）#18 SCP/代替食品

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken OR human)
OR
("alternative food"~1 OR "alternative groceries"~1 OR "alternative beverage"~1 OR "alternative drink"~1 OR "alternative dairy"~1 OR "alternative milk"~1 OR "alternative meat"~1 OR "alternative beef"~1 OR "alternative seafood"~1 OR "alternative pork"~1 OR "alternative chicken"~1 OR "sustainable food"~1 OR "sustainable groceries"~1 OR "sustainable beverage"~1 OR "sustainable drink"~1 OR "sustainable dairy"~1 OR "sustainable milk"~1 OR "sustainable meat"~1 OR "sustainable beef"~1 OR "sustainable seafood"~1 OR "sustainable pork"~1 OR "sustainable chicken"~1 OR "plant-based food"~1 OR "plant-based groceries"~1 OR "plant-based beverage"~1 OR "plant-based drink"~1 OR "plant-based dairy"~1 OR "plant-based milk"~1 OR "plant-based meat"~1 OR "plant-based beef"~1 OR "plant-based seafood"~1 OR "plant-based pork"~1 OR "plant-based chicken"~1 OR "animal free food"~1 OR "animal free groceries"~1 OR "animal free beverage"~1 OR "animal free drink"~1 OR "animal free dairy"~1 OR "animal free milk"~1 OR "animal free meat"~1 OR "animal free beef"~1 OR "animal free seafood"~1 OR "animal free pork"~1 OR "animal free chicken"~1 OR "cultured food"~1 OR "cultured groceries"~1 OR "cultured beverage"~1 OR "cultured drink"~1 OR "cultured dairy"~1 OR "cultured milk"~1 OR "cultured meat"~1 OR "cultured beef"~1 OR "cultured seafood"~1 OR "cultured pork"~1 OR "cultured chicken"~1 OR "cultivated food"~1 OR "cultivated groceries"~1 OR "cultivated beverage"~1 OR "cultivated drink"~1 OR "cultivated dairy"~1 OR "cultivated milk"~1 OR "cultivated meat"~1 OR "cultivated beef"~1 OR "cultivated seafood"~1 OR "cultivated pork"~1 OR "cultivated chicken"~1 OR "cell based food"~1 OR "cell based groceries"~1 OR "cell based beverage"~1 OR "cell based drink"~1 OR "cell based dairy"~1 OR "cell based milk"~1 OR "cell based meat"~1 OR "cell based beef"~1 OR "cell based seafood"~1 OR "cell based pork"~1 OR "cell based chicken"~1 OR "lab grown food"~1 OR "lab grown groceries"~1 OR "lab grown beverage"~1 OR "lab grown drink"~1 OR "lab grown dairy"~1 OR "lab grown milk"~1 OR "lab grown meat"~1 OR "lab grown beef"~1 OR "lab grown seafood"~1 OR "lab grown pork"~1 OR "lab grown chicken"~1 OR "food substitute"~1 OR "food alternative"~1 OR "food analogue"~1 OR "groceries substitute"~1 OR "groceries alternative"~1 OR "groceries analogue"~1 OR "beverage substitute"~1 OR "beverage alternative"~1 OR "beverage analogue"~1 OR "drink substitute"~1 OR "drink alternative"~1 OR "drink analogue"~1 OR "dairy substitute"~1 OR "dairy alternative"~1 OR "dairy analogue"~1 OR "milk substitute"~1 OR "milk alternative"~1 OR "milk analogue"~1 OR "meat substitute"~1 OR "meat alternative"~1 OR "meat analogue"~1 OR "beef substitute"~1 OR "beef alternative"~1 OR "beef analogue"~1 OR "seafood substitute"~1 OR "seafood alternative"~1 OR "seafood analogue"~1 OR "pork substitute"~1 OR "pork alternative"~1 OR "pork analogue"~1 OR "chicken substitute"~1 OR "chicken alternative"~1 OR "chicken analogue"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Candida OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconobacter OR Haematococcus OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Methanococcus OR Methylacidiphilum OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Propionibacterium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella)

（１）調査のアプローチ

（補足４）検索クエリ　２（２）#19 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR psychobiotic OR immunobiotic OR eubiotic) AND NOT (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail OR aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")

2．論文等の動向｜論文（被引用数Top10%）

（1）調査のアプローチ

（補足４）検索クエリ　2（2）#20 合成生物学や代謝工学

(food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken) AND ("synthetic biology"~1 OR "DNA synthesis"~1 OR "RNA synthesis"~1 OR "gene synthesis"~1 OR "oligonucleotide synthesis"~1 OR "protein synthesis"~1 OR "peptide synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "metabolic engineering"~1 OR "peptide engineering"~1 OR "pathway engineering"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acetobacter OR Acetobacterium OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanocaldococcus OR Methanococcus OR Methanosarcina OR Methanothrix OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)

（１）調査のアプローチ

（補足４）検索クエリ　２（２）#21 未利用資源活用や大量生産

(food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken) AND ("biomass fermentation"~1 OR "biomass valorization"~1 OR "biomass upcycling"~1 OR "circular bioeconomy"~1 OR byproducts OR "non-edible part"~1 OR "non-edible fraction"~1 OR "inedible part"~1 OR "inedible fraction"~1 OR "non food part"~1 OR "non food fraction"~1 OR "underutilized biomass"~1 OR "underutilised biomass"~1 OR "underused biomass"~1 OR "unused biomass"~1 OR "untapped biomass"~1 OR "residual biomass"~1 OR "waste biomass"~1 OR lignocellulose OR "lignocellulosic biomass"~1 OR "lignocellulosic material"~1 OR "lignocellulosic feedstock"~1 OR "cellulosic biomass"~1 OR "cellulosic feedstock"~1 OR "cellulosic material"~1 OR "woody biomass"~1 OR "plant biomass"~1 OR "lignocellulosic hydrolysate"~1 OR "cellulosic hydrolysate"~1 OR "hemicellulose hydrolysate"~1 OR biomanufacturing OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1 OR "scale up"~1 OR "large scale"~1 OR "high throughput"~1 OR "Contract Manufacturing Organization"~1 OR "Contract Development and Manufacturing Organization"~1 OR "Fermentation-as-a-Service"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acaulospora OR Acetobacter OR Acetobacterium OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Methanococcus OR Methanoculleus OR Methanomicrobium OR Methanothermobacter OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrosospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Selenomonas OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #22 有用菌探索

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(genomics OR proteomics OR transcriptomics OR metabolomics OR "DNA sequencing"~1 OR "sequencing DNA"~1 OR "RNA sequencing"~1 OR "sequencing RNA"~1 OR "single cell sequencing"~1 OR "amplicon sequencing"~1 OR "protein sequencing"~1 OR "peptide sequencing"~1 OR "DNA amplification"~1 OR "RNA amplification"~1 OR PCR OR "gene probes"~1 OR "DNA probes"~1 OR "DNA markers"~1 OR "molecular marker"~1 OR "gene chip"~1 OR bioinformatics OR "computational biology"~1 OR "resource mining"~1 OR "gene profiling"~1 OR "RNA profiling"~1 OR "protein profiling"~1 OR "proteome profiling"~1 OR "peptide profiling"~1 OR "metabolic profiling"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #23 設計・合成・改変

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

("genetic engineering"~1 OR "engineering genetic"~1 OR "genome engineering"~1 OR "engineering genome"~1 OR "genetically engineered"~1 OR "engineered genetically"~1 OR "genetic modification"~1 OR "modification genetic"~1 OR "genetically modified"~1 OR "modified genetically"~1 OR "protein engineering"~1 OR "engineering protein"~1 OR "enzyme engineering"~1 OR "engineering enzyme"~1 OR "metabolic engineering"~1 OR "engineering metabolic"~1 OR "peptide engineering"~1 OR "engineering peptide"~1 OR "pathway engineering"~1 OR "engineering pathway"~1 OR "strain engineering"~1 OR "engineering strain"~1 OR "host engineering"~1 OR "engineering host"~1 OR "chassis engineering"~1 OR "engineering chassis"~1 OR bioengineering OR "bio engineering"~1 OR "biological engineering"~1 OR "engineering biological"~1 OR "tissue engineering"~1 OR "engineering tissue"~1 OR "cell engineering"~1 OR "engineering cell"~1 OR "cellular engineering"~1 OR "engineering cellular"~1 OR "synthetic biology"~1 OR "biology synthetic"~1 OR "DNA synthesis"~1 OR "synthesis DNA"~1 OR "RNA synthesis"~1 OR "synthesis RNA"~1 OR "gene synthesis"~1 OR "synthesis gene"~1 OR "oligonucleotide synthesis"~1 OR "synthesis oligonucleotide"~1 OR "protein synthesis"~1 OR "synthesis protein"~1 OR "peptide synthesis"~1 OR "synthesis peptide"~1 OR biosynthesis OR "bio synthesis"~1 OR "biological synthesis"~1 OR "synthesis biological"~1 OR "gene editing"~1 OR "editing gene"~1 OR "genome editing"~1 OR "editing genome"~1 OR "genetic editing"~1 OR "editing genetic"~1 OR "genetically edited"~1 OR "edited genetically"~1 OR CRISPR OR recombinant OR "heterologous expression"~1 OR "expression heterologous"~1 OR overexpression OR "strain improvement"~1 OR "improvement strain"~1 OR "strain development"~1 OR "development strain"~1 OR "strain optimization"~1 OR "optimization strain"~1 OR "strain selection"~1 OR "selection strain"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #24 培養・生産・デジタル

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(bioprocess OR "bio process"~1 OR "biological process"~1 OR "process biological"~1 OR biorefining OR "bio refining"~1 OR bioreactor OR "bio reactor"~1 OR biofoundry OR "bio foundry"~1 OR "fed batch"~1 OR "batch fed"~1 OR "perfusion culture"~1 OR "culture perfusion"~1 OR chemostat OR "cell culture"~1 OR "culture cell"~1 OR "tissue culture"~1 OR "culture tissue"~1 OR "embryo culture"~1 OR "culture embryo"~1 OR biocatalysis OR "bio catalysis"~1 OR biotechnology OR "bio technology"~1 OR biomanufacturing OR "bio manufacturing"~1 OR "precision fermentation"~1 OR "fermentation precision"~1 OR "microbial breeding"~1 OR "breeding microbial"~1 OR "industrial microbiology"~1 OR "microbiology industrial"~1 OR "applied microbiology"~1 OR "microbiology applied"~1 OR "scale up"~1 OR "up scale"~1 OR "large scale"~1 OR "scale large"~1 OR "high throughput"~1 OR "throughput high"~1 OR "Contract Manufacturing Organization"~1 OR "Manufacturing Organization Contract"~1 OR "Contract Development and Manufacturing Organization"~1 OR "Development and Manufacturing Organization Contract"~1 OR "Fermentation-as-a-Service" OR "digital twin"~1 OR "twin digital"~1 OR "process analytical technology"~1 OR "analytical technology process"~1 OR "quality by design"~1 OR "design quality"~1 OR "soft sensor"~1 OR "sensor soft"~1 OR "virtual sensor"~1 OR "sensor virtual"~1 OR chemometrics OR "model predictive control"~1 OR "predictive control model"~1 OR "state estimation"~1 OR "estimation state"~1 OR "digital thread"~1 OR "thread digital"~1 OR "big data"~1 OR "data big"~1 OR "machine learning"~1 OR "learning machine"~1 OR "deep learning"~1 OR "learning deep"~1 OR "neural network"~1 OR "network neural"~1 OR "random forest"~1 OR "forest random"~1 OR "gradient boosting"~1 OR "boosting gradient"~1 OR "support vector"~1 OR "vector support"~1 OR "Gaussian process"~1 OR "process Gaussian"~1 OR "Bayesian optimization"~1 OR "optimization Bayesian"~1 OR "reinforcement learning"~1 OR "learning reinforcement"~1 OR "active learning"~1 OR "learning active"~1 OR "transfer learning"~1 OR "learning transfer"~1 OR "semi-supervised"~1 OR "self-supervised"~1 OR "anomaly detection"~1 OR "detection anomaly"~1 OR "computer vision"~1 OR "vision computer"~1 OR "image analysis"~1 OR "analysis image"~1 OR "object detection"~1 OR "detection object"~1 OR IoT OR "edge computing"~1 OR "computing edge"~1 OR "fog computing"~1 OR "computing fog"~1 OR "cloud computing"~1 OR "computing cloud"~1 OR "wireless sensor"~1 OR "sensor wireless"~1 OR "sensor network"~1 OR "network sensor"~1 OR SCADA OR biofoundry OR "bio foundry"~1 OR automation OR autonomous OR robot OR autosampler OR "auto sampler"~1 OR "microplate handler"~1 OR "handler microplate"~1 OR "liquid handling"~1 OR "handling liquid"~1 OR "colony picker"~1 OR "picker colony"~1)

