KIRIN

KIRIN Research & Development

Kirin Holdings Company, Limited

Committed to Creating New Value

The R&D Division of Kirin Holdings Company, Limited made a fresh start in April 2020 by reorganizing its six research laboratories into three research institutes: the Kirin Central Research Institute, the Institute for Future Beverages, and the Institute for Packaging Innovation. The reorganization is intended to accelerate the Kirin Group's R&D efforts across the boundaries of business domains more efficiently and effectively. In the previous organization, our staffers had opportunities to take part in cross-divisional, crossover research projects on an ad hoc basis to bring their expertise and ideas in diverse fields together to create and share something new. The latest reorganization goes one step further in fostering an environment in which researchers are encouraged to come up with innovative ideas on a daily basis without confining themselves within their respective research units. We believe that, when each of them has a chance to achieve their full potential, we will collectively be able to create new value down the road.

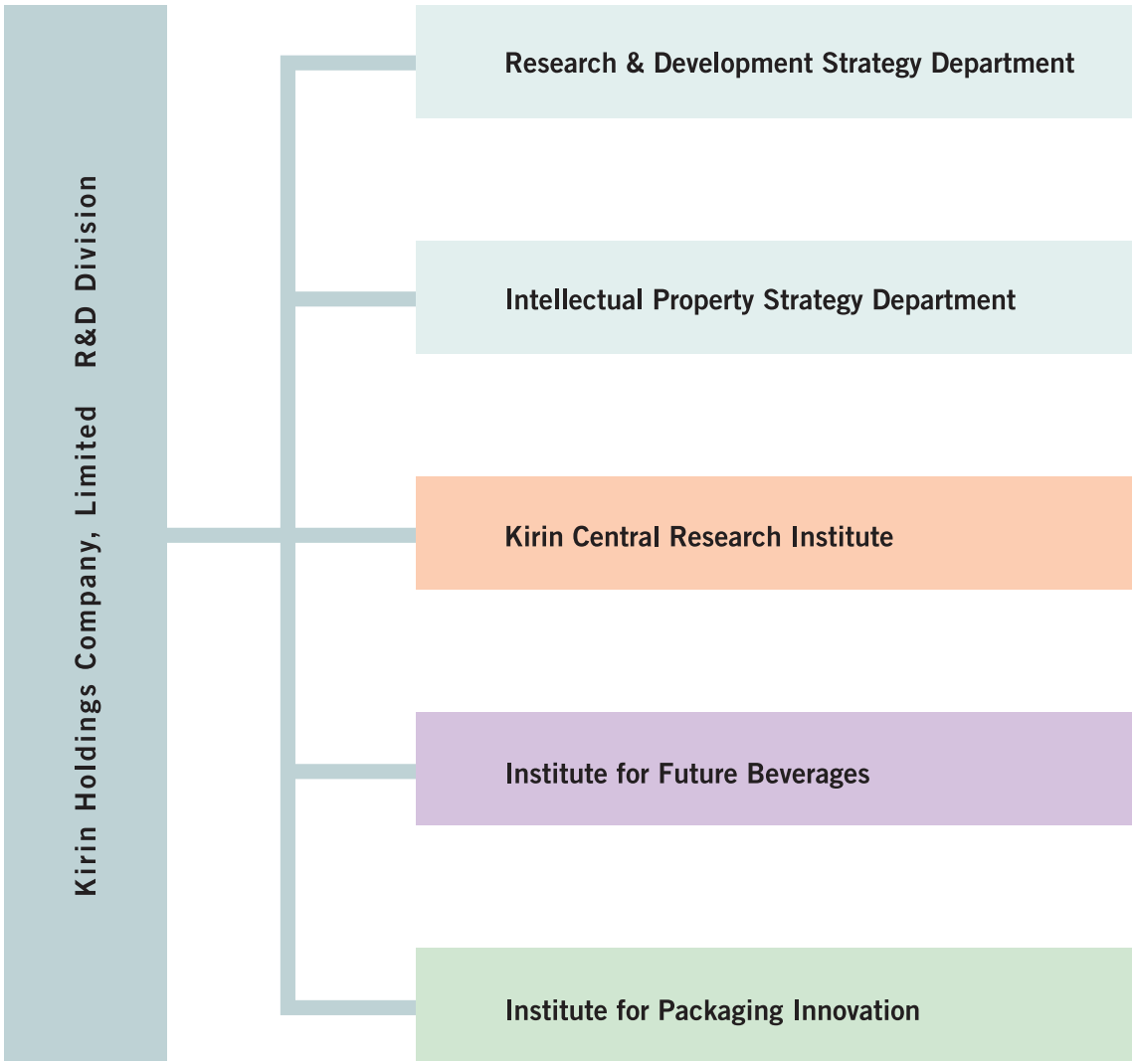
The Kirin Group addresses health and other social issues through its core businesses—the alcoholic beverage, non-alcoholic beverage, pharmaceutical, and biochemical businesses. By creating and delivering new value in these businesses, the Group strives to achieve sustained growth together with society. As part of its efforts to implement this CSV (Creating Shared Value) approach, the Group announced in 2019 its intention to start a health science business.

