

## **Analysis of the Structural Characteristics of Technology Fusion Networks Using the International Patent Classification: Focusing on Patents in the Pet Food Industry**

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### **Abstract**

*We investigated and analyzed the technological landscape of the global pet food industry, focusing on related industries in Korea and abroad. This industry accounts for the largest share of the rapidly growing global pet market. We aimed to identify and develop technologies that can strengthen Korea's position in this market. Our study employed various quantitative methods, including time series analysis, country and applicant analysis, and International Patent Classification (IPC) technology analysis. These analyses allowed us to objectively assess the current technological status, patent application distribution, and technological trends in the pet food industry. Our findings revealed that the United States currently holds the leading position in terms of patent applications within the pet food industry. This suggests that to establish a differentiated competitive edge in this field, it's crucial to develop technologies with high usability and target specific segments within related industries. Additionally, focusing on interdisciplinary research that combines Korea's existing advanced technologies with other relevant fields is essential.*

**Keywords:** *Pet food, Pet Industry, Patents, Patent Analysis, Statistical Analysis*

## **1. INTRODUCTION**

On August 9, 2023, the Ministry of Agriculture, Food and Rural Affairs announced the "Companion Animal-Related Industry Promotion Plan," aiming to foster companion animal-related industries as a national strategic sector. This plan includes the promotion of pet food and pet healthcare as key components, with a focus on expanding global market presence and actively pursuing industrialization for export. The ministry also pledged to support improvements in regulations and related research to promote the domestic pet industry. Pet food, a prominent subsector within the companion animal-related industries, is recognized as one of the four major pillars. It holds a significant share of the global companion animal industry [1, 2]. Despite a consistent growth trend in related markets and research activities [3], The domestic market in South Korea remains relatively small compared to advanced overseas countries with developed companion animal industries. Additionally, the domestic market heavily relies on imported products [4]. Internationally, there is a substantial amount of

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research and product development related to pet food, targeting various categories of companion animal consumers [5-7]. Intellectual property rights related to these innovations have played a crucial role in establishing the competitiveness of pet food companies. As a result, foreign companies that recognized the significance of the pet food industry early on have taken the lead in securing market share through technology acquisition and establishing trusted quality control systems [8]. These patents are widely considered reliable indicators due to their well-defined nature within a vast sea of information, and they can provide a clear objective assessment of the distinctiveness and relevance of technology [9]. Importantly, such patents have a positive impact on a company's performance and competitiveness through technological innovation, and they extend beyond the corporate realm to benefit society and the nation as a whole [10]. As a result, foreign multinational companies that entered the pet food industry early have gained substantial footholds through technology acquisition and the establishment of reliable quality control systems [11]. Domestic pet food consumers in South Korea also exhibit a preference for products from foreign multinational companies [12]. While there have been some developments in technology and research related to companion animal industries, there remain doubts and skepticism regarding whether these efforts align with consumer demands and effectiveness [13]. Furthermore, research on intellectual property related to pet food is limited in scope. While some domestic patent research on pet food exists, it can be considered limited in comparison to the overall landscape of foreign multinational companies [14]. Research on patents and their relevance and utilization of the latest science and technology is active in a variety of industries, similar to the research mentioned above [15]. In addition, several studies examine not only the domestic but also the global status of the consumer goods industry [16-18]. Thus, this study aims to investigate relevant patent technologies in the domestic and international pet food industry. It seeks to examine the current technological landscape of both domestic and international markets and provide a foundational resource that outlines directions for technology, development, and market competitiveness expansion for domestic and international pet food industries.

## **2. THEORY**

### **2.1 Pet Industry**

With the increase in the number of pet-owning households, a culture emphasizing the importance of the bond with pets, known as "pet-friendly" culture, and a culture treating pets as family members, known as "pet families," have emerged. As these cultures have become more widespread, they have become connected to related industries, leading to the development of a new industry known as the "petconomy" [20]. The global pet industry is experiencing rapid growth worldwide and the domestic pet industry in South Korea is also expanding [21]. The pet industry encompasses various fields related to pets, including fashion products, food products, hygiene and grooming products, medical products, as well as services such as pet-friendly travel products. It has even expanded into sectors like insurance and education services [22]. This modern pet industry is evolving by integrating with various industries across society and culture [23].

### **2.2 Pet Food**

Pet food, referring to the food consumed by companion animals, has evolved from being primarily associated with basic sustenance in the past to a level of quality comparable to human consumption. This shift in demand has been observed recently [24]. Pet food can be broadly categorized into main meals, snacks, beverages, and health supplements that pets consume. Currently, in South Korea, there is no clear distinction between commercial animal feed and pet food, and efforts are underway to improve the related regulations [25].