（１）調査のアプローチ

（補足４）検索クエリ　３ #25 環境・資源

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(bioremediation OR "bio remediation"~1 OR biofiltration OR "bio filtration"~1 OR phytoremediation OR "phyto remediation"~1 OR "biological treatment"~1 OR "treatment biological"~1 OR bioaugmentation OR "bio augmentation"~1 OR "life cycle assessment"~1 OR "cycle assessment life"~1 OR environment OR sustainability OR "climate change"~1 OR "change climate"~1 OR "global warming"~1 OR "warming global"~1 OR decarbonization OR decarbonisation OR "net zero"~1 OR "zero net"~1 OR "carbon neutrality"~1 OR "neutrality carbon"~1 OR "carbon capture"~1 OR "capture carbon"~1 OR "carbon utilization"~1 OR "utilization carbon"~1 OR "carbon storage"~1 OR "storage carbon"~1 OR "carbon footprint"~1 OR "footprint carbon"~1 OR "greenhouse gas"~1 OR "gas greenhouse"~1 OR CO2 OR "carbon dioxide"~1 OR "dioxide carbon"~1 OR methane OR CH4 OR "nitrous oxide"~1 OR "oxide nitrous"~1 OR N2O OR syngas OR "circular economy"~1 OR "economy circular"~1 OR "water footprint"~1 OR "footprint water"~1 OR wastewater OR "waste water"~1 OR effluent)

付属資料１　論文の分析（キーワード）

（1）調査のアプローチ

- **論文データベースとしてLens.orgを用い、対象期間は2015年1月～2025年9月とし、本調査が対象とする研究領域に該当する論文数を調査した。**

実施手順

1．検索クエリ設計	- 対象研究領域に対して、25の検索クエリを策定。
2．初期データセット作成	- Lens.org（https://www.lens.org/）に検索クエリを入力し、初期的なデータセットを作成（検索期間は2015年1月～2025年9月）。
3．AIによる整合性判断	- 本プロジェクトの制約条件や、検索クエリの設計意図をAIに入力し、初期データセットの各論文に対して、その対象項目との整合性をAIが判断。
4．人間によるデータセット最終化	- AIの判断を人間がサンプルチェックし、その対象項目に含まれるべき論文を最終化（データセット最終化）。
5-1.国別年次別の定量分析（付属資料１ 論文の分析（論文数））	- 最終化されたデータセットの書誌情報（出版年、著者所属機関の国名）を用いて、国別・年次別の論文数を分析。
5-2.被引用数Top10%の定量分析（付属資料１ 論文の分析（被引用数））	- 最終化されたデータセットから、年毎の被引用数Top10%の論文（整数カウント法, 境界同率は全件含む）を抽出。その被引用数Top10%の論文データセットにおいて、国別の論文数を分析。
5-3.キーワードの定量分析（付属資料１ 論文の分析（キーワード））	- 最終化されたデータセットの書誌情報（キーワードタグ）を用いて、国別（中国とそれ以外）・年次別・キーワード別の論文数を分析

（１）調査のアプローチ

（補足１）Lens.orgについて

- **Journal Articleを約1.4億件収録するデータベース**

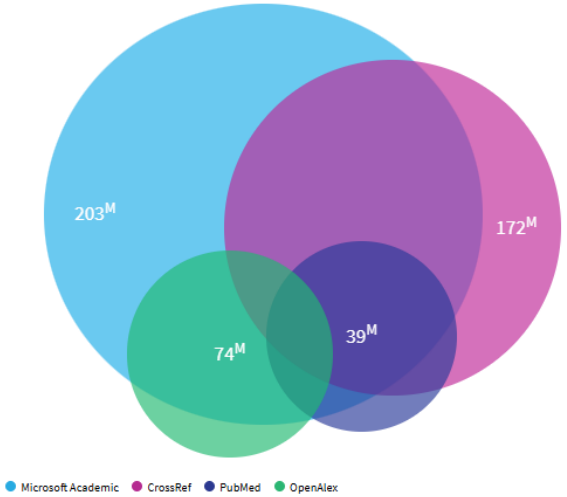
参考比較）Scopus（Elsevier）：9,060万件の文献[1]

参考比較）Web of Science Core Collection（Clarivate）：9700万件の文献[2]

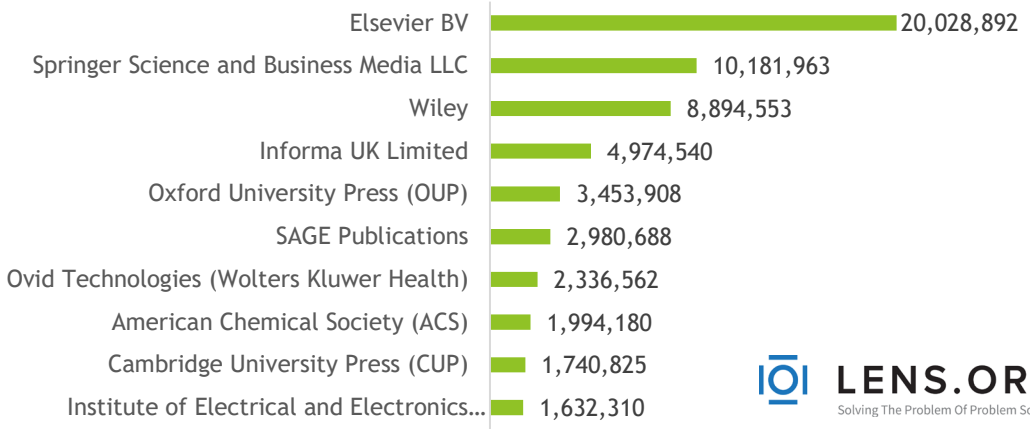
Lens.org概要

Lens.orgは世界的な非営利の社会的企業であるCambia（https://cambia.org/）が運営するオープンプラットフォーム（https://www.lens.org/）

書誌情報の主要なデータソース



主要な収録出版社（収録数Top10）（数値はJournal Article）



[1] https://view.highspot.com/viewer/6551e65b86380b4ef0fb87f9
[2] https://clarivate.com/academia-government/scientific-and-academic-research/research-discovery-and-referencing/web-of-science/web-of-science-core-collection/

（１）調査のアプローチ

（補足２）検索クエリ設計｜25の検索対象について

- ノイズは後工程で省かれることを念頭に、広めに25の検査クエリを設計※１

検索対象

１．微生物を活用した農林水産業の生産性向上に資する技術開発		
（１）肥料・農薬・バイオスティミュラントの生産技術開発		
#1	微生物肥料	バイオファーティライザーや肥料成分に関与する微生物・微細藻類
#2	微生物農薬	バイオペスティサイドや生物防除に関与する微生物・微細藻類
#3	バイオスティミュラント	栄養利用率や非生物的ストレス耐性、品質特性に好影響を及ぼす微生物・微細藻類
#4	人工土壌	人工土壌の創製に関与する微生物・微細藻類
（２）（２－１）畜産｜飼料・餌料等（添加物含む）の生産技術開発		
#5	発酵飼料	発酵処理、発酵エコフィード、サイレージ発酵における微生物・微細藻類
#6	SCP/微生物たんぱく質	Single cell Proteinや微生物たんぱく質
#7	xx-biotics	プロバイオティクスやポストバイオティクス、飼料添加物、AGP代替物における微生物・微細藻類
#8	必須アミノ酸等のバイオ生産	必須栄養素（アミノ酸等）や酵素剤の生産に関わる微生物・微細藻類
#9	糞尿処理	糞尿の堆肥化やバイオガス化、臭気対策に関わる微生物・微細藻類
（２）（２－２）水産｜飼料・餌料等（添加物含む）の生産技術開発		
#10	発酵飼料	発酵処理、発酵エコフィード、サイレージ発酵における微生物・微細藻類
#11	SCP/微生物たんぱく質	Single cell Proteinや微生物たんぱく質（魚粉代替）
#12	xx-biotics	プロバイオティクスやポストバイオティクス、飼料添加物、AGP代替物における微生物・微細藻類
#13	SCO/藻油/必須脂肪酸等のバイオ生産	魚油代替としてのSCOや藻油、必須脂肪酸（DHAやEPA）の生産に関与する微生物・微細藻類
#14	水質管理	水質の維持管理、硝化・脱窒に関与する微生物・微細藻類
#15	生物防除	抗菌性を高める生物防除としての微生物・微細藻類
２．微生物を活用した食料生産技術開発（健康に資する食品を含む）		
（１）伝統発酵による高付加価値食料生産技術開発		
#16	発酵食品	発酵食品の品質安定化や風味変化、健康機能の向上に関するバイオ工学等
（２）微生物による食料生産技術開発（伝統発酵以外）		
#17	精密発酵	精密発酵や目的成分の拡張を目指したバイオ工学等
#18	SCP/代替食品	SCPや代替食品（代替肉や代替シーフード等）における微生物・微細藻類
#19	xx-biotics	プロバイオティクスやポストバイオティクス、サプリメントにおける微生物・微細藻類
#20	合成生物学や代謝工学	合成生物学による新たな機能や代謝設計に関する研究
#21	未利用資源活用や大量生産	未利用資源活用における微生物・微細藻類、大量発酵施設やB2B発酵等の産業化に関する研究
３．微生物を産業として活用することに資する研究開発		
#22	有用菌探索	ゲノミクスやシーケンシング、プロファイリング等に関する研究
#23	設計・合成・改変	ゲノムエンジニアリングや合成生物学、株開発等に関する研究
#24	培養・生産・デジタル	バイオ生産や培地、育種、産業化（大量生産やB2Bサービス）、AIやIoT等に関する研究
#25	環境・資源	環境配慮型、CO2削減等に資する研究開発

※１）定量分析のアウトプット自体は、報告書の章立てに沿った形式でアウトプットしている。

（１）調査のアプローチ

（補足３）検索クエリのサンプル※1

- **およその設計思想としては、「代表的な言葉」 OR 「関連語の組み合わせ」としている※2**

※「関連語の組み合わせ」をサポートクエリとして用意することで、「代表的な言葉を使っていないが、同じ目的の研究だと考えられる論文」の抽出も行うことが狙い。
※なお、検索結果に含まれ得るノイズの多くは、実施手順③AIによる整合性判断で弾かれる。

サンプル｜1（1）#1 微生物肥料

メイン

("bio fertilizer"~1 OR biofertilizer OR "bio inoculant"~1 OR bioinoculant OR "bio compost"~1 OR biocompost OR "microbial fertilizer"~1 OR "microbial inoculant"~1 OR "microbial compost"~1 OR "Plant Growth Promoting")
OR

サポート（（肥料成分）×（農業用語）×（微生物用語））

((nitrogen OR nitrogenous OR nitrate OR nitrite OR ammonia OR ammonium OR urea OR phosphate OR phosphoric OR phosphatic OR phosphorus OR phosphite OR potash OR potassium OR potassic OR kalium OR fertilizer OR inoculant OR compost OR NH3 OR NH4 OR NO3 OR NO2 OR PO4 OR P2O5 OR K2O OR KCl OR K2SO4) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

