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# Meat Expectations

## Innovation trends for substitute meat

July 2020



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## SUMMARY

This report analyses trends in meat substitute technologies, an emerging market as conscious consumerism and sustainability awareness grows. It considers two technologies; imitation meat and lab-grown meat.

Recent patent data shows imitation meat technology is an area of growth and investment across the world. Between 2000 and 2012, patenting of imitation meat technologies maintained a low and relatively steady rate, with a significant increase since 2013. Large food companies are among the top applicants.

China dominates this sector as both the largest source of innovation and the largest patent filing destination in imitation meat. It is also responsible for much of the recent growth in patenting in this technology with Guizhou Bezon Food Industry filing the largest number of patents in this sector.

The United States, Europe and Japan are the other major players in this sector, with Australia ranking equal fifth, alongside Canada, as a patent filing destination.

Lab-grown meat is a technology in its infancy, with only 10 patent families filed globally.

This report outlines findings from an investigation of patent families filed since 2000, analysing trends, markets and commercial players in meat substitute technologies.



**258 patent families** have been filed in **imitation meat**



**Patent family filings** for imitation meat **increased from 2013** onwards



**85 per cent** of imitation meat patent families are in an **active** state (in force or seeking patent protection)



Guizhou Bezon Food Industry Company is the **top global patent filer**, with **18 patent families**



**China** is the **largest filing destination** in the world for imitation meat patent families



**Australia** is **equal fifth** filing destinations for imitation meat. This report did not identify any patents filed by Australian applicants

## INTRODUCTION

IP Australia is dedicated to building prosperity for Australia and ensuring that Australians benefit from great ideas. Using patent analytics to provide evidence of innovation, we leverage our unique access to IP data, knowledge and expertise to deliver value to the broader economy.

The patent analytics report has been prepared for the Business Facilitation and Food Policy Branch of the Department of Industry, Innovation and Science. It helps to build an understanding of how consumer demand for environmentally sustainable or ethical practices and products is driving innovation, productivity and competitiveness in the food manufacturing industry. It focuses on meat substitute technologies, namely imitation meat and lab-grown meat. This report is intended to provide an overview of where this technology is being developed, where the markets may be and who the major players are, to help inform policy making around Australia's meat and food industry.

### Conscious consumers and meat

Conscious or ethical consumerism is a growing trend in consumer behaviour for choosing products or services based on a range of personal concerns, including health impacts, ethical considerations, product provenance and environmental sustainability.<sup>1,2,3</sup> It is a phenomenon that is having a real impact on a variety of Australian industries ranging from cosmetics to fast food.<sup>4,5</sup>

A prominent area where this trend is being observed is protein consumption, particularly of meat. The global demand for protein is expected to increase by 20 per cent on 2018 levels by 2025, driven by global population growth and a burgeoning consumer class in Asia.<sup>6</sup> However, concerns about the environmental impact of traditional meat production through animal agriculture, coupled with concerns about animal cruelty, is leading consumers in a number of countries to find alternative

sources of protein for their diets.<sup>7</sup> For example, the percentage of vegetarians in Australia rose from 9.7 per cent in 2012 to 11.2 per cent in 2016. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) predicts that domestic consumer preferences for sustainable and ethical foods, coupled with growing exports to vegetarian markets like India, will drive growth of alternative proteins by \$2.9 billion by 2030.<sup>8</sup>

Consumers are increasingly able to access alternative proteins designed to mimic the appearance, taste, texture and nutritional profile of meat. These imitation meats are largely made from plant-derived proteins and other ingredients, with well-known examples including the imitation hamburgers produced by Impossible Foods and Beyond Meat.<sup>7</sup>

Lab-grown or 'cell-based' meat products are also being developed as an artificial meat substitute. These products are prepared by taking samples of animal cells and multiplying them in a nutrient medium, using bio-scaffolds to direct the cells to produce muscle tissue-like structures.<sup>7</sup>

### Why patent data?

Patents can be used as indicators of innovative activity. By extracting and analysing data associated with patent documents, we can measure aspects of inventive activity such as scope, intensity, collaboration and impact. These metrics can be developed across technology sectors and by measures including individuals (inventors), institutions (applicants) and regions.

Patents are granted for devices, substances, methods or processes that are new, inventive and useful, giving exclusive commercial rights in exchange for full public disclosure of the invention. This means patents are a source of data on innovation trends in science and technology. More information about the patent system is given in Appendix A: Definitions.

<sup>1</sup> Euromonitor International (2019), *Top 10 Global Consumer Trends 2019*. <https://www.euromonitor.com/top-10-global-consumer-trends-2019/report>

<sup>2</sup> KPMG (February 2019), *Retail Trends 2019: Global Consumer & Retail*. <https://home.kpmg/xx/en/home/insights/2019/02/retail-trends-2019.html>

<sup>3</sup> Deloitte (2019), *2019 consumer products outlook*. <https://www2.deloitte.com/us/en/pages/consumer-business/articles/consumer-products-industry-outlook.html>

<sup>4</sup> IBISWorld (August 2019), *Cosmetic and Toiletry Retailing in Australia*.

<https://www.ibisworld.com.au/industry-trends/market-research-reports/wholesale-trade/other-goods-wholesaling/cosmetics-toiletry-wholesaling.html>

<sup>5</sup> IBISWorld (April 2019), *Fast Food and Takeaway Food Services in Australia*.