### 2.3 Patents

According to Article 1 of the Patent Act, the patent system aims to "promote the development of technology by protecting and encouraging inventions and facilitating their utilization, thereby contributing to industrial development" [26]. Patents (intellectual property rights) serve as a cornerstone that grants intellectual property rights to inventors of knowledge property rights but also encourages cornerstones to encourage invention, promote technological innovation, and enhance economic welfare levels [27].

## 3. RESEARCH METHODS

### 3.1 Research Framework and Tools

In this study, we performed patent searches using relevant keywords through two patent information retrieval services: KIPRIS (Korea Intellectual Property Rights Information Service, [www.kipris.or.kr](http://www.kipris.or.kr)), a service maintained by the Korean Intellectual Property Office, and IP-Radar (IPR, [www.ipradar.co.kr](http://www.ipradar.co.kr)), a patent information and company search service. KIPRIS provides the advantage of being able to search for all intellectual property-related information, both domestic and international. IP-Radar (IPR), on the other hand, uses AI-based big data analysis technology to comprehensively quantitatively analyze domestic and foreign patent database materials, allowing for data visualization.

### 3.2 Research Subjects and Procedures

Table 1 shows the public specifications of patents related to pet food (companion animal food). To collect data, a search was conducted from patents registered in the 1990s to December 2022, specifically focusing on patents related to pet food. The search keywords used in the research were [("companion animals" or pets) and ("pet food" or "functional pet food")]. From the initial search results of 13,572 documents, non-relevant patent documents such as utility models, trademarks, designs, and duplicates not directly related to pet food were classified as noise and excluded. Finally, only patents related to pet food were selected. The final selection yielded a total of 2,501. publicly disclosed patent applications filed in Korea, the United States, China, the European Union, and under the PCT from 1990 to December 2022. These patents are analyzed in terms of their patent status, International Patent Classification (IPC), detailed patent analysis by category, and keyword Statistical time series analysis, with a focus on examining the patent status and industry trends of these patents.

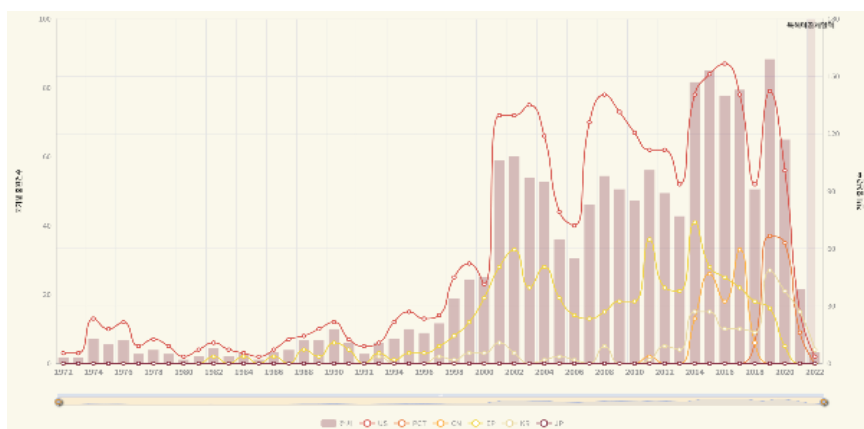
**Table 1. Scope of research**

Category	Scope
Country	Korea, USA, China, EU, and PCT
Year	From the initial patent to December 2022
Search DB	KIPRIS, IP-RADAR
Keywords	("companion animals" or "pets") AND ("pet food" or "functional pet food")
Search term	Title, Abstract, Main Claims
Status	Published, Registered, Rejected, Expired, Canceled, Abandoned, Invalid

## 4. RESULT AND DISCUSSION

### 4.1 Pet Food Patent Time Series Statistics

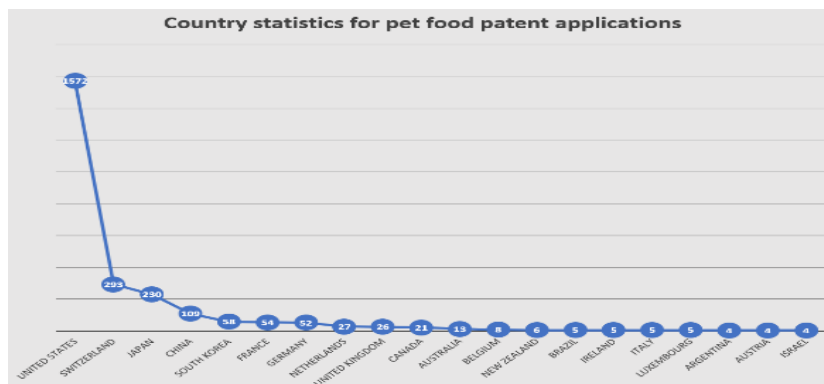
Through time series statistical analysis of pet food, it is possible to graphically quantify the effective patent counts on public and registered patents searched by year, thereby enabling an understanding of the overall level and trends of technology (Fig.1). The number of patents in the pet food industry, both domestically and internationally, has steadily increased over the past 50 years, with the United States, China, and Europe being the leading countries in patent applications. Furthermore, in recent years, the number of patents filed under the PCT (Patent Cooperation Treaty) has also been increasing. This indicates a growing trend of companies applying for patents internationally. Overall, this reflects the dynamic and innovative nature of the global pet food industry, which is constantly evolving. These pet food patents are a testament to the protection, authority, and continued growth of technological innovation in the industry.