The R&D Division is committed to establishing a foundation for conducting comprehensive research and development in a variety of domains ranging from food and beverages to pharmaceuticals so as to play a greater role in helping other Group companies grow their existing businesses and create new ones. To achieve the objective of delivering research and development outcomes that have the potential to transform people's lifestyles and communities, we will stay abreast of social and consumer trends, continue to hone the technology assets we have accumulated, and make the best use of the professional networks we have developed inside and outside the Group.

Kirin's Research & Development

The R&D Division comprises three research institutes responsible for basic and applied research as well as technical development. In addition, the division has the Research & Development Strategy Department, which is tasked with developing, implementing, and promoting the Group's R&D strategy; and the Intellectual Property Strategy Department, which is responsible for creating, protecting, and promoting the use of the Group's intellectual property assets. The entire R&D Division works closely with other divisions of Kirin Holdings and Group companies. Our mission is to create new value in the food and beverage domain and the health science domain so that the Group will continue to offer innovative products and services to consumers.

Organization Chart of R&D Division



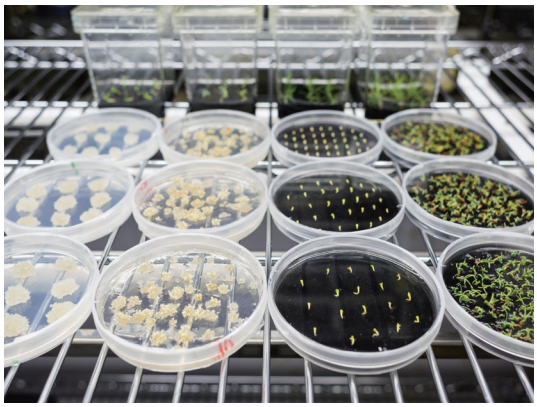
※The contents presented are as of April 2020.

Kirin Central Research Institute

The Kirin Central Research Institute carries out research and development projects in health science and other wide-ranging fields with the goal of helping create new businesses beyond the boundaries of alcoholic and non-alcoholic beverage domains. The institute has as its core technology assets the technology to develop and evaluate materials with health benefits, plant biotechnology, and regenerative medicine technology. The institute uses those technologies in collaboration with universities and companies in diverse fields outside the Group to create much greater value than we could deliver on our own.