※１）本紙論文パートの末尾に全ての検索クエリを掲載
※２）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

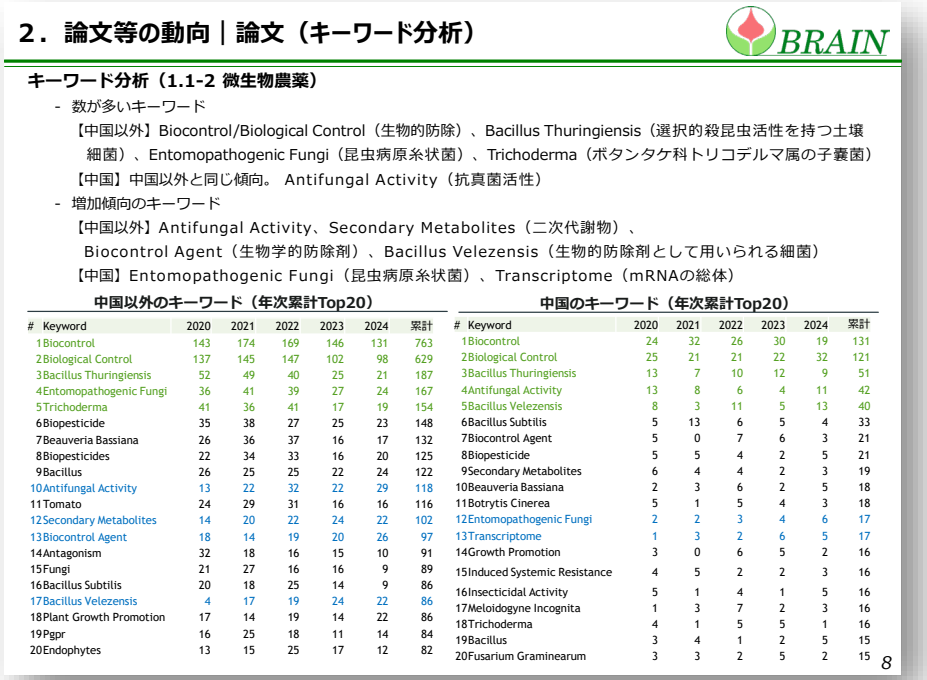
（1）調査のアプローチ

（補足４）キーワード分析の目的・実施概要

- 研究テーマのトレンドを把握することを目的とし、各論文にタグ付けされているキーワード別に、論文数を集計した。
  - 対象国｜「中国」と「中国以外の国」に分類
  - 対象期間｜2020年～2024年（年毎に集計）
  - 対象分野｜微生物肥料、微生物農薬、バイオスティミュラント、人工土壌、飼料餌料等（畜産）、飼料餌料等（水産）、伝統発酵による高付加価値食料生産技術開発、微生物による食料生産技術開発（伝統発酵以外）、微生物を産業として活用することに資する研究開発
- なお、コメント欄には、数が多いキーワード（緑色）と増加傾向のキーワード（青色）を採り上げた。

コメント

年次累計Top20のキーワード



2．論文等の動向｜論文（キーワード分析）

キーワード分析（1.1-2 微生物農薬）

- 数が多いキーワード

【中国以外】Biocontrol/Biological Control（生物的防除）、Bacillus Thuringiensis（選択的殺昆虫活性を持つ土壌細菌）、Entomopathogenic Fungi（昆虫病原糸状菌）、Trichoderma（ボタンタケ科トリコデルマ属の子嚢菌）

【中国】中国以外と同じ傾向。 Antifungal Activity（抗真菌活性）

- 増加傾向のキーワード

【中国以外】Antifungal Activity、Secondary Metabolites（二次代謝物）、Biocontrol Agent（生物学的防除剤）、Bacillus Velezensis（生物的防除剤として用いられる細菌）

【中国】Entomopathogenic Fungi（昆虫病原糸状菌）、Transcriptome（mRNAの総体）

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Biocontrol	143	174	169	146	131	763
2	Biological Control	137	145	147	102	98	629
3	Bacillus Thuringiensis	52	49	40	25	21	187
4	Entomopathogenic Fungi	36	41	39	27	24	167
5	Trichoderma	41	36	41	17	19	154
6	Biopesticide	35	38	27	25	23	148
7	Beauveria Bassiana	26	36	37	16	17	132
8	Biopesticides	22	34	33	16	20	125
9	Bacillus	26	25	25	22	24	122
10	Antifungal Activity	13	22	32	22	29	118
11	Tomato	24	29	31	16	16	116
12	Secondary Metabolites	14	20	22	24	22	102
13	Biocontrol Agent	18	14	19	20	26	97
14	Antagonism	32	18	16	15	10	91
15	Fungi	21	27	16	16	9	89
16	Bacillus Subtilis	20	18	25	14	9	86
17	Bacillus Velezensis	4	17	19	24	22	86
18	Plant Growth Promotion	17	14	19	14	22	86
19	Pgpr	16	25	18	11	14	84
20	Endophytes	13	15	25	17	12	82

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Biocontrol	24	32	26	30	19	131
2	Biological Control	25	21	21	22	32	121
3	Bacillus Thuringiensis	13	7	10	12	9	51
4	Antifungal Activity	13	8	6	4	11	42
5	Bacillus Velezensis	8	3	11	5	13	40
6	Bacillus Subtilis	5	13	6	5	4	33
7	Biocontrol Agent	5	0	7	6	3	21
8	Biopesticide	5	5	4	2	5	21
9	Secondary Metabolites	6	4	4	2	3	19
10	Beauveria Bassiana	2	3	6	2	5	18
11	Botrytis Cinerea	5	1	5	4	3	18
12	Entomopathogenic Fungi	2	2	3	4	6	17
13	Transcriptome	1	3	2	6	5	17
14	Growth Promotion	3	0	6	5	2	16
15	Induced Systemic Resistance	4	5	2	2	3	16
16	Insecticidal Activity	5	1	4	1	5	16
17	Meloidogyne Incognita	1	3	7	2	3	16
18	Trichoderma	4	1	5	5	1	16
19	Bacillus	3	4	1	2	5	15
20	Fusarium Graminearum	3	3	2	5	2	15

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キーワード分析（1.1-1 微生物肥料）

- 数が多いキーワード

  【中国以外】Biofertilizer（バイオ肥料）、PGPR（植物生育促進根圏微生物）、Rhizosphere（菌根菌）

  【中国】Bacterial/Microbial Community（微生物群集）、PGPR、Composting（堆肥化）、Rhizosphere

- 増加傾向のキーワード

  【中国以外】なし

  【中国】Microbial Community（微生物群集）

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Biofertilizer	116	132	149	63	41	501
2	Pgpr	111	107	97	50	52	417
3	Yield	88	69	89	16	15	277
4	Biofertilizers	64	86	79	25	19	273
5	Plant Growth Promotion	47	59	64	54	46	270
6	Rhizosphere	53	67	63	47	36	266
7	Sustainable Agriculture	34	57	54	38	46	229
8	Nitrogen Fixation	37	49	38	35	24	183
9	Rhizobium	54	45	48	8	8	163
10	Arbuscular Mycorrhizal Fungi	42	30	32	24	30	158
11	Phosphorus	41	33	38	15	30	157
12	Plant Growth-Promoting Bacteria	18	28	41	26	37	150
13	Soybean	38	35	42	20	11	146
14	Rhizobacteria	42	38	32	17	16	145
15	Growth	47	42	44	8	3	144
16	Biocontrol	23	34	36	30	20	143
17	Wheat	38	24	36	24	16	138
18	Nitrogen	39	32	38	7	9	125
19	Compost	38	37	26	16	7	124
20	Maize	32	35	29	16	10	122

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Bacterial Community	12	13	17	10	7	59
2	Pgpr	13	9	18	5	11	56
3	Composting	11	16	9	12	7	55
4	Microbial Community	9	7	12	12	13	53
5	Rhizosphere	14	10	15	5	8	52
6	Biochar	7	7	15	10	6	45
7	Biofertilizer	9	10	10	5	6	40
8	Arbuscular Mycorrhizal Fungi	2	7	17	7	6	39
9	Soybean	6	4	6	9	7	32
10	Rice	6	6	11	3	5	31
11	Nitrogen Fixation	6	6	8	6	4	30
12	Plant Growth Promotion	5	4	8	3	7	27
13	Microbiome	3	3	10	4	6	26
14	Maize	6	4	5	6	3	24
15	Yield	6	2	6	1	9	24
16	Organic Fertilizer	2	6	7	6	2	23
17	High-Throughput Sequencing	4	4	6	4	4	22
18	Wheat	3	4	8	3	2	20
19	Microbial Diversity	3	5	3	2	6	19
20	Phosphate-Solubilizing Bacteria	2	6	3	4	4	19

キーワード分析（1.1-2 微生物農薬）

- 数が多いキーワード

【中国以外】Biocontrol/Biological Control（生物的防除）、Bacillus Thuringiensis（選択的殺昆虫活性を持つ土壌細菌）、Entomopathogenic Fungi（昆虫病原糸状菌）、Trichoderma（ボタンタケ科トリコデルマ属の子嚢菌）

【中国】中国以外と同じ傾向。 Antifungal Activity（抗真菌活性）

- 増加傾向のキーワード

【中国以外】Antifungal Activity、Secondary Metabolites（二次代謝物）、Biocontrol Agent（生物学的防除剤）、Bacillus Velezensis（生物的防除剤として用いられる細菌）

【中国】Entomopathogenic Fungi（昆虫病原糸状菌）、Transcriptome（mRNAの総体）

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Biocontrol	143	174	169	146	131	763
2	Biological Control	137	145	147	102	98	629
3	Bacillus Thuringiensis	52	49	40	25	21	187
4	Entomopathogenic Fungi	36	41	39	27	24	167
5	Trichoderma	41	36	41	17	19	154
6	Biopesticide	35	38	27	25	23	148
7	Beauveria Bassiana	26	36	37	16	17	132
8	Biopesticides	22	34	33	16	20	125
9	Bacillus	26	25	25	22	24	122
10	Antifungal Activity	13	22	32	22	29	118
11	Tomato	24	29	31	16	16	116
12	Secondary Metabolites	14	20	22	24	22	102
13	Biocontrol Agent	18	14	19	20	26	97
14	Antagonism	32	18	16	15	10	91
15	Fungi	21	27	16	16	9	89
16	Bacillus Subtilis	20	18	25	14	9	86
17	Bacillus Velezensis	4	17	19	24	22	86
18	Plant Growth Promotion	17	14	19	14	22	86
19	Pgpr	16	25	18	11	14	84
20	Endophytes	13	15	25	17	12	82

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Biocontrol	24	32	26	30	19	131
2	Biological Control	25	21	21	22	32	121
3	Bacillus Thuringiensis	13	7	10	12	9	51
4	Antifungal Activity	13	8	6	4	11	42
5	Bacillus Velezensis	8	3	11	5	13	40
6	Bacillus Subtilis	5	13	6	5	4	33
7	Biocontrol Agent	5	0	7	6	3	21
8	Biopesticide	5	5	4	2	5	21
9	Secondary Metabolites	6	4	4	2	3	19
10	Beauveria Bassiana	2	3	6	2	5	18
11	Botrytis Cinerea	5	1	5	4	3	18
12	Entomopathogenic Fungi	2	2	3	4	6	17
13	Transcriptome	1	3	2	6	5	17
14	Growth Promotion	3	0	6	5	2	16
15	Induced Systemic Resistance	4	5	2	2	3	16
16	Insecticidal Activity	5	1	4	1	5	16
17	Meloidogyne Incognita	1	3	7	2	3	16
18	Trichoderma	4	1	5	5	1	16
19	Bacillus	3	4	1	2	5	15
20	Fusarium Graminearum	3	3	2	5	2	15