<https://www.ibisworld.com.au/industry-trends/market-research-reports/accommodation-food-services/fast-takeaway-food-services.html>

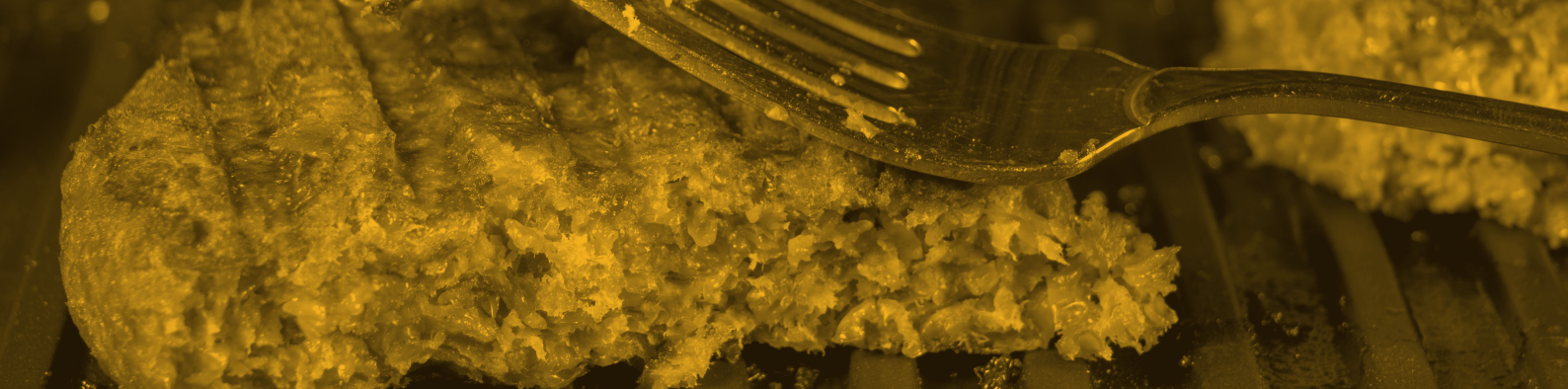
<sup>6</sup> Food Innovation Australia Limited (March 2019), *Protein Market: Size of The Prize Analysis For Australia*. [https://fiial.com.au/Attachment?Action=Download&Attachment\\_id=200](https://fiial.com.au/Attachment?Action=Download&Attachment_id=200)

<sup>7</sup> Food Frontier (September 2019), *Meat The Alternative: Australia's \$3 Billion Opportunity*. <https://www.foodfrontier.org/reports/>

<sup>8</sup> CSIRO (2019), *Growth opportunities for Australian food and agribusiness: Economic analysis and market sizing*.

<https://www.csiro.au/en/Do-business/Futures/Reports/Opportunities-for-Food-and-Agribusiness>





# IMITATION MEAT

## Overview

As the basis for this study, worldwide patent databases were searched for all products and processes for producing foodstuffs that were intended to imitate animal meat in appearance, texture and/or flavour. The search returned a total of 258 relevant INPADOC patent families (Appendix A) filed from 2000 onwards. A majority of the patents were directed to imitation meat products derived from plants, such as soy, but some were also directed to technologies that used non-meat animal-derived products, such as milk and eggs. These were not specifically excluded from the search.

The search strategy used a combination of keywords, International Patent Classification (IPC) symbols and Cooperative Patent Classification (CPC) symbols (Appendix B: Search Strategy).

## Timeline

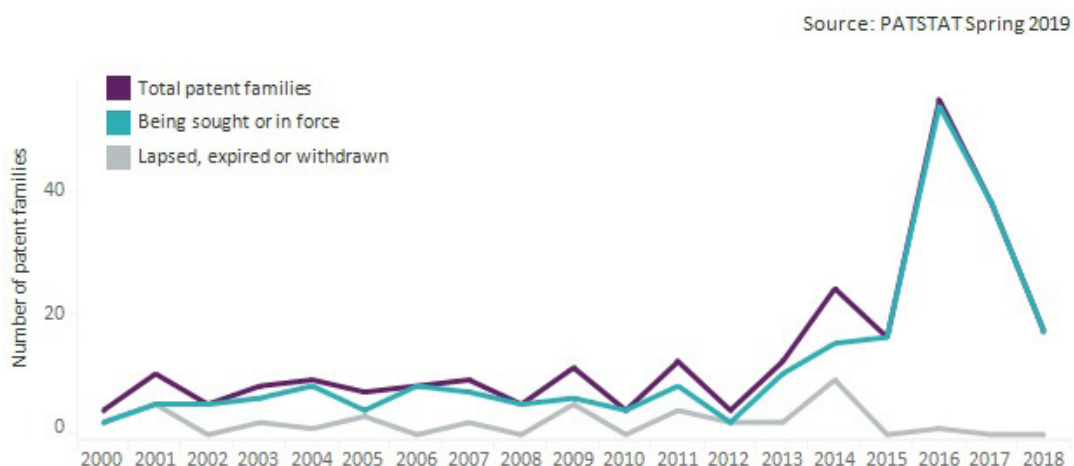
Analysing patent family filing across time can indicate growth or declines in innovation or interest in a technology. Figure 1 shows the number of patent families filed each year, both in total and by their legal status. The number of patents that are in an active state (ie that are either in force or for which protection is being sought, and are not lapsed, expired or withdrawn) provides an indication of whether applicants are continuing to protect their inventions.

It is clear from Figure 1 that imitation meat is an area of growing interest. Patenting activity was low but regular up until 2012, after which the number of applications increased significantly. In 2016, 55 new families were filed.

The data is not complete from 2017 onwards due to a lag in patent publication; the dip in 2017–18 reflects incomplete data rather than a trend decline.

Much of the recent activity has been due to a few Chinese companies, who have submitted many applications in a short space of time. These companies will be discussed further below in the Markets and Top Applicants sections.