Aiming to Contribute to CSV* and New Fields with Plant Biotechnology at the Core

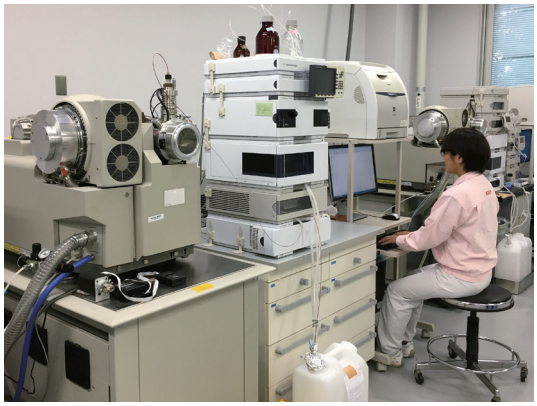
Since 1985, Kirin has been engaged in research related to propagation technology for plants. The technology for inducing pluripotent stem cells from the cells gathered from seeds and seedlings is highly difficult to handle and requires proficient skills. We had made intensive trials and error process and managed to establish a technology for mass culturing of plants using the embryo propagation method (somatic embryo method). In addition, we succeeded in establishing a technology for the mass production of buds, stems and tubers as well as in developing a simple proprietary bag-type culture vessel system. The system composed of a series of these propagation technology is almost unprecedented even on a global basis, and we adopted this system to achieve mass culturing of flowers, vegetables, trees, etc. Currently in Japan, in an effort to achieve mass propagation of Japanese black pine trees, we are engaged in growing young plants to reclaim forests for damage prevention along the coasts of the Tohoku region damaged by the tsunami.
Furthermore, we are applying this technology for production of useful materials. With using unique capability of plant cells, we are taking on challenges for useful materials that are difficult to produce with the conventional synthesis method.



*CSV (Creating Shared Value): To achieve the Company's sustainable growth through addressing social issues.

Supporting the Kirin Group with Cutting-Edge Analytical Chemistry

At the Central Laboratories for Key Technologies, we have sophisticated analytical and assessment technologies that draw on cutting-edge devices. By utilizing these technologies and cooperating with the research laboratories of the R&D Division, we are pursuing development of technologies for creating new value for the Kirin Group. We will further reinforce these forms of cutting-edge analytical chemistry technologies.



R&D Feature

Initiatives for Promoting Open Innovation within the Group

Kirin Holdings, Kyowa Kirin, and Kyowa Hakko Bio have cultivated technologies, materials and know-how in the areas of alcoholic beverages, non-alcoholic beverages, and pharmaceuticals and bio-chemicals. By combining them, we are aiming to create new value, concentrating on the field of health in this way, and promoting open innovation within the Group. We will make sure to move forward with cross-sectional collaboration through holding group-wide exchange meetings where research scientists have free and vigorous discussion for the purpose of applying specific research findings to actual practice. In addition, we are also working in a proactive manner to utilize and develop R&D personnel through the exchange of human resources within the Group. Going forward, we will continue to implement initiatives that encourage people to take on new challenges.

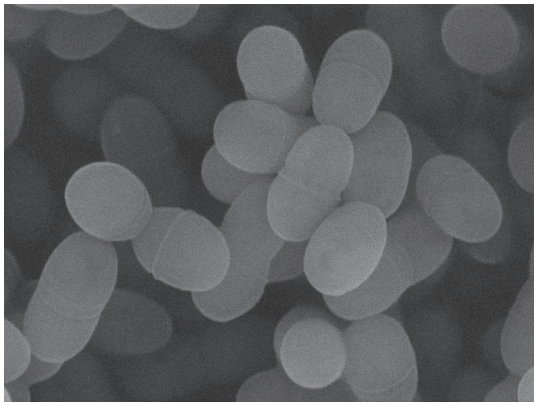
Research Laboratories for Health Science & Food Technologies

At the Research Laboratories for Health Science & Food Technologies, we actively pursue development of functional products to create innovation in the area of health and well-being of the Kirin Group. We do this by conducting basic and applied research and development activities on health functionality and nutrition. We conduct research and development of functional materials and acquire necessary evidence to back food for specified health uses and function claims to help each of our operating companies deploy products that offer health functionality.