キーワード分析（1.1-3 バイオスティミュラント）

- 数が多いキーワード

  【中国以外】PGPR（植物生育促進根圏微生物）、Plant Growth Promotion（植物成長促進）、Rhizosphere（菌根菌）

  【中国】PGPR、Arbuscular Mycorrhizal Fungi（アーバスキュラー菌根菌）、Rhizosphere、Salt Stress（塩ストレス）

- 増加傾向のキーワード

  【中国以外】Abiotic Stress（非生物的ストレス）、Drought（水不足）

  【中国】Bacterial/Microbial Community（微生物群落）、Microbiome（微生物群集）、Drought Stress（水不足ストレス）など

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Pgpr	129	125	113	67	67	501
2	Biostimulant	47	66	82	42	43	280
3	Plant Growth Promotion	52	52	70	50	51	275
4	Biostimulants	48	66	61	38	34	247
5	Rhizosphere	37	52	55	47	40	231
6	Sustainable Agriculture	33	52	55	33	44	217
7	Abiotic Stress	32	40	54	40	35	201
8	Salinity	34	51	50	30	19	184
9	Drought	26	39	50	25	41	181
10	Salt Stress	27	34	41	34	35	171
11	Biocontrol	25	45	37	30	28	165
12	Endophytes	24	39	43	30	25	161
13	Plant Growth-Promoting Bacteria	18	34	40	30	38	160
14	Wheat	38	29	39	27	25	158
15	Rhizobacteria	36	34	33	17	26	146
16	Drought Stress	14	30	30	29	41	144
17	Arbuscular Mycorrhizal Fungi	32	25	33	27	24	141
18	Plant Growth	20	24	43	27	21	135
19	Biofertilizer	21	29	36	27	16	129
20	Yield	31	25	35	17	20	128

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Pgpr	15	13	22	11	16	77
2	Arbuscular Mycorrhizal Fungi	7	14	13	5	14	53
3	Rice	3	10	11	7	13	44
4	Rhizosphere	7	10	9	6	11	43
5	Salt Stress	5	7	8	9	9	38
6	Wheat	4	5	12	6	8	35
7	Plant Growth-Promoting Rhizobacteria	5	7	4	6	12	34
8	Biochar	4	7	10	6	5	32
9	Plant Growth Promotion	5	3	11	3	9	31
10	Cadmium	9	3	4	6	7	29
11	Phytoremediation	7	6	6	3	7	29
12	Photosynthesis	5	5	7	5	5	27
13	Drought	4	4	7	6	5	26
14	Microbial Community	2	2	8	7	7	26
15	Bacterial Community	3	4	10	2	6	25
16	Microbiome	2	5	7	3	6	23
17	Drought Stress	1	5	8	2	6	22
18	Maize	2	4	8	3	5	22
19	Transcriptome	2	5	4	5	6	22
20	Heavy Metal	5	5	5	1	5	21

キーワード分析（1.1-4 人工土壌）

- 数が多いキーワード

  【中国以外】文献数が少ない。Cyanobacteria（藍藻）、Biocrust（土壌表面に形成される生物由来の薄い層）、Biological Soil Crust（土壌微生物のコロニー）

  【中国】文献数が少ない。Bacterial Community（微生物群落）、Biocrust

- 増加傾向のキーワード

  【中国以外】 Cyanobacteria

  【中国】なし。

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Cyanobacteria	1	2	2	4	4	13
2	Biocrust	1	3	0	2	0	6
3	Biocrusts	0	1	0	3	2	6
4	Biological Soil Crust	1	1	0	0	2	4
5	Attract-and-Kill	0	1	0	1	1	3
6	Biological Soil Crusts	0	1	1	0	1	3
7	Cyanosphere	0	1	0	1	1	3
8	Drylands	1	1	1	0	0	3
9	Soil	0	0	3	0	0	3
10	Soil Microbiome	0	0	1	1	1	3
11	Soil Restoration	0	2	0	1	0	3
12	Arbuscular Mycorrhizal Fungi	1	0	0	0	1	2
13	Artificial Soil	0	1	0	0	1	2
14	Biochar	2	0	0	0	0	2
15	Biodiversity	1	1	0	0	0	2
16	Biogeochemistry	0	0	0	1	1	2
17	Bioremediation	0	1	0	0	1	2
18	Compost	2	0	0	0	0	2
19	Dehydration	0	0	0	2	0	2
20	Desiccation	0	0	0	2	0	2

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	2025	累計
1	Artificial Soil	0	0	0	1	1	2	4
2	Bacterial Community	0	0	2	0	1	1	4
3	Biocrust	0	1	2	0	0	1	4
4	Biological Soil Crust	0	0	2	1	0	0	3
5	Autotrophic Bacteria	0	0	1	1	0	0	2
6	Biocrusts	0	0	0	0	0	2	2
7	Bioremediation	0	0	0	0	1	1	2
8	Iron Ore Tailings	0	0	0	2	0	0	2
9	Microbial Function	0	0	1	0	1	0	2
10	Mineral Weathering	0	0	0	2	0	0	2
11	Organo-Mineral Association	0	0	0	2	0	0	2
12	Phosphogypsum	0	0	0	0	1	1	2
13	Red Mud	0	0	0	0	1	1	2
14	Restoration	0	0	1	0	0	1	2
15	Tropical Coral Island	0	0	0	1	0	1	2

キーワード分析（1.2-1 畜産）

- 数が多いキーワード

【中国以外】Probiotics（健康に有用な微生物）、Biogas、Fermentation（発酵）、
Anaerobic Digestion（嫌気性消化）、Microbiota（微生物叢）

【中国】 Composting（堆肥化）、Gut Microbiota（腸内菌叢）、Bacterial Community（微生物群落）、
Antibiotic Resistance Genes（抗微生物薬耐性遺伝子）

- 増加傾向のキーワード

【中国以外】 Gut Microbiota（腸内菌叢）、Gut Health（腸の健康）

【中国】 Aerobic Composting（好気性堆肥化）、Intestinal Microbiota（腸内微生物叢）

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Probiotics	76	78	100	68	62	384
2	Broiler	73	73	78	46	71	341
3	Probiotic	102	72	78	40	48	340
4	Growth Performance	38	61	56	59	80	294
5	Biogas	76	64	45	21	9	215
6	Fermentation	52	50	46	27	26	201
7	Anaerobic Digestion	50	54	42	21	21	188
8	Microbiota	37	30	45	33	36	181
9	Poultry	41	34	47	31	28	181
10	Performance	47	30	33	29	32	171
11	Broilers	33	38	24	28	23	146
12	Gut Microbiota	17	18	34	22	28	119
13	Safety	30	24	26	17	19	116
14	Gut Health	13	24	22	25	29	113
15	Digestibility	25	23	25	12	26	111
16	Immunity	15	22	31	18	22	108
17	Broiler Chickens	19	31	27	16	13	106
18	Efficacy	30	16	25	20	15	106
19	Methane	28	24	21	9	15	97
20	Microbiome	13	15	20	23	26	97

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Growth Performance	19	40	31	21	30	141
2	Composting	27	35	16	24	12	114
3	Gut Microbiota	17	21	32	14	15	99
4	Broiler	13	25	22	15	20	95
5	Bacterial Community	19	16	20	7	12	74
6	Antibiotic Resistance Genes	20	16	15	9	11	71
7	Anaerobic Digestion	18	17	18	5	8	66
8	Microbiota	15	14	16	8	12	65
9	Probiotics	6	15	17	13	12	63
10	Microbial Community	10	16	22	8	6	62
11	Pig Manure	13	12	12	7	4	48
12	Immunity	5	13	14	3	8	43
13	Broilers	7	7	10	6	9	39
14	Intestinal Health	4	10	12	4	9	39
15	Meat Quality	10	7	8	5	9	39
16	Rumen Fermentation	7	9	14	3	6	39
17	Swine Manure	8	12	10	2	5	37
18	Biochar	11	12	6	5	2	36
19	Aerobic Composting	3	13	5	4	9	34
20	Intestinal Microbiota	3	6	5	8	12	34

キーワード分析（1.2-2 水産）

- 数が多いキーワード

  【中国以外】Probiotics（健康に有用な微生物）、Aquaculture（水産養殖）、Immunity（免疫）、Bioflo（養殖水槽内で微生物によって形成される微細な凝集体）、Microalgae（微細藻類）

  【中国】 Gut/Intestinal Microbiota（腸内微生物叢）、Probiotics

- 増加傾向のキーワード

  【中国以外】Immune Response（免疫応答）、Disease Resistance（耐病性）、Gut Microbiota（腸内菌叢）

  【中国】なし。

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Probiotics	39	63	59	40	44	245
2	Aquaculture	49	55	56	36	36	232
3	Probiotic	27	45	36	29	16	153
4	Growth	36	36	33	11	27	143
5	Growth Performance	16	30	33	21	24	124
6	Immunity	16	15	17	18	23	89
7	Biofloc	22	27	21	9	9	88
8	Microalgae	11	24	11	17	14	77
9	Nile Tilapia	13	16	11	5	16	61
10	Fish	18	12	10	8	6	54
11	Litopenaeus Vannamei	7	13	14	9	9	52
12	Oreochromis Niloticus	12	14	9	9	6	50
13	Fermentation	16	5	18	7	3	49
14	Immune Response	4	7	13	11	13	48
15	Disease Resistance	1	6	17	12	9	45
16	Gut Microbiota	4	5	8	9	19	45
17	Shrimp	8	16	6	7	7	44
18	Microbiota	6	7	13	10	6	42
19	Tilapia	4	16	12	7	2	41
20	Microbiome	5	7	10	12	6	40

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Gut Microbiota	6	8	8	10	9	41
2	Intestinal Microbiota	11	10	9	6	4	40
3	Probiotics	5	11	6	10	7	39
4	Growth Performance	4	3	11	4	5	27
5	Nitrogen Removal	6	6	6	3	4	25
6	Growth	7	3	8	2	4	24
7	Microbial Community	8	2	5	4	5	24
8	Immunity	7	2	4	5	5	23
9	Denitrification	4	5	5	2	4	20
10	Litopenaeus Vannamei	5	4	9	1	1	20
11	Docosahexaenoic Acid	3	5	2	5	3	18
12	Mariculture Wastewater	4	5	3	5	1	18
13	Astaxanthin	3	6	2	1	4	16
14	Antioxidant Capacity	1	3	4	4	3	15
15	Immune Response	5	4	5	1	0	15
16	Probiotic	2	6	2	3	2	15
17	Aquaculture	2	4	3	2	3	14
18	Intestinal Health	4	3	2	2	3	14
19	Metabolic Engineering	1	8	1	1	3	14
20	Bacillus Subtilis	1	2	6	1	3	13

キーワード分析（2.1 伝統食品）

- 数が多いキーワード

  【中国以外】Fermentation（発酵）、Lactic Acid Bacteria（乳酸菌）、Probiotics（健康に有用な微生物）、Saccharomyces Cerevisiae（出芽酵母）

  【中国】中国以外と同じ傾向

- 増加傾向のキーワード

  【中国以外】Lactiplantibacillus Plantarum（植物由来の発酵物分離される菌）、Volatile Compounds（揮発性有機物質）など

  【中国】Gut Microbiota（腸内菌叢）、Microbial Community（微生物群落）など

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Fermentation	102	147	156	116	112	633
2	Lactic Acid Bacteria	101	99	118	107	82	507
3	Probiotics	37	68	83	55	38	281
4	Saccharomyces Cerevisiae	56	52	41	33	30	212
5	Yeast	35	37	41	33	28	174
6	Probiotic	36	41	33	32	31	173
7	Antioxidant Activity	23	24	34	26	24	131
8	Lactobacillus	34	27	25	15	17	118
9	Wine	27	36	20	20	14	117
10	Lactiplantibacillus Plantarum	1	18	25	23	28	95
11	Antioxidant	15	19	21	15	13	83
12	Volatile Compounds	9	14	22	13	23	81
13	Lactobacillus Plantarum	27	17	16	6	6	72
14	Yeasts	16	24	15	7	8	70
15	Non-Saccharomyces	21	21	12	10	3	67
16	Metabolomics	3	7	13	16	24	63
17	Microbial Community	6	7	12	12	24	61
18	Starter Culture	14	7	16	11	13	61
19	Gut Microbiota	3	11	13	18	14	59
20	Fermented Food	8	10	13	7	13	51