Figure 1: Timeline for imitation meat patent family filings since 2000



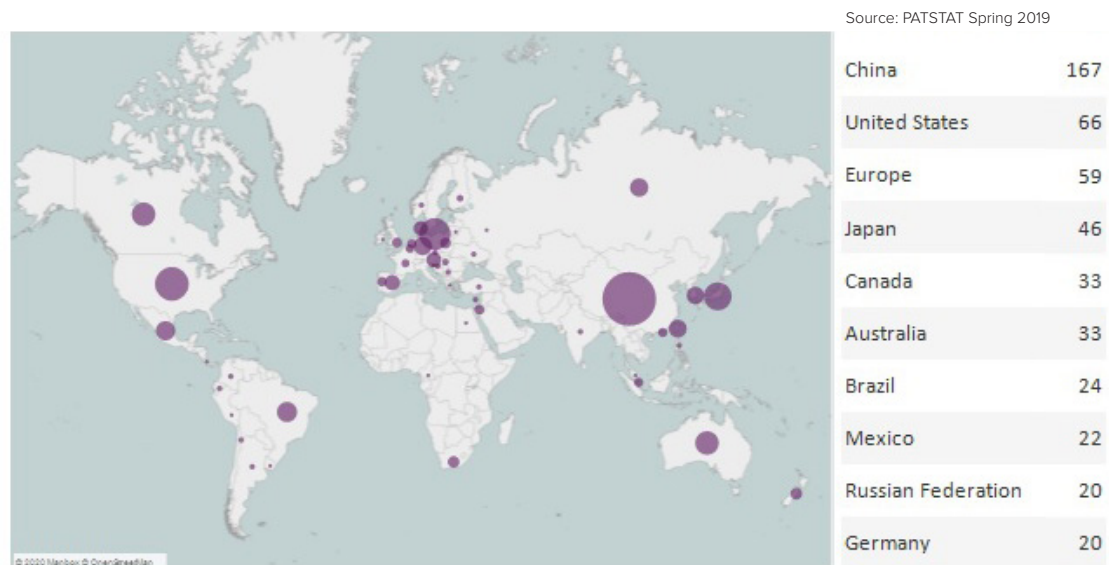
## Filing destinations

Figure 2 shows the filing destinations for patents directed to imitation meat technologies with the top 10 jurisdictions listed in the table. This data shows where applicants are seeking to protect their inventions, indicating potential markets and commercialisation or manufacturing destinations for imitation meat products. From the coverage on this map the global commercial interest is obvious, with protection being sought far and wide. European patents are enforceable in designated contracting

states to the European Patent Convention at the date of filing of the application and are included in this analysis. Patent protection may be sought in European countries directly, e.g. Germany.

The biggest destination for filing patents is China with 167 families, followed by the United States with 66. China overtook the United States as the largest destination for imitation meat patents in 2014. Europe identifies patent families filed with the European Patent Office and does not include filings with European countries' individual patent offices.

Figure 2: Imitation meat patent family filings by filing jurisdiction, 2000–18<sup>9</sup>



### Australia

Australia is a popular destination to file imitation meat patents, in equal fifth place with Canada. Most applicants filing in Australia are from either the United States or European countries including Germany and Switzerland. Periods of higher patenting activity were 2000–02, with 10 families filed; and then 2011–16, where 14 of the 33 families were filed.

### China

China is the top filings destination and has seen a rapid increase in applications since 2012, with 75 per cent of their patent families filed since 2013, including 45 patent families filed in 2016 alone. A large majority of applicants filing in China are Chinese entities, which in most cases do not file anywhere else and are only seeking protection in the Chinese market. However, there are also a number of United States and some European applicants choosing to file in China, in addition to other jurisdictions.

### United States

Like Australia, the United States had relatively high patenting activity in the early 2000s, followed by a lull around 2010, and increased activity from 2014. The most active years were 2006 and 2014, in both years seven patent families were filed in the United States. Very few applications come from Chinese applicants, with the majority of applicants being from the United States and Europe.

### Europe

At least one patent family has been filed with the European Patent Office every year since 2000, except 2010. From 2013–17 there has been a higher level of activity, with 21 families filed over that period. Most applications come from European countries, and the United States.

<sup>9</sup> The data is not complete from 2017 onwards due to a lag in patent publication.



## Places of origin

Figure 3 shows the number of patent families for imitation meat filed by the place of origin for places from which three or more patent families originate. China is clearly the largest source of patents, followed by the United States and Japan.

No patent families were identified as originating in Australia. This indicates that no Australian applicants hold any of the patents identified in this analysis for technologies associated with imitation meat.

### China

China is the leading origin of patent applicants with a total of 112 patent families filed (43 per cent). The majority of these filings occurred after 2014 when 94 families or 84 per cent of the total for China were filed. The year with the largest number of patent family filings (37) was 2016. Key companies that contributed to this large number of patents include Guizhou Bezon Food Industry Company and Foshan Jucheng Biochemical Technology R&D (more details under Top Applicants).

### United States

The United States was the second highest applicant origin with a total of 38 patent families filed (15 per cent). Most patents families, (61 per cent) filed by applicants from the United States were filed in the period 2001–08.

### Japan

Japanese applicants were most active in filing between 2013 and 2015, with two to three families filed per year. The largest contributor to this was Fuji Oil, with four patent families filed over this period (more details in Top Applicants), and Nisshin Oillio Group with two filings.

### Germany

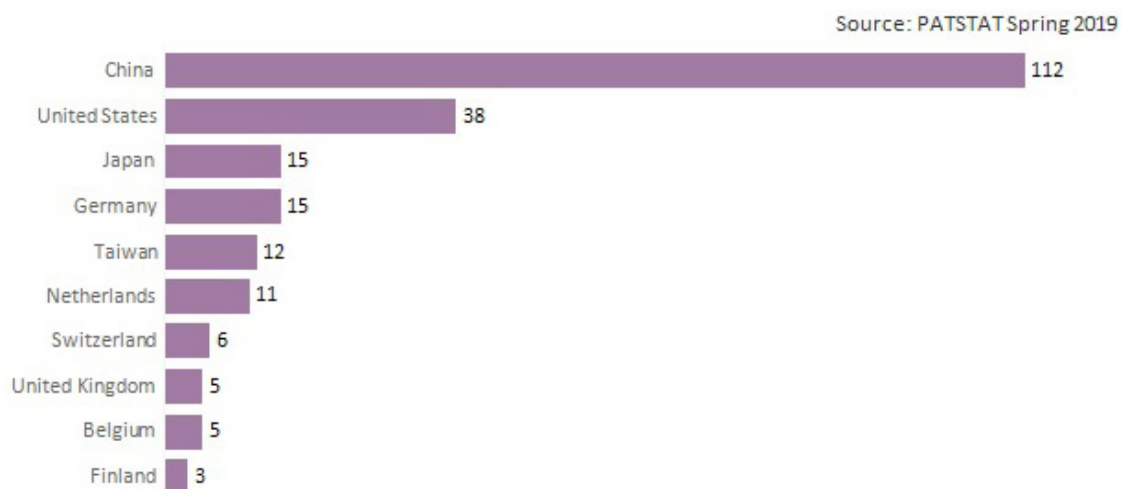
Patents filed from German applicants had their most intensive period from 2004–05, when seven of the 20 patent families were filed. Four of these were by Nug Nahrungs Genussmittel (more details under Top Applicants). There were no filings by German applicants from 2006–12, with two filings in 2013 and only one family filed each year from 2014–17.