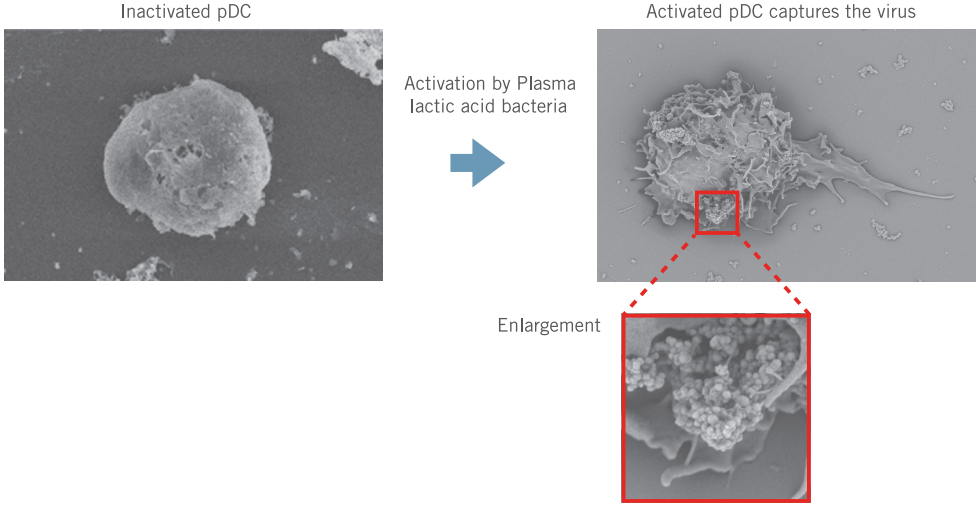
Research on Lactic Acid Bacteria that Strengthen the Primary Immunity

Focusing attention on immunity, which is important for maintaining the well-being of people, Kirin has been moving forward with its research on lactic acid bacteria. Over the last few years, risks associated with viruses, such as the spread of seasonal influenza and emerging infectious diseases, have been increasing. Meanwhile, the existence of plasmacytoid dendritic cells (pDC), which are drivers of immune responses against virus infections, has been discovered and is attracting attention. Thinking that discovering a type of lactic acid bacteria that can activate pDC can lead to establishing a useful technology for reducing virus infection risks, we examined over 100 types of lactic acid bacteria. As a result, we newly discovered the "Plasma lactic acid bacteria (*Lactococcus lactis* strain Plasma) ",which directly activates pDC and some part of its immunity activating mechanism.

We then verified the effect on humans and confirmed that taking in the Plasma lactic acid bacteria leads to a significant decline in the number of persons with symptoms of cold and influenza. Kirin was commended for the results reached from the series of research on the Plasma lactic acid bacteria and the application to business in various forms of products, including yogurt, soft drinks and supplements. As a result, we received the 2016 JSBBA (Japan Society for Bioscience, Biotechnology, and Agrochemistry) Award for Achievement in Technological Research.



Plasma lactic acid bacteria (*Lactococcus lactis* strain Plasma)



Research on Hop Component that Has an Effect of Reducing Body Fat

Kirin has been revealing that hops - one of the essential ingredients of beer- have series of health benefits: preventing Alzheimer's disease, inhibiting cancer and restraining decline in bone density. Kirin is also the first in the world to prove that bitter acids derived from matured hops have the effect of reducing body fat via activating brown adipose tissues. Furthermore, we established a mass-production system of matured hop extract, a new material containing matured hop bitter acids, which can be applied in various beverages. Kirin continues to investigate the health function of hops to provide effective solutions to social issues such as obesity (CSV).

R&D Feature

Kirin's Food for Specified Health Uses & Function Claims Products

Food for specified health uses is approved food in Japan which has been inspected and approved by the Consumer Affairs Agency with respect to the labeling of functions of the food. The foods with function claims system was introduced as a new structure in April 2015, allowing food business operators to place function claims on food labels. They can do this by being responsible for confirming scientific evidence for the function and registering the food with function claims with the Consumer Affairs Agency. Food for specified health uses and food with function claims are both food with health claims that can bear food labels indicating certain effects or functions of the food.

In 2012, Kirin developed "*Kirin Mets Cola,*" the first cola-type beverage in the history of food for specified health uses that contains digestion-resistant dextrin which suppresses the absorption of fat during a meal. "*Kirin Perfect Free*" is the first product as food with a function claim, in a non-alcoholic beer tasting beverage category.

Institute for Future Beverages

The Institute for Future Beverages conducts research and development work on alcoholic and non-alcoholic beverages. Its mission is to use unconventional thinking to create types of beverages that consumers have yet to see. In this institute, researchers leverage core technologies for fermentation control, the processing of ingredients, flavor control, and selected component removal to create groundbreaking beverages and ways to enjoy them that have the potential to transform people's lifestyles and society.