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Fermentation	15	24	25	24	21	109
2	Saccharomyces Cerevisiae	17	14	13	9	12	65
3	Lactic Acid Bacteria	15	5	17	8	17	62
4	Gut Microbiota	3	9	12	7	10	41
5	Microbial Community	5	7	5	14	10	41
6	High-Throughput Sequencing	15	5	7	3	6	36
7	Antioxidant Activity	6	11	5	7	5	34
8	Correlation Analysis	5	5	4	10	8	32
9	Metabolomics	5	3	3	6	12	29
10	Lactiplantibacillus Plantarum	1	5	6	6	10	28
11	Volatile Compounds	4	4	5	8	7	28
12	Lactobacillus Plantarum	6	9	6	3	2	26
13	Metabolites	3	4	8	5	6	26
14	Lactobacillus	6	7	4	4	3	24
15	Flavor	5	2	6	7	3	23
16	Microbial Diversity	3	5	3	6	6	23
17	Probiotics	1	5	7	4	6	23
18	Antioxidant	1	4	5	5	3	18
19	Baijiu	8	2	2	4	2	18
20	Solid-State Fermentation	3	3	3	5	4	18

キーワード分析（2.2 伝統食品以外）

- 数が多いキーワード

  【中国以外】Probiotics（健康に有用な微生物）、Gut Microbiota/Microbiota/Microbiome（微生物叢）、Prebiotics（腸内細菌の増殖に前もって必要とされる栄養成分）

  【中国】Gut Microbiota、Probiotics

- 増加傾向のキーワード

  【中国以外】Inflammation（炎症）、Dysbiosis（腸内細菌叢の異常状態）、Postbiotics（有用代謝産物）など

  【中国】Metabolic Engineering（細胞内の特定の代謝物の産生や分解を人工的にコントロールする技術）、Short-Chain Fatty Acids（短鎖脂肪酸）、など

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Probiotics	767	919	1005	893	889	4473
2	Probiotic	430	464	505	344	370	2113
3	Gut Microbiota	163	259	333	324	368	1447
4	Prebiotics	192	190	222	173	192	969
5	Microbiota	181	205	185	171	181	923
6	Microbiome	130	148	155	135	162	730
7	Lactic Acid Bacteria	131	150	176	117	124	698
8	Prebiotic	123	161	165	114	117	680
9	Lactobacillus	138	127	122	91	89	567
10	Inflammation	81	85	101	109	126	502
11	Gut Microbiome	55	71	102	123	119	470
12	Dysbiosis	81	95	96	87	110	469
13	Obesity	69	88	74	94	78	403
14	Synbiotics	66	67	81	62	81	357
15	Fermentation	63	60	73	67	80	343
16	Postbiotics	22	38	87	62	114	323
17	Bifidobacterium	56	57	56	56	52	277
18	Gut-Brain Axis	26	42	55	59	90	272
19	Synbiotic	55	59	66	41	49	270
20	Short-Chain Fatty Acids	30	29	59	56	55	229

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Gut Microbiota	91	138	192	188	227	836
2	Probiotics	98	146	165	153	156	718
3	Probiotic	40	55	48	53	63	259
4	Metabolic Engineering	25	20	36	24	40	145
5	Prebiotics	25	23	30	29	23	130
6	Inflammation	15	20	32	26	19	112
7	Short-Chain Fatty Acids	12	22	21	18	25	98
8	Inflammatory Bowel Disease	3	13	11	25	38	90
9	Obesity	15	18	21	16	17	87
10	Microbiota	12	19	24	16	15	86
11	Ulcerative Colitis	2	12	11	27	28	80
12	Saccharomyces Cerevisiae	11	13	18	13	24	79
13	Meta-Analysis	23	14	20	6	15	78
14	Fermentation	11	11	17	19	15	73
15	Gut Microbiome	8	7	15	17	25	72
16	Intestinal Microbiota	8	16	19	18	11	72
17	Synthetic Biology	5	9	18	19	21	72
18	Lactic Acid Bacteria	10	14	16	17	13	70
19	Lactobacillus	10	13	16	16	7	62
20	Colitis	7	9	15	14	16	61
21	Prebiotic	14	14	15	9	9	61

キーワード分析（3. 微生物の産業活用）

- 数が多いキーワード

  【中国以外】Probiotics（健康に有用な微生物）、Microbiome/Gut Microbiota/Microbiota（微生物叢）

  【中国】Gut Microbiota（腸内細菌叢）、Saccharomyces Cerevisiae（出芽酵母の一つ）、Probiotics、Metabolic Engineering（細胞内の特定の代謝物の産生や分解を人工的にコントロールする技術）

- 増加傾向のキーワード

  【中国以外】Prebiotics（腸内細菌の増殖に前もって必要とされる栄養成分）、 Metabolomicsなど

  【中国】Metabolomics、Microbiome、Fermentation（発酵）、Synthetic Biology（合成生物学）など

中国以外のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Probiotics	196	261	428	389	368	1642
2	Microbiome	71	121	169	142	158	661
3	Gut Microbiota	50	90	160	165	175	640
4	Probiotic	88	96	189	129	133	635
5	Microbiota	67	79	112	110	106	474
6	Lactic Acid Bacteria	58	82	121	94	73	428
7	Fermentation	58	68	120	87	83	416
8	Prebiotics	47	67	113	94	92	413
9	Biocontrol	69	71	92	88	74	394
10	Gut Microbiome	27	32	85	97	88	329
11	Metabolomics	28	38	70	62	80	278
12	Pgpr	43	65	62	47	44	261
13	Biological Control	39	50	82	42	43	256
14	Dysbiosis	24	45	55	60	63	247
15	Sustainable Agriculture	29	47	55	39	56	226
16	Rhizosphere	37	44	61	42	33	217
17	Lactobacillus	38	39	47	48	40	212
18	Microbiology	37	41	49	54	28	209
19	Prebiotic	29	30	49	49	46	203
20	Biotechnology	34	47	53	43	23	200

中国のキーワード（年次累計Top20）

#	Keyword	2020	2021	2022	2023	2024	累計
1	Gut Microbiota	32	52	70	78	86	318
2	Probiotics	31	42	62	74	65	274
3	Metabolic Engineering	22	25	29	23	34	133
4	Saccharomyces Cerevisiae	15	21	25	14	29	104
5	Probiotic	7	22	19	27	25	100
6	Metabolomics	10	21	22	19	25	97
7	Microbiome	10	12	17	19	22	80
8	Microbial Community	16	10	16	14	21	77
9	Fermentation	10	10	19	19	18	76
10	High-Throughput Sequencing	21	13	17	12	10	73
11	Synthetic Biology	3	10	18	15	23	69
12	Biocontrol	8	18	16	17	9	68
13	Biological Control	14	14	16	11	12	67
14	Microbiota	7	11	24	9	13	64
15	Bacillus Subtilis	11	11	16	8	12	58
16	Lactic Acid Bacteria	6	4	19	11	12	52
17	Bacterial Community	7	11	18	8	6	50
18	Growth Performance	3	11	9	7	17	47
19	Biosynthesis	8	9	8	10	11	46
20	Intestinal Microbiota	7	1	13	13	12	46

（１）調査のアプローチ

（補足５）検索クエリ　１（１）#1 微生物肥料

("bio fertilizer"~1 OR biofertilizer OR "bio inoculant"~1 OR bioinoculant OR "bio compost"~1 OR biocompost OR "microbial fertilizer"~1 OR "microbial inoculant"~1 OR "microbial compost"~1 OR "Plant Growth Promoting")
OR
((nitrogen OR nitrogenous OR nitrate OR nitrite OR ammonia OR ammonium OR urea OR phosphate OR phosphoric OR phosphatic OR phosphorus OR phosphite OR potash OR potassium OR potassic OR kalium OR fertilizer OR inoculant OR compost OR NH3 OR NH4 OR NO3 OR NO2 OR PO4 OR P2O5 OR K2O OR KCl OR K2SO4) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足５）検索クエリ　１（１）#2 微生物農薬

("bio pesticide"~1 OR biopesticide OR "bio insecticide"~1 OR bioinsecticide OR "bio fungicide"~1 OR biofungicide OR "bio nematicide"~1 OR bionematicide OR "bio herbicide"~1 OR bioherbicide OR "bio virucide"~1 OR biovirucide OR "microbial pesticide"~1 OR "microbial insecticide"~1 OR "microbial fungicide"~1 OR "microbial nematicide"~1 OR "microbial herbicide"~1 OR "microbial virucide"~1 OR "bio acaricide"~1 OR bioacaricide OR "microbial acaricide"~1 OR "bio bactericide"~1 OR biobactericide OR "microbial bactericide"~1 OR "bio molluscicide"~1 OR biomolluscicide OR "microbial molluscicide"~1 OR "bio larvicide"~1 OR biolarvicide OR "microbial larvicide"~1 OR "bio ovicide"~1 OR bioovicide OR "microbial ovicide"~1)
OR
((pesticide OR "pest management"~1 OR insecticide OR fungicide OR nematicide OR herbicide OR virucide OR acaricide OR bactericide OR molluscicide OR larvicide OR ovicide OR "biological control"~1 OR biocontrol OR "bio control"~1) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere) AND (bacteria OR microbiology OR archaea OR prokaryote OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR endophyte OR Acaulospora OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足５）検索クエリ　１（１）#3 バイオスティミュラント

(biostimulant OR "bio stimulant"~1 OR "Plant Growth Promoting"~1)
OR
((bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR actinomycetes OR endophyte OR epiphyte OR fungi OR fungus OR yeast OR microalgae OR microphytes OR "arbuscular mycorrhiza"~1 OR Acaulospora OR Acetobacter OR Actinomucor OR Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Funneliformis OR Galdieria OR Gigaspora OR Gluconacetobacter OR Haematococcus OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanomicrobium OR Methanothrix OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR unneliformis OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "Candidatus Kuenenia" OR "lactic acid bacteria") AND (((nutrient OR nitrogen OR phosphorus OR potassium OR water) AND ("use efficiency"~1 OR availability)) OR (stress AND (tolerance OR resistance OR resilience OR adaptation) OR "quality traits"~1)) AND (improve OR enhance OR increase OR promote OR stimulate OR augment OR boost OR mitigate OR alleviate OR protect OR preserve OR maintain OR prolong OR extension OR extend OR strengthen) AND (agriculture OR agronomy OR horticulture OR greenhouse OR arable OR "open field" OR orchard OR vineyard OR plantation OR Vegetables OR fruits OR grains OR rice OR wheat OR barley OR soybean OR potato OR sugarcane OR "sugar beet" OR rapeseed OR maize OR corn OR cabbage OR spinach OR lettuce OR onion OR scallion OR cucumber OR eggplant OR tomato OR pepper OR radish OR carrot OR celery OR asparagus OR cauliflower OR broccoli OR pumpkin OR strawberry OR melon OR orange OR apple OR cherry OR grape OR chestnut OR pineapple OR kiwifruit OR rhizosphere OR phyllosphere)