Other recent filings from European countries include Belgian company Tereos, (three families filed in 2016), and Finnish food technology start-up Gold & Green Foods (two families in 2017).

### Taiwan

The most active year for Taiwanese applicants was 2009 with four patent families, all filed by either the Food Industry Research and Development Institute or the Chia Nan University of Pharmacy & Science. Together these two research entities also account for 10 out of 12 patent families of Taiwanese origin since 2000. They were both among the top applicants overall for imitation meat patents.

Figure 3: Imitation meat patent family filings by applicant origin, 2000–18

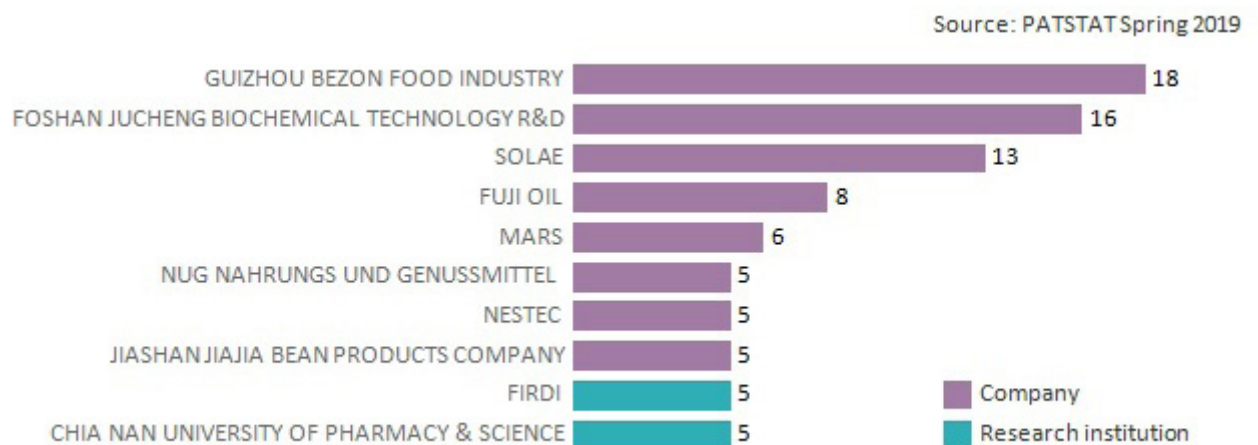


## Top applicants

A patent provides an exclusive right to the patent owner for up to 20 years over their invention, to protect their ideas and products. The number of patent families filed by an applicant in a particular technology can be indicative of their interests and market presence or desire to build and maintain a market share.

Figure 4 shows the top 10 applicants for patents directed to imitation meat, based on the number of patent families they hold. Three of these, including the top two, are Chinese companies.

Figure 4: Imitation meat patent family filings by top applicants, 2000–18



### Guizhou Bezon Food Industry

The Guizhou Bezon Food Industry Company is a Chinese business located in Guizhou Province. They filed their first patent for imitation meat in 2014, but most of their activity has been in 2017–18, when 16 of their 18 patent families were filed. Many of their inventions involve preparing imitation meat from a range of nuts, beans and other ingredients that supposedly have health benefits, such as patents CN108617794 for prevention of osteoporosis, or CN108634198 for treatment of rheumatoid arthritis. A few of their filings are directed to machine components for the production of imitation meat: CN107319570 for a forming die, CN107348548 for a screw rod, and CN107319615 for a forming and cooling device.

### Foshan Jucheng Biochemical Technology R&D

Foshan Jucheng Biochemical Technology R&D Company is a Chinese company located in Guangdong Province. All 16 of their patent families were filed in 2016, making a significant contribution to the spike in patenting activity observed in that year. Patents cover methods for producing a range of imitation meat products, including soy-based sausages (CN105746724) and corn-based vegetarian meat (CN105595345).

### Solae

Solae was an American soy products company. Patents were filed between 2001 and 2009, with the most activity in 2006–07. Solae was acquired entirely by DuPont in 2012, and no patents have been filed for imitation meat under either name since then. However, all Solae patents have been maintained and are still in force.

### **Fuji Oil**

Fuji Oil Co., Ltd is a Japanese business that produces food ingredients for/from vegetable oils and fats, industrial chocolate production, emulsified and fermented ingredients and soy-based ingredients. They have been patenting in this field since 2001, with a gap from 2004–11 and five of their eight patent families were filed between 2013 and 2016. Some patents include WO2015108142, which is for imitation shrimp meat made from plant and egg proteins; and JP2016149967, for an imitation chilled mincemeat made from soybeans and an acidic seasoning liquid. Seven of their eight families remain in force.

### **Mars**

Mars, Inc. is an American multinational company that produces a range of food and confectionary products. The six patent families owned by Mars were filed between 2000 and 2008, with no activity since. Patents include one for an imitation meat extrudate cutting device (US2005196502).

### **Nug Nahrungs und Genussmittel**

Nug Nahrungs und Genussmittel is a German company that filed five patent families between 2002 and 2005, with no activity since then. Two of the five families have since lapsed or expired. Their patents typically involved the preparation of meat analogues from dairy products, such as curd (WO03061400).

### **Nestec**

Nestec, a subsidiary of Nestle, has been patenting in this field since 2002, with a patent filing in that year for pet food products (WO2004023887). They filed the remaining four families between 2009 and 2015, all for meat analogue food products, including the preparation of vegetable-based minced meat made from gluten (WO2013087558). All of their patent families have been maintained.

### **Jiashin Jiajia Bean Products Company**

Jiashin Jiajia Bean Products Company is a Chinese company with five patent families filed in 2014, and no other patenting activity. Their patents were filed only in China. Four of those families have since lapsed or expired, three of which were for vegetarian meat rolls and one for a sauce that tastes like meat. Their active patent is for a vegetable meat floss with health benefits.

### **Food Industry Research and Development Institute (FIRDI)**

FIRDI is a government non-profit research organisation in Taiwan. They have filed five patent families, between 2006 and 2018. Their most recent patent was directed to a device for manufacturing vegetarian meat (TWM563157). Other interesting patents include one for vegetarian imitation dried bonito (TW201100020). All their patent filings since 2009 have only been filed in Taiwan or China.