Maximizing the Possibility of Hops

One of the ingredients essential for beer products is hops, which add aroma and bitterness in beer products. Ever since its founding, Kirin has been actively engaged in research related to hops and has succeeded in developing a breeding technology for improving hops to start with as well as in developing processing technologies for distribution and storage of hops harvested and technologies for use in manufacturing sites. These technologies contribute to exercising effective control over the quality of varying aroma and bitterness unique to hops and achieving different types of aroma for our various beer products.

For example, the "Dip hop brewing method" is applied for the *Grand Kirin* series, which offers a distinguished aroma. This method involves an extra touch of dipping the hops during the fermentation process to achieve a complex flavor which cannot be attained with the conventional method.

Meanwhile, we also collaborate with hops producers and local government entities in Tono City in Iwate Prefecture and other parts of the Tohoku region, a hops-producing area in Japan. With them, we carry out initiatives to secure a stable supply of quality hops and continue to take part in contributing to the vitalization of local communities.

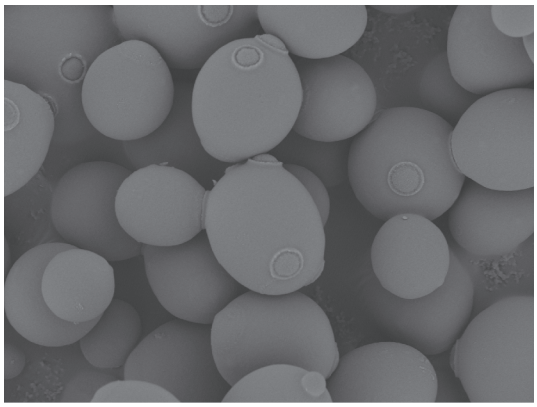
Creating New Value with Diverse Types of Yeast

To produce beer products of high quality and good taste, it is crucial to keep yeast in a healthy condition. Kirin established a technology to identify the complicated physiological state of yeast placed under various conditions in a precise manner and make judgment, and applies this technology to ensure stable production and quality improvement of beer.

The taste and aroma of beer are often generated by yeast during the fermentation process. Kirin has approximately 1,100 yeast strains and maintains a database of flavors and brewing characteristics based on fermentation testing for using different types of yeast depending on the product concept.

The bottom fermentation yeast used in the pilsner-type beer brewing, which is the mainstream in Japan, has a complex genotypic composition compared to other types of yeast and is considered difficult to crossbreed using a general method. At Kirin, we developed a proprietary crossbreeding technology, which has allowed us to mate different brewing yeasts, such as brewer's yeast, sake yeast and wine yeast, to create new types.

We utilize this yeast technology to develop new beer-related products while also making efforts to improve the flavor of alcoholic beverages other than beer, such as shochu and wine.



Aiming to Produce Beverages with New Value

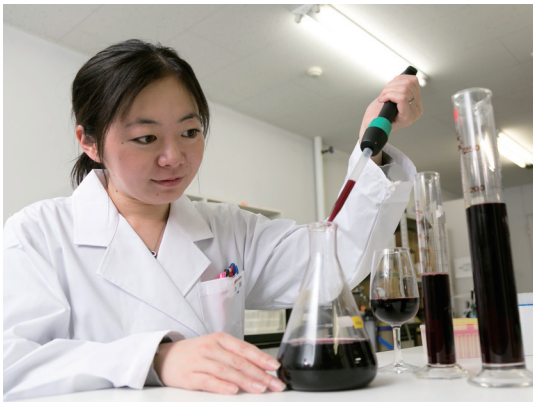
Kirin has become capable of producing beer products that offer a new flavor or feature that was not available before by making efficient use of ingredients, such as hops and malt, and different types of yeast. We do this while leveraging technologies that control the various flavor constituents. These technologies are not only used to renew existing products such as "*Kirin Ichiban Shibori Nama*" and "*Kirin Nodogoshi Nama*" but also applied in products in Kirin's craft beer brand "*Spring Valley Brewery*".

The results from our research and development activities on fruit juice are utilized to develop new flavors or improve flavors of RTD products such as the "*Kirin Hyoketsu* (R)" series and "*Kirin Hon Shibori* (TM) *Chuhai*".