（１）調査のアプローチ

（補足５）検索クエリ　１（１）#4 人工土壌

(Technosol OR Technosoil OR "constructed soil"~1 OR "soil constructed"~1 OR "manufactured soil"~1 OR "soil manufactured"~1 OR "engineered soil"~1 OR "soil engineered"~1 OR "synthetic soil"~1 OR "soil synthetic"~1 OR "artificial soil"~1 OR "soil artificial"~1 OR "bio crust"~1 OR biocrust) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR actinomycetes OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Acutodesmus OR Akanthomyces OR Anabaena OR Arthrobacter OR Aspergillus OR Aureobasidium OR Azotobacter OR Bacillus OR Bradyrhizobium OR Chlorella OR Claroideoglomus OR Clostridium OR Desmodesmus OR Ensifer OR Enterobacter OR Funneliformis OR Herbaspirillum OR Hydrogenophaga OR Lactiplantibacillus OR Mesorhizobium OR Metarhizium OR Methylacidimicrobium OR Methylocystis OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrospira OR Nostoc OR Paenibacillus OR Paracoccus OR Phormidium OR Pseudomonas OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Saccharomyces OR Scytonema OR Streptomyces OR Thauera OR Thermoanaerobacter OR Trichoderma)

（1）調査のアプローチ

（補足5）検索クエリ　1（2）（2-1）#5 発酵飼料

((fermented OR fermentation OR fermenting OR fermentative) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail))
OR
((silage OR haylage OR ensile) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacter OR Akanthomyces OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Brevibacterium OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leuconostoc OR Levilactobacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanocorpusculum OR Methanoculleus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methanothermobacter OR Methanothrix OR Methylococcus OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Nannochloropsis OR Nitrobacter OR Nitrososphaera OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetraselmis OR Thauera OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足５）検索クエリ　１（２）（2-1）#6 SCP/微生物たんぱく質

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)
OR
("alternative protein"~1 OR "sustainable protein"~1 OR "plant-based protein"~1 OR "animal-free protein"~1 OR "cultured protein"~1 OR "cultivated protein"~1 OR "cell-based protein"~1 OR "lab-grown protein"~1 OR "protein alternative"~1 OR "protein sustainable"~1 OR "protein plant-based"~1 OR "protein animal-free"~1 OR "protein cultured"~1 OR "protein cultivated"~1 OR "protein cell-based"~1 OR "protein lab-grown"~1 OR "protein substitute"~1 OR "protein analogue"~1) AND (feed OR meal OR diet OR ration OR grain) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Botryococcus OR Brevibacterium OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Megasphaera OR Methanococcus OR Methanoculleus OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrosomonas OR Nitrosospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Shewanella OR Skeletonema OR Spirulina OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR "Candidatus Brocadia" OR "lactic acid bacteria")

（１）調査のアプローチ

（補足５）検索クエリ　1（2）（2-1）#7 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR immunobiotic OR eubiotic OR phytobiotic) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)
OR ((feed OR meal OR diet OR ration OR grain) AND (("additive" OR "supplement" OR "direct fed"~1) OR ((("antimicrobial growth promoter"~1 OR "antibiotic growth promoter"~1) AND (alternative OR replacement)) OR "non antibiotic growth promoter"~1 OR "non antimicrobial growth promoter"~1))) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR "lactic acid bacteria" OR Acetobacter OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Beauveria OR Bifidobacterium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gigaspora OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Isochrysis OR Issatchenkia OR Kazachstania OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanobacterium OR Methanobrevibacter OR Methanocorpusculum OR Methanosphaera OR Methanothermobacter OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Purpureocillium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Selenomonas OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "lactic acid bacteria")

（１）調査のアプローチ

（補足５）検索クエリ　１（２）（2-1）#8 必須アミノ酸等のバイオ生産

(feed OR meal OR diet OR ration OR grain) AND (("amino acid" OR lysine OR methionine OR threonine OR tryptophan OR valine OR isoleucine OR leucine OR phenylalanine OR histidine OR arginine OR enzyme OR Phytase OR Xylanase OR "Beta-glucanase" OR "Beta-mannanase" OR "Alpha-galactosidase" OR Cellulase OR Pectinase OR Polygalacturonase OR "Alpha-amylase" OR Glucoamylase OR Pullulanase OR Protease OR "Ferulic acid esterase") AND ("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1)) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)

（１）調査のアプローチ

（補足５）検索クエリ　１（２）（2-1）#9 糞尿処理

((manure OR slurry OR litter OR dung OR feces OR faeces OR excreta OR urine) AND (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail)) AND (fertilizer OR compost OR biogas OR biomethane OR "anaerobic digestion"~1 OR "anaerobic digester"~1 OR "co-digestion"~1 OR "co-digester"~1 OR "bio filter"~1 OR biofilter OR "bio filtration"~1 OR biofiltration OR "bio trickling"~1 OR biotrickling OR "bio scrubber"~1 OR bioscrubber OR "bio remediation"~1 OR bioremediation OR "bio filtration"~1 OR biofiltration OR "phyto remediation"~1 OR phytoremediation OR "biological treatment"~1 OR bioaugmentation OR "bio augmentation"~1)

（1）調査のアプローチ

（補足5）検索クエリ　1（2）（2-2）#10 発酵飼料

(fermented OR fermentation OR fermenting OR fermentative) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
(silage OR haylage OR ensile) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacter OR Actinomucor OR Acutodesmus OR Akanthomyces OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanomicrobium OR Methanothrix OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "lactic acid bacteria")

（１）調査のアプローチ

（補足５）検索クエリ　１（２）（2-2）#11 SCP/微生物たんぱく質

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
("alternative protein"~1 OR "sustainable protein"~1 OR "plant-based protein"~1 OR "animal-free protein"~1 OR "cultured protein"~1 OR "cultivated protein"~1 OR "cell-based protein"~1 OR "lab-grown protein"~1 OR "protein alternative"~1 OR "protein sustainable"~1 OR "protein plant-based"~1 OR "protein animal-free"~1 OR "protein cultured"~1 OR "protein cultivated"~1 OR "protein cell-based"~1 OR "protein lab-grown"~1 OR "protein substitute"~1 OR "protein analogue"~1) AND (feed OR meal OR diet OR ration OR grain) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Botryococcus OR Brevibacterium OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Enterobacter OR Euglena OR Galdieria OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanococcus OR Methanosaeta OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Shewanella OR Skeletonema OR Spirulina OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thauera OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium)

（１）調査のアプローチ

（補足５）検索クエリ　1（2）（2-2）#12 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR immunobiotic OR eubiotic OR phytobiotic) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")
OR
((feed OR meal OR diet OR ration OR grain) AND (("additive" OR "supplement" OR "direct fed"~1) OR ((("antimicrobial growth promoter"~1 OR "antibiotic growth promoter"~1) AND (alternative OR replacement)) OR "non antibiotic growth promoter"~1 OR "non antimicrobial growth promoter"~1))) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR cyanobacteria OR "lactic acid bacteria" OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Hanseniaspora OR Isochrysis OR Kazachstania OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanomassiliicoccus OR Methanosarcina OR Methylococcus OR Methylocystis OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrosospira OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "lactic acid bacteria")

（1）調査のアプローチ

（補足5）検索クエリ　1（2）（2-2）#13 SCO/藻油/必須脂肪酸等のバイオ生産

(("single cell oil"~1 OR "microbial oil"~1 OR "fungal oil"~1 OR "bacterial oil"~1 OR "yeast oil"~1 OR "microalgal oil"~1 OR "oleaginous bacteria"~1 OR "oleaginous yeast"~1 OR "oleaginous fungus"~1 OR "oleaginous fungi"~1 OR "oleaginous microalgae"~1) AND ("eicosapentaenoic acid" OR "docosahexaenoic acid" OR "arachidonic acid" OR "omega-3 fatty acids" OR "essential fatty acid" OR "long-chain polyunsaturated fatty acids" OR "unsaturated fatty acid" OR astaxanthin))
OR
(("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1) AND ("eicosapentaenoic acid" OR "docosahexaenoic acid" OR "arachidonic acid" OR "omega-3 fatty acids" OR "essential fatty acid" OR "long-chain polyunsaturated fatty acids" OR "unsaturated fatty acid" OR astaxanthin) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clonostachys OR Clostridium OR Corynebacterium OR Crypthecodinium OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Diversispora OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconobacter OR Haematococcus OR Halanaerobium OR Herbaspirillum OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lactiplantibacillus OR Leptolyngbya OR Leuconostoc OR Lysinibacillus OR Metarhizium OR Methanobrevibacter OR Methanococcus OR Methylacidimicrobium OR Methylocaldum OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Nannochloropsis OR Nitrospira OR Nitzschia OR Nostoc OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Staphylococcus OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Wickerhamomyces OR Yarrowia OR Zygosaccharomyces OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足５）検索クエリ　１（２）（2-2）#14 水質管理

((biofilter OR "bio filter"~1 OR biofiltration OR "bio filtration"~1 OR "bio trickling"~1 OR biotrickling OR "biological filter"~1 OR bioreactor OR "bio reactor"~1 OR biofloc OR "bio floc"~1 OR bioremediation OR "bio remediation"~1 OR bioaugmentation OR "bio augmentation"~1 OR phytoremediation OR "biological treatment"~1 OR anammox) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus"))
OR
((nitrification OR denitrification) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acaulospora OR Acetobacter OR Acidithiobacillus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clostridium OR Corynebacterium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Diversispora OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gallionella OR Gigaspora OR Haematococcus OR Hanseniaspora OR Herbaspirillum OR Hydrogenophaga OR Isochrysis OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leptothrix OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanobacterium OR Methanobrevibacter OR Methanocaldococcus OR Methanococcus OR Methanosaeta OR Methanosarcina OR Methanothrix OR Methylacidimicrobium OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Microchloropsis OR Moorella OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrososphaera OR Nitrosospira OR Nitrosotalea OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Rhizobium OR Rhizophagus OR Rhodobacter OR Rhodopseudomonas OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Selenomonas OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thauera OR Thiobacillus OR Tisochrysis OR Trichoderma OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR "Candidatus Brocadia" OR "Candidatus Jettenia" OR "Candidatus Kuenenia" OR "lactic acid bacteria"))

（１）調査のアプローチ

（補足５）検索クエリ　１（２）（2-2）#15 生物防除

(biocontrol OR "biological control" OR "antagonistic bacteria"~1 OR "bacterial antagonist"~1 OR "quorum quenching"~1 OR bacteriocin) AND (aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus") AND (Acutodesmus OR Akanthomyces OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconacetobacter OR Haematococcus OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptothrix OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Mesorhizobium OR Metarhizium OR Methanopyrus OR Methanosarcina OR Methanothrix OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Nannochloropsis OR Nitrobacter OR Nitrosocosmicus OR Nitrosomonas OR Nitrosospira OR Nitrospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Serratia OR Shewanella OR Skeletonema OR Spirulina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetraselmis OR Thalassiosira OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Yarrowia OR "Candidatus Kuenenia" OR "lactic acid bacteria")

（１）調査のアプローチ

（補足５）検索クエリ　２（１）#16 発酵食品

((fermented OR fermentation OR fermenting OR fermentative) AND ("food" OR "ready to eat" OR "beverage" OR "drink" OR "alcoholic beverage" OR "dairy product" OR "milk product") OR (miso OR "soy sauce" OR sake OR shochu OR amazake OR vinegar OR nukazuke OR pickles OR kimchi OR sauerkraut OR natto OR tempeh OR sourdough OR yogurt OR cheese OR kefir OR buttermilk OR katsuobushi OR narezushi OR "fish sauce" OR "nam pla" OR "nuoc mam" OR shiokara OR wine OR beer OR cider OR kombucha)) AND (Acetobacter OR Actinomucor OR Acutodesmus OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Bifidobacterium OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Methanosphaera OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pythium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Verticillium OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Jettenia" OR "lactic acid bacteria" OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)
AND
(safety OR "shelf life" OR "freshness" OR "preservation" OR "clean label" OR quality OR stability OR consistency OR "batch-to-batch" OR "standardized" OR "spoilage control" OR "mold control" OR "yeast control" OR contamination OR poisoning OR "flavor" OR "aroma" OR "smell" OR "taste" OR "aftertaste" OR "mouthfeel" OR "texture" OR "thickness" OR "creaminess" OR "smoothness" OR "crispiness" OR "springiness" OR "chewiness" OR "crumb structure" OR "richness" OR "balance" OR "sweetness" OR "sourness" OR "bitterness" OR "saltiness" OR "umami" OR "savory" OR "off odor" OR health OR digestion OR immunity OR antioxidant OR anti-inflammatory OR "blood sugar" OR "blood pressure" OR cholesterol)
AND
("bio engineering"~1 OR bioengineering OR "biological engineering"~1 OR "bio manufacturing"~1 OR biomanufacturing OR "synthetic biology"~1 OR "bio synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1 OR "bio process"~1 OR bioprocess OR "biological process"~1 OR "bio refining"~1 OR biorefining OR "bio reactor"~1 OR bioreactor OR "bio foundry"~1 OR biofoundry OR "fed batch"~1 OR fedbatch OR "perfusion culture"~1 OR chemostat OR "cell culture"~1 OR "tissue culture"~1 OR "embryo culture"~1 OR "bio catalysis"~1 OR biocatalysis OR "bio technology"~1 OR biotechnology OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1)