### **Chia Nan University of Pharmacy and Science**

Chia Nan University of Pharmacy and Science is a Taiwan university that filed two patent families in 2007 and three in 2009. All were single patent families filed only in Taiwan and focused on methods for manufacturing vegetarian meats from soybean curd (e.g. TW200913908) or mushrooms (e.g. TW201026237).

### **Other companies of interest**

There were several well-known companies noticeably absent from the list of top applicants due to the low total number of patents filed by these organisations. This section provides a brief overview of the patenting activities observed for some of these companies.

### **Beyond Meat**

Beyond Meat is one of the most recognisable imitation meat companies based in the United States. They sell plant-based food products internationally. The company's Beyond Burger® is available at select outlets across Australia, including Grill'd, IGA stores and Coles.

Patents owned by Beyond Meat were filed under their former corporate name, Savage River.<sup>10</sup> The company filed four patents across 2014–15 putting them in the top 15 applicants overall. Given their focus on the burger market, many of the patents filed relate to the production of ground meat substitutes made from plant material that are nutritious (WO2015161105) and realistic compared with animal ground meat (WO2017070303).

<sup>10</sup> U.S. Securities and Exchange Commission: Beyond Meat, Inc. <https://www.sec.gov/Archives/edgar/data/1655210/000162828019004543/beyondmeats-1a5.htm>

### **Impossible Foods**

Impossible Foods is a company based in the United States producing imitation meat, particularly imitation minced meat and burger patties. In 2019, Burger King introduced the Impossible™ Whopper® across America, using Impossible Food's burger patty. All Impossible Food patents identified in this report fall under a single patent family from 2011, which covers a variety of processes involved in producing realistic artificial meat. These include methods for producing heme-containing polypeptides (US2017342131), and also non-meat applications like the production of non-dairy cheese replicas through enzymatic processes (WO2014110540).

### **Sunfed**

Sunfed is a New Zealand start-up artificial meat company that produces vegetable-based imitation chicken products. They filed in 2015 in Australia, China, Europe and WIPO for a meat substitute product, with the focus being on creating imitation meat that can be free of soy, gluten or allergenic ingredients (WO2017046659).

### **Just, Inc.**

Just, Inc. an American company better known for producing imitation egg products, is also investigating the production of cell cultured beef.<sup>11</sup> They also filed a patent family relevant to imitation meat production in 2016, with patents directed to the preparation of protein compositions from adzuki beans and mung beans (WO2017143301 and WO2017143298)

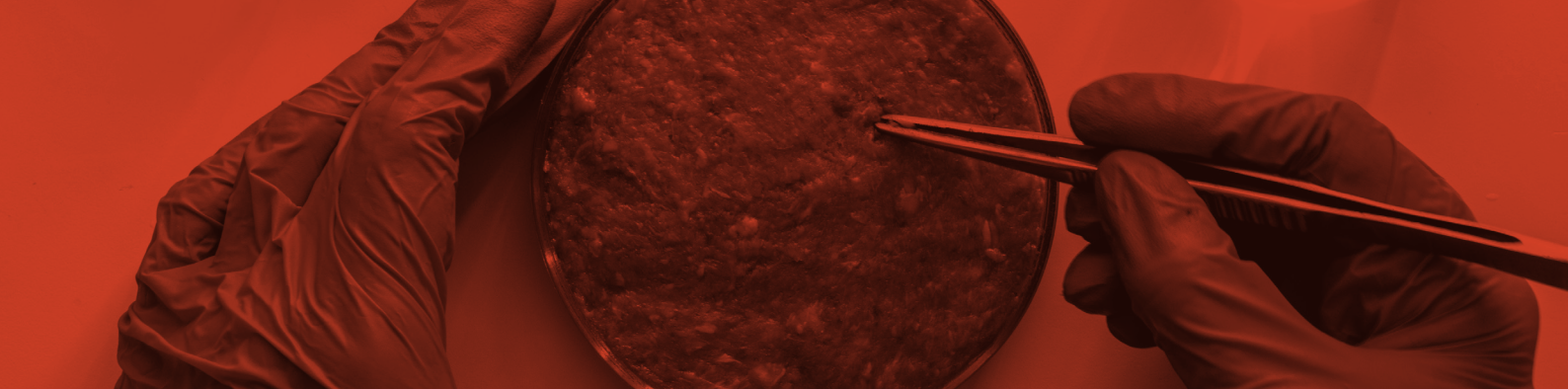
### **Marlow Foods**

Marlow Foods Ltd. is a British food company that launched Quorn® imitation meat products in 1985. They were sold to Monde Nissin, a leading food company from the Philippines, for £550 million in 2015.<sup>12</sup>

Marlow Foods filed three patent families between 2013 and 2016, which relate to producing vegan meat substitute products from fungi and agar, including patent application WO2018002587. Their patent portfolio includes further families for edible formulations and edible fungi since 2000. These patent families do not focus on imitation meat and therefore are not captured in this analysis.

<sup>11</sup> Food Frontier (March 2019), Meat Re-imagined: The Global Emergence of Alternative Proteins. <https://www.foodfrontier.org/reports/>

<sup>12</sup> Foodnavigator <https://www.foodnavigator.com/Article/2015/10/02/Quorn-sold-to-Filipino-firm-for-550M>



# LAB-GROWN MEAT

## Overview

The search for lab-grown meat focuses on technologies for cell culture or tissue engineering of animal cells to create tissue similar to animal-derived meat. Culturing techniques for human cells, and culturing techniques directed at modifying the growth of cells in living animals, were not included in the analysis. With these restrictions in place, there is only a small number of patent families filed since 2000 that are directed to production of lab-grown meat for human consumption.

The search strategy used a combination of keywords, International Patent Classification (IPC) symbols and Cooperative Patent Classification (CPC) symbols (Appendix B: Search Strategy).

## Timeline

We identified a total of 10 patent families filed for lab-grown meat, five in the early 2000's and five between 2011 and 2017, see Figure 5. The data is incomplete from 2017 onwards due to a lag in patent publications.

