

# Development of the Arctic reindeer industry from the perspective of Sino-Russian green biomanufacturing cooperation

LUO Ying<sup>1</sup>, WANG Jinhui<sup>2\*</sup>, Andrew Alexandrovich LOBANOV<sup>3</sup>, Natalia Sergeevna KULESHOVA<sup>2</sup>, ZHU Yan<sup>4</sup>, Sergei Vasilevich ANDRONOV<sup>3</sup>, Lidiya Petrovna LOBANOVA<sup>3</sup>, Elena Nikolaevna BOGDANOVA<sup>5</sup>, Irina Alexandrovna GRISHECHKINA<sup>3</sup> & Andrei Ivanovich POPOV<sup>6</sup>

<sup>1</sup> South China Business College, Guangdong University of Foreign Studies, Guangzhou 510545, China;

<sup>2</sup> Moscow State University, Institute of Asian and African Studies, Moscow 125009, Russian Federation;

<sup>3</sup> National Medical Research Center for Rehabilitation and Balneology, Ministry of Health of the Russian Federation, Moscow 121099, Russian Federation;

<sup>4</sup> Department of Investigation, Guangdong Police College, Guangzhou 510230, China;

<sup>5</sup> Northern Arctic Federal University, Arhangelsk 163000, Russian Federation;

<sup>6</sup> Arctic Research Scientific Centre of Yamalo–Nenets Autonomous Okrug, Nadym 629730, Russian Federation

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**Abstract** Russia's reindeer population accounts for two thirds of the world's total. There is a strong and resilient population of reindeer on the tundra, and reindeer herders inherit and transmit the unique culture of the north. Reindeer products have become the subject of innovative developments in the biopharmaceutical and healthcare products industry owing to their unique raw material properties. Because deer antlers and blood are widely used in traditional Chinese medicine, significant quantities of Arctic reindeer products are likely to be sold in China. Strengthening understanding of the Russian Arctic reindeer industry will help Chinese companies invest in the Russian Arctic, promote Sino-Russian Arctic cooperation on green biomanufacturing, and lead to the development of new products that promote human health.

**Keywords** reindeer industry, Russian Arctic, green biomanufacturing, Sino-Russian cooperation

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## 1 Introduction

Russia accounts for two thirds of the world's reindeer population (Arctic Russia, 2020), with a strong and resilient population of reindeer on its tundra. Reindeer herding is one of the oldest forms of animal husbandry, and reindeer

herders preserve a unique northern culture.

The largest group of domesticated reindeer in Russia is raised within the autonomous region of the Yamal and Tamil Peninsulas, where the Nenets, Evenki, Dolgan, and Nganasan live. Among the Yamal Nenets alone, local reindeer herders have 300 reindeer per person, raising one third of the world's reindeer population. The global total is currently estimated at approximately 2.5 million (Klimov, 2017).

\* Corresponding author, E-mail: office@iaas.msu.ru

As a result of cultural assimilation, the number of indigenous Russian Arctic people has gradually decreased. According to the most recent Russian census, only the Nenets and Dolgan have increased their populations (Obedkov, 2017). The reindeer industry is crucial for protecting traditional lifestyles, family patterns, ethnic housing, and clothing, and native languages. If reindeer and other traditional industries disappear, the associated unique culture will also disappear.

## 2 Material and methods

### 2.1 Sample survey method

The study involved residents of national settlements and tundra areas of Nyda, Nyda tundra, the village of Tazovsky, Taz tundra, Nakhodka tundra, Gyda, Yavai-Salin tundra, the village of Se-Yakh, and Tambey tundra located along the southern coast of the Gulf of Ob, the northeast coast of the Yamal Peninsula, and the Tazovsky and Gydan Peninsulas. A total of 500 respondents were surveyed. Among those surveyed, indigenous residents (Nenets) made up 70.3% and newcomers 29.7%; in total, 27.7% were men and 72.3% were women. The average age of the respondents was  $42.2 \pm 13.3$  years (with respondents ranging from 18–69 years). The average experience or length of time in the northern area among the “alien” population was  $20.7 \pm 16.1$  years. All patients were examined by a therapist, cardiologist, and pulmonologist, and anamnesis data were collected. A diet analysis was performed using the frequency method. Because the consumption of local products involves seasonality, the analysis of the consumption of local food (venison and

local fish) was carried out using questionnaires developed by the authors of this article, based on knowledge and studies of nutrition.