（1）調査のアプローチ

（補足5）検索クエリ　2（2）#17 精密発酵

"precision fermentation"
OR
((("genetic engineering"~1 OR "genome engineering"~1 OR "engineering genome"~1 OR "genetically engineered"~1 OR "engineered genetically"~1 OR "genetic modification"~1 OR "genetically modified"~1 OR "modified genetically"~1 OR "protein engineering"~1 OR "engineering protein"~1 OR "enzyme engineering"~1 OR "engineering enzyme"~1 OR "metabolic engineering"~1 OR "peptide engineering"~1 OR "pathway engineering"~1 OR "engineering pathway"~1 OR "strain engineering"~1 OR "engineering strain"~1 OR "host engineering"~1 OR "engineering host"~1 OR "chassis engineering"~1 OR ("bio engineering"~1 OR bioengineering) OR "biological engineering"~1 OR "tissue engineering"~1 OR "cell engineering"~1 OR "cellular engineering"~1 OR "synthetic biology"~1 OR "DNA synthesis"~1 OR "RNA synthesis"~1 OR "gene synthesis"~1 OR "oligonucleotide synthesis"~1 OR "protein synthesis"~1 OR "peptide synthesis"~1 OR ("bio synthesis"~1 OR biosynthesis) OR "biological synthesis"~1 OR "gene editing"~1 OR "genome editing"~1 OR "editing genome"~1 OR "genetic editing"~1 OR "genetically edited"~1 OR "edited genetically"~1 OR CRISPR OR recombinant OR "heterologous expression"~1 OR overexpression OR "strain improvement"~1 OR "strain development"~1 OR "strain optimization"~1 OR "strain selection"~1) AND (food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product") AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acetobacter OR Acetobacterium OR Acidithiobacillus OR Alcaligenes OR Anabaena OR Arthrobacter OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Bifidobacterium OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Chlorella OR Chromobacterium OR Clonostachys OR Clostridium OR Coniothyrium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cutibacterium OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR enococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Galdieria OR Gallionella OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Hanseniaspora OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Lecanicillium OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Metarhizium OR Methanococcus OR Methanomassiliicoccus OR Methanosaeta OR Methanosarcina OR Methanosphaera OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moorella OR Nannochloropsis OR Nitrobacter OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "Candidatus Brocadia" OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella))

（1）調査のアプローチ

（補足5）検索クエリ　2（2）#18 SCP/代替食品

("single cell protein"~1 OR "Single-cell ingredient"~1 OR mycoprotein OR "fungal protein"~1 OR "bacterial protein"~1 OR "yeast protein"~1 OR "microbial protein"~1 OR "microalgal protein"~1) AND (food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken OR human)
OR
("alternative food"~1 OR "alternative groceries"~1 OR "alternative beverage"~1 OR "alternative drink"~1 OR "alternative dairy"~1 OR "alternative milk"~1 OR "alternative meat"~1 OR "alternative beef"~1 OR "alternative seafood"~1 OR "alternative pork"~1 OR "alternative chicken"~1 OR "sustainable food"~1 OR "sustainable groceries"~1 OR "sustainable beverage"~1 OR "sustainable drink"~1 OR "sustainable dairy"~1 OR "sustainable milk"~1 OR "sustainable meat"~1 OR "sustainable beef"~1 OR "sustainable seafood"~1 OR "sustainable pork"~1 OR "sustainable chicken"~1 OR "plant-based food"~1 OR "plant-based groceries"~1 OR "plant-based beverage"~1 OR "plant-based drink"~1 OR "plant-based dairy"~1 OR "plant-based milk"~1 OR "plant-based meat"~1 OR "plant-based beef"~1 OR "plant-based seafood"~1 OR "plant-based pork"~1 OR "plant-based chicken"~1 OR "animal free food"~1 OR "animal free groceries"~1 OR "animal free beverage"~1 OR "animal free drink"~1 OR "animal free dairy"~1 OR "animal free milk"~1 OR "animal free meat"~1 OR "animal free beef"~1 OR "animal free seafood"~1 OR "animal free pork"~1 OR "animal free chicken"~1 OR "cultured food"~1 OR "cultured groceries"~1 OR "cultured beverage"~1 OR "cultured drink"~1 OR "cultured dairy"~1 OR "cultured milk"~1 OR "cultured meat"~1 OR "cultured beef"~1 OR "cultured seafood"~1 OR "cultured pork"~1 OR "cultured chicken"~1 OR "cultivated food"~1 OR "cultivated groceries"~1 OR "cultivated beverage"~1 OR "cultivated drink"~1 OR "cultivated dairy"~1 OR "cultivated milk"~1 OR "cultivated meat"~1 OR "cultivated beef"~1 OR "cultivated seafood"~1 OR "cultivated pork"~1 OR "cultivated chicken"~1 OR "cell based food"~1 OR "cell based groceries"~1 OR "cell based beverage"~1 OR "cell based drink"~1 OR "cell based dairy"~1 OR "cell based milk"~1 OR "cell based meat"~1 OR "cell based beef"~1 OR "cell based seafood"~1 OR "cell based pork"~1 OR "cell based chicken"~1 OR "lab grown food"~1 OR "lab grown groceries"~1 OR "lab grown beverage"~1 OR "lab grown drink"~1 OR "lab grown dairy"~1 OR "lab grown milk"~1 OR "lab grown meat"~1 OR "lab grown beef"~1 OR "lab grown seafood"~1 OR "lab grown pork"~1 OR "lab grown chicken"~1 OR "food substitute"~1 OR "food alternative"~1 OR "food analogue"~1 OR "groceries substitute"~1 OR "groceries alternative"~1 OR "groceries analogue"~1 OR "beverage substitute"~1 OR "beverage alternative"~1 OR "beverage analogue"~1 OR "drink substitute"~1 OR "drink alternative"~1 OR "drink analogue"~1 OR "dairy substitute"~1 OR "dairy alternative"~1 OR "dairy analogue"~1 OR "milk substitute"~1 OR "milk alternative"~1 OR "milk analogue"~1 OR "meat substitute"~1 OR "meat alternative"~1 OR "meat analogue"~1 OR "beef substitute"~1 OR "beef alternative"~1 OR "beef analogue"~1 OR "seafood substitute"~1 OR "seafood alternative"~1 OR "seafood analogue"~1 OR "pork substitute"~1 OR "pork alternative"~1 OR "pork analogue"~1 OR "chicken substitute"~1 OR "chicken alternative"~1 OR "chicken analogue"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbe OR microbiome OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphytes OR Acetobacterium OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Bacillus OR Botryococcus OR Bradyrhizobium OR Brevibacterium OR Candida OR Chaetoceros OR Chlorella OR Claroideoglomus OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Enterobacter OR Enterococcus OR Euglena OR Galdieria OR Gluconobacter OR Haematococcus OR Hydrogenophaga OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Methanococcus OR Methylacidiphilum OR Methylococcus OR Methylocystis OR Methylomonas OR Methylophilus OR Metschnikowia OR Microchloropsis OR Nannochloropsis OR Nitrobacter OR Nitzschia OR Nostoc OR Paenibacillus OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Propionibacterium OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Shewanella OR Skeletonema OR Spirulina OR Sporosarcina OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thermoanaerobacter OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella)

（１）調査のアプローチ

（補足５）検索クエリ　２（２）#19 xx-biotics

(probiotic OR prebiotic OR synbiotic OR postbiotic OR paraprobiotic OR psychobiotic OR immunobiotic OR eubiotic) AND NOT (livestock OR "farm animal"~1 OR ruminant OR monogastric OR cattle OR cow OR bovine OR heifer OR calf OR sheep OR ovine OR goat OR caprine OR swine OR pig OR poultry OR broiler OR turkey OR duck OR quail OR aquaculture OR mariculture OR fish OR aqua OR marine OR teleost OR salmon OR trout OR tilapia OR catfish OR "sea bream" OR seabream OR "sea bass" OR seabass OR barramundi OR yellowtail OR amberjack OR Seriola OR cobia OR halibut OR turbot OR eel OR milkfish OR shrimp OR prawn OR "Litopenaeus vannamei" OR "Penaeus monodon" OR crayfish OR lobster OR crab OR shellfish OR oyster OR mussel OR clam OR scallop OR abalone OR "bluefin tuna" OR "carp" OR "flounder" OR "grouper" OR "mackerel" OR "pufferfish" OR "sturgeon" OR "Marsupenaeus japonicus")

（1）調査のアプローチ

（補足5）検索クエリ　2（2）#20 合成生物学や代謝工学

(food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken) AND ("synthetic biology"~1 OR "DNA synthesis"~1 OR "RNA synthesis"~1 OR "gene synthesis"~1 OR "oligonucleotide synthesis"~1 OR "protein synthesis"~1 OR "peptide synthesis"~1 OR biosynthesis OR "biological synthesis"~1 OR "metabolic engineering"~1 OR "peptide engineering"~1 OR "pathway engineering"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acetobacter OR Acetobacterium OR Acidithiobacillus OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aulosira OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Brettanomyces OR Brevibacterium OR Burkholderia OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Desmodesmus OR Dunaliella OR Oenococcus OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Metarhizium OR Methanocaldococcus OR Methanococcus OR Methanosarcina OR Methanothrix OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Pochonia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Purpureocillium OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR Aurantiochytrium OR Mortierella OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)