Figure 5: Timeline for lab-grown meat patent family filings

Source: PATSTAT Spring 2019 and Derwent Innovation

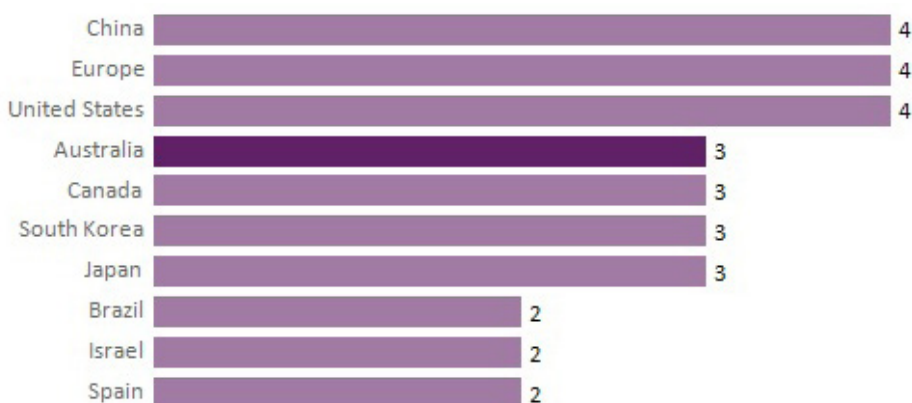
Family Status	2000	2004	2011	2013	2016	2017
Being sought or in force	1	3	1	1	1	2
Lapsed, expired or withdrawn		1				

## Filing destinations

Figure 6 shows the jurisdictions where two or more lab-grown meat patent families were filed. In contrast with imitation meat, an equal number of applications have been filed in both the United States and China.

None of those applications came from Chinese applicants. Australia remains a relevant market, sitting in joint fourth place, with three patent families filed for protection here.

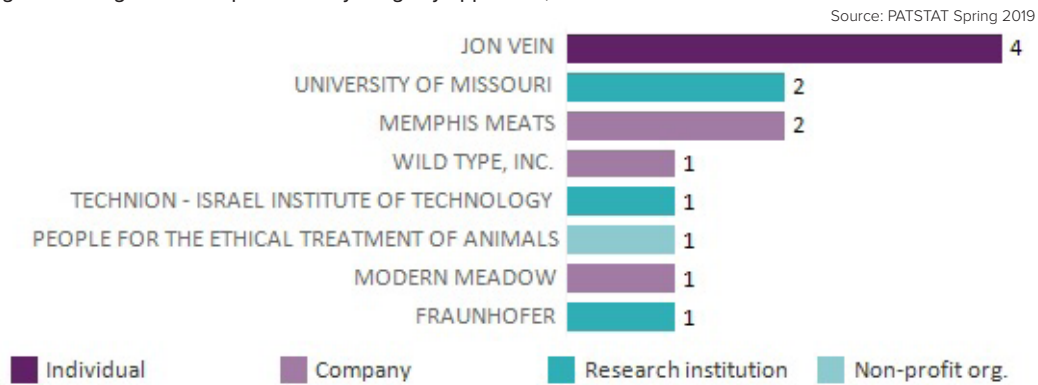
Figure 6: Lab-grown meat patent family filings by filing jurisdiction 2000-18



Source: PATSTAT Spring 2019 and Derwent Innovation



Figure 7: Lab-grown meat patent family filings by applicants, 2000–18



## Top Applicants

Figure 7 displays the applicants for inventions relating to lab-grown meat. Eight applicants contributed to the 10 family filings which includes co-filed patent families. Six of the eight applicants are American, with the remaining two from Israel and Germany.

The active players are developing lab grown meats. No company in the lab grown meat space, is at a commercial scale, Memphis Meats are building a pilot plant to produce their lab-grown meat products.<sup>13</sup>

### Jon Vein

There are four patent families filed by Jon Vein as an individual applicant. Jon Vein is an American businessman and entrepreneur who filed patents in 2000 and 2004 for *ex vivo* meat production, both still maintained. These are the earliest identified patents for lab grown meat (US2005010965 and WO2006041429).

### University of Missouri

The University of Missouri holds two patent families in cell cultured meat. In 2011, the University co-filed a patent family with Modern Meadow relating to culturing cells (WO2013016547). In 2013, they co-filed a patent family with People for the Ethical Treatment of Animals (PETA) and later with Memphis Meats on the same family directed to culturing muscle cells for human consumption (US2016251625). In addition, the University of Missouri also has a patent family directed to an imitation meat product, filed in 2010 (WO2012051428).

### Memphis Meats

Memphis Meats is an American company founded in 2015, with a focus on producing meat cultured from cells. In 2016 they produced cell-based beef meatball and in 2017 cell-based chicken and duck.<sup>14</sup> In addition to the patent family co-filed with the University of Missouri and PETA, Memphis Meats has a second patent family filed in 2016 that is directed

towards using CRISPR technology for extending the capacity of muscle cells to replicate (WO2017124100).

### Wild Type, Inc.

Wild Type is an American company working on producing meat and fish products with cultured cells.<sup>15</sup> Their first product developed is based on salmon.<sup>16</sup> The company filed a patent family in 2017, for *ex vivo* production of cell cultured food products, including cultured sushi and foie gras (WO2018227016).

### Technion – Israel Institute of Technology

Technion is an Israeli research university based in Haifa. The company filed one patent family in 2017 that is directed to cultured meat production (WO2019016795). One of the two inventors, Professor Shulamit Levenberg, is a co-founder of Israeli food-tech start-up Aleph Farms (founded in 2017), which is known for producing cell cultured artificial steak.<sup>17, 18</sup> No patent families from Aleph Farms were identified in this analysis.

### Modern Meadow

Modern Meadow is an American company that mainly focuses on using biotechnology and cell culturing to produce materials like leather, rather than meat tissue for consumption.<sup>19</sup> However, the company did co-file a patent family directed to lab-grown meat with the University of Missouri in 2011. Patents in this family covered both edible bio-scaffolds (such as pectin) (WO2015038988), and the procedure for making dried food products from the cultured cells (WO2015120174).

### Fraunhofer

Fraunhofer-Gesellschaft is a German non-profit applied science research organisation based in Munich. They have patents in both imitation and lab-grown meat. The patent for lab-grown meat (WO2005097975) was filed in 2004, while their patent in plant-based protein products (WO2016000940) was filed a decade later, in 2014.