Research Laboratories for Wine Technologies

The Research Laboratories for Wine Technologies engage in the development and assessment of core technologies that contribute to the Kirin Group's alcoholic beverages business, primarily wine, spirits and liqueur. We develop technologies to bring out good tastes and flavors from grapes and various other fruits that are used as ingredients for our products and research ways to identify and extract substances that are useful in maintaining and improving people's well-being. In addition, we are engaged in research and development activities relating to manufacturing technologies for bringing out the aroma specific to each variety of grape and its unknown flavor substances.

Controlling the Flavor of Wine



At the Research Laboratories for Wine Technologies, we conduct a wide range of research and technological development activities to control the aroma and bouquet of wines. Conducting research on grapes as an raw material of wine is imperative for bringing out a good flavor of wine. In the course of Kirin's research activities, we were the first in the world to discover the genes of yeast that metabolize furaneol, which is one of the aromatic components of an hybrid grape variety, Muscat Bailey A, one of the indigenous grapes to Japan, and to clarify the functions of those genes. Kirin was commended for the series of these research activities and received the technology award in the 2015 ASEV Japan symposium.

We were also the first in the world to discover the genes of yeast associated with the biosynthesis of rotundone and succeed in unraveling the functions of such genes. Rotundone is a substance having a characteristic spicy aroma that is one of the features of the Syrah wine produded in Rhône of France. It is anticipated that the results attained from this research will be the key to identifying the aroma formation of the Syrah wine.

Uncovering the Functions of Wine Components

Given the keen interest in the health functionality of red wine in recent years, a broad range of research activities are being conducted. At the Research Laboratories for Wine Technologies where research on red wine components has been conducted over many years, we are focusing on resveratrol, a type of polyphenol having a strong antioxidative effect, and proceeding with our research.

Our recent achievements resulting from joint research with universities include identifying the mechanism of resveratrol serving as a visceral fat accumulation inhibitor and the effect of resveratrol to prevent arteriosclerosis.

CSV Initiatives in Collaboration with Producing Sites

Based on the results of research on grapes, Kirin also takes initiatives to enhance the characteristic flavor of wine, in collaboration with contract vineyards . We have clarified the fact that the content of linalool, a substance with a floral flavor included in a major white wine variety Riesling, is increased in the fruit as the grape berry receives more sunlight. Given the results of this research, we cooperated with vineyard owners in the Omori District of Yokote City, Akita Prefecture, where the climate is blessed with good weather for growing Riesling grapes, in controlling the amount of sun exposure received by grape berries and succeeded in enhancing the characteristic flavor of Riesling wine (*Chateau Mercian Omori Riesling*).

The technologies and development expertise we have fostered for wine are also utilized for our Japanese plum wine. We recognize Japanese plum as one of the fruits and pursue technology development activities to bring out the distinctive natural potential of plum in terms of fragrance and flavor. We do this in cooperation with Japanese Apricot Laboratory, Wakayama Fruit Tree Experiment Station and local orchards in the producing site of Nanko-ume plum. Results of these research activities are effectively applied in Mercian's "*Ume Makkoi*" series and other liqueurs.

R&D Feature

Development of Raw Materials in Collaboration with Overseas Partners

In order to maintain a steady supply of our products of high quality with reasonable and competitive price, it is important to secure technologies and technique; from the manufacturing condition at our partner's site to produce raw materials to the conditions at our site to maximize its potential during the production. Kirin also collaborates with overseas suppliers in directly getting involved in growing and harvesting grapes and handling processing and production lines in order to produce the ideal wines. Those works and experiences are resulted in various of our domestic products such as "*Every*".