**Figure 1. Pet food patent time series statistics**

#### 4.2 Country Statistics For Pet Food Patent Applications

Fig. 2 shows the examining the analysis of pet food patent applications by country. In 2,501 of the patents in the active literature, the United States took first place with 1,572 patents, followed by Switzerland with 293 patents, ranking second. Following that, Japan with 230 patents, and China with 109 patents secured the third and fourth positions, respectively. The top four countries accounted for more than half of all patent applications. South Korea, France, Germany, and the Netherlands held 58, 54, 52, and 27 patents, respectively, securing the fifth and sixth positions. Other countries appeared to possess a minimal number of patents, typically less than five. These results indicate that the global pet food industry is a diverse field with various patent applications, and it's evident that the United States overwhelmingly dominates pet food patent applications, with Switzerland also playing a significant role, accounting for more than half of total applications.



**Figure 2. Country statistics patent applications**

### 4.3 Statistics on Pet Food Patent Applicants

Table 2 shows the analysis of the patent applications with a high distribution of active cases in the overseas pet food industry. The table shows the number of patent applications filed by different companies in the overseas pet food industry. MARS, INC is the leading company with 139 patents, followed by HILL'S PET NUTRITION, INC. with 134 patents. UNICHARM CORP is in third place, with 59 patents. These three companies account for over half of the total number of patent applications. THE IAMS COMPANY, NESTEC S.A., and SOCIÉTÉ DES PRODUITS NESTLÉ S.A. are in the next four places, with 45, 44, and 38 patents, respectively. The remaining companies in the table have 30 or fewer patents.

This data suggests that a few key players are driving the industry. These companies are investing heavily in research and development, and they are filing for patents to protect their innovations. The future of the pet food industry is likely to be driven by innovation, and patents will play an important role in protecting that innovation.

The top 10 companies account for over half of the total number of patents. This suggests that a small number of companies are responsible for the majority of the innovation in the pet food industry. The only non-US company in the top 10 is UNICHARM CORP. This suggests that Japanese companies are also active in the research and development of pet food technologies. The remaining companies in the table are all US companies. This suggests that the US is a major center for pet food research and development.

Overall, the table shows that the pet food industry is a dynamic and innovative industry that is constantly evolving. The leading companies in the industry are investing heavily in research and development, and they are filing for patents to protect their innovations. Related industries of the pet food industry will be driven by innovation. Additionally, patents will play an important role in protecting these innovations.

**Table 2. Statistics on pet food patent applicants**

<b>Company</b>	<b>Nationality</b>	<b>Case</b>
Mars, Inc.	United States	139
Hill's Pet Nutrition, Inc.	United States	134
Nestle S.A.	Switzerland	82
Unicharm Corp.	Japan	59
The Iams Company (merged with Mars, Inc.)	United States	45
The Quaker Oats Company	United States	30
Colgate-Palmolive Company	United States	22
General Foods Corporation	United States	15
The Procter & Gamble Company	United States	14
Ralston Purina Company	United States	13
Specialties Pet Food	United States	13
Gregory Dean Sunvold	United States	12
Kaneka Corporation	Japan	12
Kabushiki Kaisha Hayashibara	Japan	11
Seibutsu Kagaku Kenkyujo		
Michael Griffin Hayek	United States	10
George Roth	United States	9