<sup>13</sup> TWired: The race to bring meat alternatives to scale. <https://www.wired.com/story/uma-valeti-memphis-meats-wired25/>

<sup>14</sup> Memphis Meats. <https://www.memphismeats.com/about>

<sup>15</sup> The Wild Type. <https://www.thewildtype.com/mission>

<sup>16</sup> TechCrunch: Wild Type raises \$3.5M to reinvent meat for the 21st century. <https://techcrunch.com/2018/03/29/wild-type-raises-3-5m-to-reinvent-meat-for-the-21st-century/>

<sup>17</sup> Food Frontier (March 2019), Meat Re-imagined: The Global Emergence of Alternative Proteins. <https://www.foodfrontier.org/reports/>

<sup>18</sup> Aleph Farms. <https://www.aleph-farms.com/>

<sup>19</sup> <http://www.modernmeadow.com/>



## CONCLUSION

This report set out to explore the patent landscape for innovations in imitation meat and lab-grown meat, to shed light on trends as conscious consumerism and sustainability awareness grows. We identified 258 patent families filed globally relating to imitation meat and 10 patent families relating to lab-grown meat since 2000.

Imitation meat has seen an increase in patenting activity since 2013, with 55 filings in 2016 alone. Recent growth has been prominently driven by China, with 43 per cent of the patent families originating there. We observed a subtle growth in patent families originating from Europe and Japan, while patenting from the United States appears steady.

Australia is the fifth largest filing destination, with many companies from Europe and the United States choosing to file applications here. We did not identify any patent families filed by Australian applicants.

China is the largest filing destination with many Chinese applicants only patenting in China, while entities from the United States and Europe often choose to protect their inventions worldwide. Chinese companies are among the top applicants, some having filed large numbers of patent families in short periods of time.

Patent families in lab-grown meat originate mainly from American applicants, 90 per cent are active and are filed internationally. No Chinese applicants were identified, contrasting to our findings for imitation meat technologies.

It is evident that lab-grown meat is at an early stage of research, with only five patent families being filed since 2011, of which 60 per cent had collaborations involving a company and research institution.

Such low filing numbers indicate the underlying technologies to support the commercialisation of lab-grown meat, such as optimised cell culture conditions, are still in development. This assessment is further upheld by the lack of known availability of lab-grown meat to consumers.

Companies may seek to protect their innovations by means other than patenting, such as trade secrets which do not require full disclosure of the invention. This can be an alternative route for companies to protect their IP, particularly if a process or product is difficult to reverse engineer. Companies may elect to patent a process only when they perceive that competition may be encroaching on their monopoly.

Overall, this analysis shows imitation meat technologies are expanding with global commercial interest. We expect continued development in the foreseeable future to meet the ever-growing market demand. Lab-grown meat is a technology in its infancy and, as such, is a space to be watched.

## APPENDIX A: DEFINITIONS

### Patent, applications and publications

A patent is a right that is granted for any device, substance, method or process that is new, inventive and useful. Australian patent rights are legally enforceable and give the owner, or patentee, exclusive rights to commercially exploit the invention in Australia for a period of up to 20 years. In this report, an application refers to a single patent filing. A patent application is usually published within 18 months of its earliest filing date (also known as the priority date). We consider that the priority date is most relevant for our analysis as it is the closest date to that when the invention occurred.

There are two major routes for filing a patent application: the international route and direct filing. The international route involves filing a Patent Cooperation Treaty (PCT) application, which establishes a filing date in all 152 contracting states.<sup>20</sup> Subsequent prosecution at national patent offices, referred to as national-phase entry, is made at the discretion of the applicant. A patent can only be enforced once it has been granted and a PCT application must enter the national-phase to proceed towards grant. Alternatively, applications can be filed directly in the jurisdictions of interest.

A patent application is considered to be in force when it has not lapsed (due to expiry or non-payment of renewal fees), been revoked or withdrawn. Data was taken from the most recent legal status action in the PATSTAT database. A family has been designated as being in force if it contains at least one in force application.

### Patent families

Applications with the same priority document, but filed in different jurisdictions, are known as patent families. Patent families enable us to analyse inventive activity regardless of the number of jurisdictions in which protection is sought. Patent families are used in analytics to represent a single invention. We determine patent families based on INPADOC database definition, with a unique family ID for patents that share a common priority document.<sup>21</sup> The number of patent families is typically used as a metric. There are some exceptions when reporting individual applications, as each application represents a legal right in an individual jurisdiction. When analysing applicants, related commercial entities are grouped by a single, harmonised name. When individual publication numbers are quoted, we have chosen a representative publication from the patent family, typically US or WO English language documents.

### Classification

Patents are classified by technology into the hierarchical IPC or CPC systems. The CPC began in 2013 and provides significantly more depth to the hierarchy of the IPC.<sup>22</sup> For more information on the coverage of the CPC, see the CPC Annual Report 2017-18.<sup>23</sup>

<sup>20</sup> WIPO, [www.wipo.int/pct/en/pct\\_contracting\\_states.html](http://www.wipo.int/pct/en/pct_contracting_states.html)

<sup>21</sup> Martinez, 'Insight into Different Type of Patent Families', OECD Science, Technology and Industry Working Papers, No. 2010/2, OECD Publishing, Paris; see section 3.2, 'Extended families'.

<sup>22</sup> European Patent Office and United States Patent and Trademark Office, [www.cooperativepatentclassification.org/](http://www.cooperativepatentclassification.org/)

<sup>23</sup> EPO and USPTO, <http://www.cooperativepatentclassification.org/publications/AnnualReports/CPCAnnualReport20172018.pdf>

## APPENDIX B: SEARCH STRATEGY

Searching patent information to identify relevant records for analysis requires a stepped approach to identify broad categories of relevance, and then specific records within them that meet the technology brief.

The following outlines the detail of the search and analysis process conducted.

### Data extraction and analysis

We used five phases of data extraction and analysis.