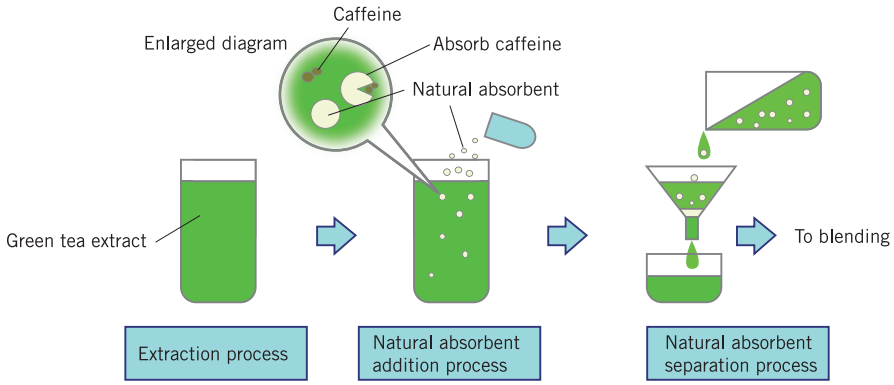
Research Laboratories for Beverage Technologies

The Research Laboratories for Beverage Technologies conduct development and assessment of technologies that contribute to the soft drinks business of the Kirin Group. We develop technologies to selectively remove specific substances from drinks, introduce new technologies that lead to creating new value for customers and society, create technological seeds for new product development, and promote development of a concept model based on new value creation.

Toward Realizing a Lifestyle with Controlled Caffeine Intake

While caffeine in tea, coffee, etc. is a natural food ingredient, there are growing needs to control the amount of caffeine intake since it can have variable effects. To remove caffeine from green tea or black tea, it is common to apply the method of washing away caffeine from tea leaves with hot water, etc. The drawback of this method, however, is the loss of aroma and flavor.

The Research Laboratories for Beverage Technologies therefore has taken on the challenge of removing caffeine from green tea and black tea extracts in order to maintain the aroma and flavor of tea. As a result of the research conducted, Kirin succeeded in developing a suitable and versatile beverage technology by making use of a natural absorbent to selectively absorb caffeine. In this way, it managed to remove caffeine while maintaining the good flavor of tea. Kirin acquired a patent right for this technology referred to as the "Caffeine Clear Method." This technology received the Japan Bioscience, Biotechnology and Agrochemistry Society Award for Achievement in Technological Research and the Japanese Society for Food Science and Technology's Technology Award in 2017. Also it received Tojuro Iijima Award for Food Technology, and awarded by the Minister of Education, Culture, Sports, Science and Technology in 2018.



Caffeine Clear Method for green tea

The Caffeine Clear Method realized the launch of the world's first caffeine-free, calorie-free green tea drink in a plastic (PET) bottle, and Japanese first PET-bottled, caffeine- and calorie-free black tea drink. This technology received the highest three-star Excellent Taste Award in the 2014 Excellent Taste Award organized by iTQi (International Taste & Quality Institute), and the method is still applied to varieties of products such as "*Namacha DECAF*" "*Gogo-no Kocha Straight Tea DECAF*".

In addition, Kirin further advanced the technology to improve the quality of the natural absorbent and has been developing low-caffeine coffee and taking other initiatives.

R&D Feature

Technological Collaboration between Beer and Beverages

The Research Laboratories for Packaging Technologies introduced a new way of drinking coffee, referred to as "*Awa Presso* ("froth" in Japanese + (es)presso) Ultra Creamy Iced Coffee" (hereinafter, "*Awa Presso*") using the "*Sugo Awa Tap*" (we are in the process of obtaining a patent right) developed for beer. The idea of combining beer and beverage technologies came up during discussions on froth among researchers of Kirin's R&D Division.