（１）調査のアプローチ

（補足５）検索クエリ　２（２）#21 未利用資源活用や大量生産

(food OR groceries OR "ready to eat" OR beverage OR drink OR "dairy product" OR "milk product" OR meat OR beef OR seafood OR pork OR chicken) AND ("biomass fermentation"~1 OR "biomass valorization"~1 OR "biomass upcycling"~1 OR "circular bioeconomy"~1 OR byproducts OR "non-edible part"~1 OR "non-edible fraction"~1 OR "inedible part"~1 OR "inedible fraction"~1 OR "non food part"~1 OR "non food fraction"~1 OR "underutilized biomass"~1 OR "underutilised biomass"~1 OR "underused biomass"~1 OR "unused biomass"~1 OR "untapped biomass"~1 OR "residual biomass"~1 OR "waste biomass"~1 OR lignocellulose OR "lignocellulosic biomass"~1 OR "lignocellulosic material"~1 OR "lignocellulosic feedstock"~1 OR "cellulosic biomass"~1 OR "cellulosic feedstock"~1 OR "cellulosic material"~1 OR "woody biomass"~1 OR "plant biomass"~1 OR "lignocellulosic hydrolysate"~1 OR "cellulosic hydrolysate"~1 OR "hemicellulose hydrolysate"~1 OR biomanufacturing OR "precision fermentation"~1 OR "microbial breeding"~1 OR "industrial microbiology"~1 OR "applied microbiology"~1 OR "scale up"~1 OR "large scale"~1 OR "high throughput"~1 OR "Contract Manufacturing Organization"~1 OR "Contract Development and Manufacturing Organization"~1 OR "Fermentation-as-a-Service"~1) AND (bacteria OR microbiology OR prokaryote OR archaea OR microbiota OR mycobiome OR bacteriome OR phytobiome OR archaeome OR fungi OR fungus OR yeast OR microalgae OR microphyte OR Acaulospora OR Acetobacter OR Acetobacterium OR Actinomucor OR Acutodesmus OR Alcaligenes OR Anabaena OR Arthrobacter OR Arthrospira OR Aspergillus OR Aurantiochytrium OR Aureobasidium OR Auxenochlorella OR Azospirillum OR Azotobacter OR Bacillus OR Beauveria OR Bifidobacterium OR Botryococcus OR Bradyrhizobium OR Brettanomyces OR Brevibacterium OR Burkholderia OR Calothrix OR Candida OR Carnobacterium OR Chaetoceros OR Chlorella OR Chromobacterium OR Claroideoglomus OR Clonostachys OR Clostridium OR Cordyceps OR Corynebacterium OR Crypthecodinium OR Cupriavidus OR Cyberlindnera OR Debaryomyces OR Delftia OR Desmodesmus OR Dunaliella OR Ensifer OR Enterobacter OR Enterococcus OR Eubacterium OR Euglena OR Funneliformis OR Galdieria OR Gluconacetobacter OR Gluconobacter OR Haematococcus OR Halanaerobium OR Hanseniaspora OR Herbaspirillum OR Isaria OR Isochrysis OR Issatchenkia OR Kazachstania OR Klebsiella OR Kluyveromyces OR Komagataeibacter OR Komagataella OR Lacticaseibacillus OR Lactiplantibacillus OR Lactobacillus OR Lactococcus OR Leptolyngbya OR Leuconostoc OR Levilactobacillus OR Lysinibacillus OR Megasphaera OR Mesorhizobium OR Methanococcus OR Methanoculleus OR Methanomicrobium OR Methanothermobacter OR Methylacidiphilum OR Methylocaldum OR Methylococcus OR Methylocystis OR Methylomicrobium OR Methylomonas OR Methylophilus OR Methylosinus OR Metschnikowia OR Microchloropsis OR Microcoleus OR Moesziomyces OR Moorella OR Nannochloropsis OR Nitrobacter OR Nitrosomonas OR Nitrosospira OR Nitzschia OR Nostoc OR Paenibacillus OR Paraburkholderia OR Paracoccus OR Pediococcus OR Penicillium OR Phaeodactylum OR Phormidium OR Pichia OR Porphyridium OR Priestia OR Propionibacterium OR Pseudomonas OR Pseudozyma OR Pythium OR Rhizobium OR Rhizophagus OR Rhizopus OR Rhodobacter OR Rhodopseudomonas OR Rhodosporidium OR Rhodotorula OR Saccharomyces OR Scenedesmus OR Schizochytrium OR Scytonema OR Selenomonas OR Serratia OR Shewanella OR Sinorhizobium OR Skeletonema OR Spirulina OR Sporomusa OR Staphylococcus OR Streptococcus OR Streptomyces OR Tetradesmus OR Tetragenococcus OR Tetraselmis OR Thalassiosira OR Thauera OR Thermoanaerobacter OR Thiobacillus OR Tisochrysis OR Trichoderma OR Weissella OR Wickerhamomyces OR Xanthobacter OR Yarrowia OR Zygosaccharomyces OR "lactic acid bacteria" OR "starter culture"~1 OR "adjunct culture"~1 OR "protective culture"~1 OR "ripening culture"~1 OR "co culture"~1)

（１）調査のアプローチ

（補足５）検索クエリ　３ #22 有用菌探索

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(genomics OR proteomics OR transcriptomics OR metabolomics OR "DNA sequencing"~1 OR "sequencing DNA"~1 OR "RNA sequencing"~1 OR "sequencing RNA"~1 OR "single cell sequencing"~1 OR "amplicon sequencing"~1 OR "protein sequencing"~1 OR "peptide sequencing"~1 OR "DNA amplification"~1 OR "RNA amplification"~1 OR PCR OR "gene probes"~1 OR "DNA probes"~1 OR "DNA markers"~1 OR "molecular marker"~1 OR "gene chip"~1 OR bioinformatics OR "computational biology"~1 OR "resource mining"~1 OR "gene profiling"~1 OR "RNA profiling"~1 OR "protein profiling"~1 OR "proteome profiling"~1 OR "peptide profiling"~1 OR "metabolic profiling"~1)

（１）調査のアプローチ

（補足５）検索クエリ　３ #23 設計・合成・改変

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

("genetic engineering"~1 OR "engineering genetic"~1 OR "genome engineering"~1 OR "engineering genome"~1 OR "genetically engineered"~1 OR "engineered genetically"~1 OR "genetic modification"~1 OR "modification genetic"~1 OR "genetically modified"~1 OR "modified genetically"~1 OR "protein engineering"~1 OR "engineering protein"~1 OR "enzyme engineering"~1 OR "engineering enzyme"~1 OR "metabolic engineering"~1 OR "engineering metabolic"~1 OR "peptide engineering"~1 OR "engineering peptide"~1 OR "pathway engineering"~1 OR "engineering pathway"~1 OR "strain engineering"~1 OR "engineering strain"~1 OR "host engineering"~1 OR "engineering host"~1 OR "chassis engineering"~1 OR "engineering chassis"~1 OR bioengineering OR "bio engineering"~1 OR "biological engineering"~1 OR "engineering biological"~1 OR "tissue engineering"~1 OR "engineering tissue"~1 OR "cell engineering"~1 OR "engineering cell"~1 OR "cellular engineering"~1 OR "engineering cellular"~1 OR "synthetic biology"~1 OR "biology synthetic"~1 OR "DNA synthesis"~1 OR "synthesis DNA"~1 OR "RNA synthesis"~1 OR "synthesis RNA"~1 OR "gene synthesis"~1 OR "synthesis gene"~1 OR "oligonucleotide synthesis"~1 OR "synthesis oligonucleotide"~1 OR "protein synthesis"~1 OR "synthesis protein"~1 OR "peptide synthesis"~1 OR "synthesis peptide"~1 OR biosynthesis OR "bio synthesis"~1 OR "biological synthesis"~1 OR "synthesis biological"~1 OR "gene editing"~1 OR "editing gene"~1 OR "genome editing"~1 OR "editing genome"~1 OR "genetic editing"~1 OR "editing genetic"~1 OR "genetically edited"~1 OR "edited genetically"~1 OR CRISPR OR recombinant OR "heterologous expression"~1 OR "expression heterologous"~1 OR overexpression OR "strain improvement"~1 OR "improvement strain"~1 OR "strain development"~1 OR "development strain"~1 OR "strain optimization"~1 OR "optimization strain"~1 OR "strain selection"~1 OR "selection strain"~1)

（１）調査のアプローチ

（補足５）検索クエリ　３ #24 培養・生産・デジタル

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(bioprocess OR "bio process"~1 OR "biological process"~1 OR "process biological"~1 OR biorefining OR "bio refining"~1 OR bioreactor OR "bio reactor"~1 OR biofoundry OR "bio foundry"~1 OR "fed batch"~1 OR "batch fed"~1 OR "perfusion culture"~1 OR "culture perfusion"~1 OR chemostat OR "cell culture"~1 OR "culture cell"~1 OR "tissue culture"~1 OR "culture tissue"~1 OR "embryo culture"~1 OR "culture embryo"~1 OR biocatalysis OR "bio catalysis"~1 OR biotechnology OR "bio technology"~1 OR biomanufacturing OR "bio manufacturing"~1 OR "precision fermentation"~1 OR "fermentation precision"~1 OR "microbial breeding"~1 OR "breeding microbial"~1 OR "industrial microbiology"~1 OR "microbiology industrial"~1 OR "applied microbiology"~1 OR "microbiology applied"~1 OR "scale up"~1 OR "up scale"~1 OR "large scale"~1 OR "scale large"~1 OR "high throughput"~1 OR "throughput high"~1 OR "Contract Manufacturing Organization"~1 OR "Manufacturing Organization Contract"~1 OR "Contract Development and Manufacturing Organization"~1 OR "Development and Manufacturing Organization Contract"~1 OR "Fermentation-as-a-Service" OR "digital twin"~1 OR "twin digital"~1 OR "process analytical technology"~1 OR "analytical technology process"~1 OR "quality by design"~1 OR "design quality"~1 OR "soft sensor"~1 OR "sensor soft"~1 OR "virtual sensor"~1 OR "sensor virtual"~1 OR chemometrics OR "model predictive control"~1 OR "predictive control model"~1 OR "state estimation"~1 OR "estimation state"~1 OR "digital thread"~1 OR "thread digital"~1 OR "big data"~1 OR "data big"~1 OR "machine learning"~1 OR "learning machine"~1 OR "deep learning"~1 OR "learning deep"~1 OR "neural network"~1 OR "network neural"~1 OR "random forest"~1 OR "forest random"~1 OR "gradient boosting"~1 OR "boosting gradient"~1 OR "support vector"~1 OR "vector support"~1 OR "Gaussian process"~1 OR "process Gaussian"~1 OR "Bayesian optimization"~1 OR "optimization Bayesian"~1 OR "reinforcement learning"~1 OR "learning reinforcement"~1 OR "active learning"~1 OR "learning active"~1 OR "transfer learning"~1 OR "learning transfer"~1 OR "semi-supervised"~1 OR "self-supervised"~1 OR "anomaly detection"~1 OR "detection anomaly"~1 OR "computer vision"~1 OR "vision computer"~1 OR "image analysis"~1 OR "analysis image"~1 OR "object detection"~1 OR "detection object"~1 OR IoT OR "edge computing"~1 OR "computing edge"~1 OR "fog computing"~1 OR "computing fog"~1 OR "cloud computing"~1 OR "computing cloud"~1 OR "wireless sensor"~1 OR "sensor wireless"~1 OR "sensor network"~1 OR "network sensor"~1 OR SCADA OR biofoundry OR "bio foundry"~1 OR automation OR autonomous OR robot OR autosampler OR "auto sampler"~1 OR "microplate handler"~1 OR "handler microplate"~1 OR "liquid handling"~1 OR "handling liquid"~1 OR "colony picker"~1 OR "picker colony"~1)

（１）調査のアプローチ

（補足５）検索クエリ　３ #25 環境・資源

※１）項目３「微生物を産業として活用することに資する研究開発」については、項目１～２で得られたデータセットを母集団とし、母集団AND（#22～#25の関連用語）で検索

(bioremediation OR "bio remediation"~1 OR biofiltration OR "bio filtration"~1 OR phytoremediation OR "phyto remediation"~1 OR "biological treatment"~1 OR "treatment biological"~1 OR bioaugmentation OR "bio augmentation"~1 OR "life cycle assessment"~1 OR "cycle assessment life"~1 OR environment OR sustainability OR "climate change"~1 OR "change climate"~1 OR "global warming"~1 OR "warming global"~1 OR decarbonization OR decarbonisation OR "net zero"~1 OR "zero net"~1 OR "carbon neutrality"~1 OR "neutrality carbon"~1 OR "carbon capture"~1 OR "capture carbon"~1 OR "carbon utilization"~1 OR "utilization carbon"~1 OR "carbon storage"~1 OR "storage carbon"~1 OR "carbon footprint"~1 OR "footprint carbon"~1 OR "greenhouse gas"~1 OR "gas greenhouse"~1 OR CO2 OR "carbon dioxide"~1 OR "dioxide carbon"~1 OR methane OR CH4 OR "nitrous oxide"~1 OR "oxide nitrous"~1 OR N2O OR syngas OR "circular economy"~1 OR "economy circular"~1 OR "water footprint"~1 OR "footprint water"~1 OR wastewater OR "waste water"~1 OR effluent)