#### 4.4 Statistics on Pet Food Patent Applicants

Table 3 shows the insights into the current patent landscape of the overseas pet food industry across various sectors. The data showcases a diverse distribution of patents across disciplines, with a predominant focus on the 'Food' category, constituting 1508 patents. This underscores the industry's emphasis on novel formulations and innovations in pet nutrition. 'Agriculture' and 'Medicine' follow with 520 and 319 patents respectively, reflecting the intersection of veterinary science and agricultural practices. Interestingly, 'Computer Science' (64 patents) demonstrates the growing integration of technology into pet food production and distribution, indicative of evolving trends in automation and digitalization. Sectors like 'Transportation' (122 patents), 'Biochemistry' (65 patents), and 'Organic Chemistry' (62 patents) highlight the multifaceted approach to pet food, encompassing logistics, nutritional science, and ingredient research. While 'Baking' (31 patents) and 'Organic Polymer Compound' (10 patents) signify innovation in production techniques and materials. Notably, 'Slaughtering' and 'Plastic Processing' each have 18 patents, possibly reflecting concerns related to sustainability and ethical sourcing. 'Telecommunications' and 'IT Technology' (both with 11 patents) suggest emerging trends in pet-related connectivity and digital platforms. In summary, this diverse patent landscape underscores the multifarious nature of the overseas pet food industry, where a spectrum of disciplines converge to drive innovation across nutritional, technological, and ethical dimensions.

**Table 3. Statistics on pet food patent applicants**

<b>Composite Technical Indicator</b>	<b>Number of Case</b>
Food	1508
Agriculture	520
Medicine	319
Transportation	122
Biochemistry	65
Computer Science	64
Organic Chemistry	62
logistics	50
Baking	31
Furniture	22
Slaughtering	18
Plastic Processing	18
Telecommunications	14
Laminate	11
Telecommunication Technology	11
Organic Polymer Compound	10

#### 4.5 IPC Classification of Pet Food Patents

Table 4 shows the insights into patent cases categorized by IPC (International Patent Classification) codes, providing a glimpse into technological trends within the pet food industry. Notably, A23K (1,207 cases) underscores a focus on advancing animal feed formulations and processing methods to meet evolving pet dietary needs. A01K (402 cases) showcases a keen interest in animal care, extending beyond food to encompass animal welfare and pet-related technologies. A23L (242 cases) signifies research attention on pet food composition and quality, encompassing novel ingredients and processing techniques. A61K (83 cases) and A61P (72 cases) highlight a growing trend in developing therapeutic pet foods, aligning with consumer demand for functional pet products. B65D (69 cases) emphasizes efficient and sustainable packaging solutions

for pet food products. Biotechnology applications, evident in C12N (41 cases) and C07K (25 cases), reflect rising interest in alternative protein sources and nutritional enhancements. Overall, this IPC analysis offers vital insights into key areas of innovation within the pet food industry, enabling informed decision-making and strategic planning to drive competitiveness and innovation.

**Table 4. IPC Classification of pet food patents**

IPC Code	Number of Case
A23K	1207
A01K	402
A23L	242
A61K	83
A61P	72
B65D	69
A23J	62
A23P	52
A23B	43
C12N	41
G06Q	37
G01N	34
A01N	31
B65B	27
C07K	25
A23G	24
C07H	21
A23D	17
A61Q	12

#### 4.6 Keyword Analysis of Pet Food Related Patents

Fig. 3 shows that the most frequently used keywords in pet food-related patents are "pet food", "companion animal", "pet food compositions", and "pet food product". These keywords suggest that the pet food industry is focusing on developing products that use functional ingredients, new types, technology, and allergy-responsive products to improve the health and welfare of pets.

Specifically, the industry is developing products that use functional ingredients such as probiotics, and fermentable fibers, and Improve the health of targeted pets with lipoic acid. They are also developing new types of Pet food such as wet food, dry food, and food granules to meet the specific needs of pets. Additionally, they are using technologies such as pet food dispensers and conveyors to improve the efficiency and convenience of pet food production and distribution. Finally, they are developing allergy-responsive products that are hypoallergenic or non-allergenic to relieve pet allergies.

The pet food industry is expected to continue to grow and create new trends in the future. However, this study is based on patent data only, and there may be differences between the trends observed in the actual market. Additionally, the pet food industry is rapidly changing, and future studies need to develop research methods that can reflect these changes.





identified pet food consumption-related technologies, like pet food distribution and feeding, eating habit monitoring, and food preservation. We observed different technological convergence activities based on the industry's promotion areas. For example, A23K patents focus on enhancing animal feed, while A61K and A61P patents show a rise in therapeutic pet foods. Based on our findings, we recommend several actions to improve patent technology and industry convergence in the pet food industry. First, policymakers and businesses should consider the latest pet food consumption trends when making plans. We need more research on pet food consumer analysis in Korea. Second, for life science patents, it's crucial to predict trends in the pet industry due to the lengthy development process. Third, Korean companies need unique technologies to compete with foreign companies. They should also develop technologies that meet international standards. Fourth, examining the convergence of technologies with AI, IoT, and other high-tech industries could enhance domestic technological competitiveness. However, this study has limitations. We might have missed patents due to limited keywords used for searching. Further research is needed to explore pet food expertise considering different pet preferences and cultures. To develop successful patent expertise in the pet food industry, Korea should analyze the latest consumer needs and conduct industry-academia research based on those needs.

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