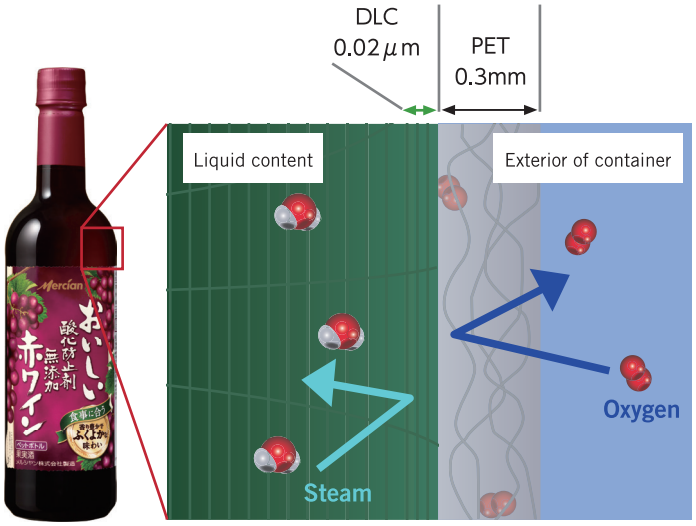
This "*Awa Presso*" is produced by carefully cold-brewing coffee beans that were matured in freezing temperature and extracting coffee from a special tap for beer. This tap allows the user to enjoy a soft creamy texture that is "even better than that of a latte" and the beautiful wave pattern generated by the fine, smooth froth while relishing the good taste of coffee. ("*Awa Presso*" was introduced as a summer limited edition drink in 2016 at Spring Valley Brewery Tokyo.)

Institute for Packaging Innovation

The primary task of the Institute for Packaging Innovation is to develop containers and packages for the Group's diverse products. The institute boasts technologies accumulated over the years in the design and evaluation of containers and packages as well as surface processing. Researchers use these base technologies in combination with emerging AI technology and affective engineering to develop functional and visually appealing containers and packages. The institute also deals with such pressing issues as labor shortages in logistic operations and plastic waste.

Container Surface Treatment Technology — DLC Coating

In general, plastics show more gas permeability than metal and glass. Kirin's proprietary technology, DLC (Diamond Like Carbon) Coating Technology prevents the inflow of oxygen into containers and the outflow of vapor and carbonic acid gas from containers by forming a thin carbon film inside the PET bottles. Using DLC technology, the PET bottle for wine offers the lightweight advantage compared to glass containers while maintaining the required quality. This also results to reducing carbon footprints including manufacturing and transport processes. Furthermore, all caps and bottles can be recycled, it contributes greatly to reducing environmental burden.



Fusion of Functions and Design - *Namacha* 525 ml PET Bottle

Kirin has developed various types of containers, including bottles, cans and PET bottles to date. In particular, the PET bottle developed for the 525 ml *Namacha* accompanying the brand renewal in March 2016 comes in a stylish design and has a silhouette similar to the look of a glass bottle. With consideration given to durability for transport and storage, we refrained as much as possible from using the panel (uneven structure on the square surface) and rib (gap), which were applied in conventional PET bottles for increasing strength. Instead, we placed smooth uneven sections vertically on the bottle to offer strength and make it easier to hold the bottle.
This PET bottle for 525 ml *Namacha* was recognized for the good balance between functionality and design and received multiple awards, such as the 2016 Asiastar, Golden Award in the 2017 Japan Package Design Awards, and 2017 Good Design Award.

Server Development Based on New Ideas

At the Research Laboratories for Packaging Technologies, combining various technological seeds owned by Kirin R&D Division, we can realize novel beer dispensing machines that were not available in the past.

KIRIN Home Tap

In order to have customers enjoy at home Kirin's fresh beer delivered directly from our plant, we developed an exclusive server for members. The server is compact and comes in a simple design. The special PET bottle can be easily exchanged to pour creamy froth. A 1-liter PET bottle with a DLC coating is used for the container so that beer can be transported, while retaining its high quality, to customers' homes.

Tap Marché

Kirin developed Tap Marché in the hope of offering customers the joy of selecting their favorite beer among various types of craft beer as if they were in a market. This compact and stylishly designed server has functions that were not available before. It is structured so that four PET bottles can be stored in one unit for pouring four types of beer from each tap. A 3-liter PET bottle with a DLC coating is used for the container.

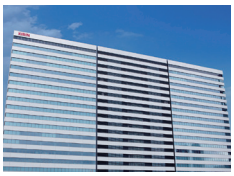
BEER INFUSER

Based on the new idea of "customizing beer," we worked with the Research Laboratories for Alcoholic Beverage Technologies to develop a beer infuser. The infuser provides customized beer for each person, after contacting beer with flavor materials such as hops, fruit or other natural ingredients. Only Spring Valley Brewery has this special server.

KIRIN

Locations of R&D Division Research Laboratories

Tokyo area



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