- Phase 1: Development of a search strategy (below).
- Phase 2: Data mining using the PATSTAT 2019 Spring edition database. The unique INPADOC family members relating to imitation meat were identified and used as the basis of the analysis.
- Phase 3: Data mining using the DWPI database accessed via Derwent Innovation. The unique patent publications relating to lab-grown meat were identified and used to extract information related to their INPADOC family from the PATSTAT 2019 Autumn edition database.
- Phase 4: Manual and semi-automated data-cleaning, to remove data duplications, unrelated families and to consolidate applicant names.
- Phase 5: Data analysis using Tableau 2019.2 for calculations and visual presentation of patent metrics.

### Search strategy

#### PATSTAT

The following searches of the PATSTAT were combined to give the dataset used for imitation meat patents.

The search for imitation meat patents was limited to patent families that had CPC symbols, IPC symbols, keywords or a combination of these as listed here.

Search Statement 1:

1.1 OR 1.2 OR 1.3 OR 1.4 OR 1.5 OR 1.6 OR 1.7 OR 1.8

Item	Details
1.1	CPC=A23J3/227 & (A23J1/006   A23J1/007   A23J3/14   A23J3/16   A23J3/18   A23V2250/548   A23V2250/5482   A23V2250/5484   A23V2250/5486   A23V2250/5488)
1.2	CPC=A23J3/227 AND (TITLE=%substitute%   %vegetarian%   %vegan%   %imitation% OR ABSTRACT=%substitute%   %vegetarian%   %vegan%   %imitation%)
1.3	CPC=A23J3/227 AND (TITLE =analog   analogs   analogue   analogues   analogous OR ABSTRACT=analog   analogs   analogue   analogues   analogous)
1.4	CPC=A23J3/227 AND (TITLE = tofu   lentil   lentils   pea   peas   peanut   peanuts   soy   soybean   soybeans   soya   soyabean   soyabeans   chickpea   chickpeas   tempe   legume   legumes   alfalfa   clover   clovers   bean   beans   lupin   lupins   mesquite   carob   tamarind   nut   nuts   wheat   corn   mung   mungbean   mungbeans   cotton   rape   rapeseed   whey   seed   seeds   sesame   safflower   oat   oats   oatmeal   seitan OR ABSTRACT= tofu   lentil   lentils   pea   peas   peanut   peanuts   soy   soybean   soybeans   soya   soyabean   soyabeans   chickpea   chickpeas   tempe   legume   legumes   alfalfa   clover   clovers   bean   beans   lupin   lupins   mesquite   carob   tamarind   nut   nuts   wheat   corn   mung   mungbean   mungbeans   cotton   rape   rapeseed   whey   seed   seeds   sesame   safflower   oat   oats   oatmeal   seitan)
1.5	TITLE= (mock & meat)   (faux & meat)   (%vegetarian meat%)   (%imitation meat%)   (%substitute meat%) OR ABSTRACT= (mock & meat)   (faux & meat)   (%vegetarian meat%)   (%imitation meat%)   (%substitute meat%)
1.6	IPC= A23J3/22   A23J3/24   A23J3/26   A23J3/28 AND (TITLE=%substitute%   %vegetarian%   %vegan%   %imitation% OR ABSTRACT=%substitute%   %vegetarian%   %vegan%   %imitation%) AND (TITLE=%meat% OR ABSTRACT=%meat%)

Item	Details
1.7	IPC= A23J3/22   A23J3/24   A23J3/26   A23J3/28 AND (TITLE=analog   analogs   analogue   analogues   analogous OR ABSTRACT= analog   analogs   analogue   analogues   analogous) AND (TITLE=%meat% OR ABSTRACT=%meat%)
1.8	IPC= A23J3/22   A23J3/24   A23J3/26   A23J3/28 AND (TITLE=tofu   lentil   lentils   pea   peas   peanut   peanuts   soy   soybean   soybeans   soya   soybean   soybeans   chickpea   chickpeas   tempe   legume   legumes   alfalfa   clover   clovers   bean   beans   lupin   lupins   mesquite   carob   tamarind   nut   nuts   wheat   corn   mung   mungbean   mungbeans   cotton   rape   rapeseed   whey   seed   seeds   sesame   safflower   oat   oats   oatmeal   seitan OR ABSTRACT= tofu   lentil   lentils   pea   peas   peanut   peanuts   soy   soybean   soybeans   soya   soybean   soybeans   chickpea   chickpeas   tempe   legume   legumes   alfalfa   clover   clovers   bean   beans   lupin   lupins   mesquite   carob   tamarind   nut   nuts   wheat   corn   mung   mungbean   mungbeans   cotton   rape   rapeseed   whey   seed   seeds   sesame   safflower   oat   oats   oatmeal   seitan) AND (TITLE=%meat% OR ABSTRACT=%meat%)

### Derwent Innovation

The search for lab-grown meat was limited to patent families that had CPC symbols, IPC symbols, keywords or a combination of these as listed here.

Search statement 2:

2.1 OR 2.2 OR 2.3

Search statement three was a specific search of the Derwent Database to extract INPADOC family information for two patents

Item	Details
2.1	CTB=((vitro OR ex*lvivo) NEAR4 (meat OR muscle)) AND AIC=(C12N000506* OR C12N000507*) AND ALL=(meat*1ball OR steak OR ((edible or consum* Or comestible) NEAR2 (meal Or diet* OR food)) OR (food ADJ product))
2.2	CTB=((synthetic OR imitat* OR pseudo OR false OR fake OR bio*1fabrica* OR simulat*) ADJ4 (meat OR muscle OR cell*1based OR myocyte)) AND AIC=(C12N000506* OR C12N000507*) AND ALL=(meat*1ball OR steak OR ((edible or consum* Or comestible) NEAR2 (meal Or diet* OR food)) OR (food ADJ product))
2.3	CTB=((tissue*1cultur* OR cultur* OR cultivat* OR engineer*) ADJ4 (meat OR muscle)) AND AIC=(C12N000506* OR C12N000507*) AND ALL=(meat*1ball OR steak OR ((edible or consum* Or comestible) NEAR2 (meal Or diet* OR food)) OR (food ADJ product))

Item	Details
3.1	INPADOC pns=(WO2017124100 OR WO2012051428)

### Technology analysis

There was no further classification of technologies beyond the searches. Patents retrieved via the first search in PATSTAT were flagged as imitation meat patents, and those retrieved through the Derwent Innovation search were flagged as lab-grown meat patents. Patent families retrieved with search item 3.1 were manually categorised in Tableau.