### 2.2 Literature analysis method

The literature research method involves reading, analyzing, and classifying the literature to determine the essential properties of the material. The significant difference between this method and others is that it does not directly deal with the object under study, but indirectly obtains information from various studies, and it is often referred to as a “non-contact method.”

We analyze and collate information from news articles, papers, and books on the Russian Arctic reindeer industry, and construct the evolution of the industry as a pharmaceutical sector. Despite its potentially important impacts on human health, few studies have examined the development of this field.

## 3 The traditional reindeer industry in Russia

The reindeer industry originated in Russia and is said to have begun among the Saami and Tungusic peoples in the Altai-Saryan Highlands, and spread from there to northern Eurasia, including Scandinavia, and the northern territories of China and Mongolia. In the Western Hemisphere, the first reindeer did not appear until 1892, in Alaska. According to archaeological records, tundra reindeer grazing has a history of more than 2000 years in the Russian Arctic (Kharinskiy, 2009; Figure 1).



**Figure 1** Reindeer: the basis of Russian Arctic life. Source: <https://sib100.ru/tolko-v-sibiri-samyepoleznye-panty-v-mire/>.

The development of the tundra reindeer industry was an important stabilizing factor in the human settlement of the Arctic because it provided a sustainable source of food for people living in the harsh environment, an essential source of materials for clothing to provide warmth, and a reliable means of transportation on the tundra. The tundra reindeer herding people comprise the Saami, Nenets, Komi, Enets, Nganasang, Dolgan, Evenki, Even, Yukaghir, Yakut, Chuvan, Chukchi, Khanty, Mansi, and Koryak.

The tundra reindeer people maintain the traditional knowledge and folklore of nomadic life, conduct the ceremonies of traditional celebrations, and make maps of sacred areas. Although traditionally it has been prohibited to reveal the locations of the sacred areas to non-tundra reindeer people, the need to protect these sites has resulted in changes to this strategy.

The reindeer industry provides not only edible but also medicinal reindeer products, as well as reindeer for transportation purposes, and reindeer fur and skin products for daily living (e.g., clothing and footwear). When the reindeer industry began, many functions and products of

reindeer were discovered and widely used.

### 3.1 Food products

The genes of indigenous people have made them adaptable to high-calorie foods. The Arctic indigenous diet consists mainly of meat and fish, and the consumption of animal blood, raw fish, and other livestock and poultry meat as primary foodstuffs is the result of indigenous bodily adaptation to the environment (Figure 2). Recent nutritional research on Arctic people shows that the natural Arctic native diet is high in protein and animal fats.

In the harsh living environment of the north, tundra reindeer people need to maintain their energy balance. Proteins and fats in the body function to provide energy, regulate temperature and hormones, and protect the heart. A lack of sufficient nutrients can lead to metabolic imbalance, and long-term stress requires psychological protection. Because northern residents have shifted to eating food shipped from middle latitudes or other countries, there has been a significant increase in the incidence of malnutrition.



**Figure 2** Russian Arctic reindeer-based foodstuffs. Source: <https://darsevera.com/catalog/podarochnye-nabory/>.

### 3.2 Daily necessities

Reindeer herders' ceremonial costumes differ from casual clothing, and all fur clothing is sewn with deer backbands and hamstring lines. Clothing is double-layered inside and outside with reindeer fur to adapt to cold weather, with excellent hygienic properties and insulation against cold. The traditional garment, known as the malika, is worn while herding and is preferred by the nomadic families. In the early 2000s, men (like children) wore no undergarments, but only a malika. Men perform a variety of activities in caring for reindeer, and the fur absorbs the sweat and mud

generated during herding activities. When the herders return to the tent, they carefully clean the malika by beating it with a special stick to separate the tubular fluff of the deer fur together with sweat and mud.

The reindeer fur was traditionally used for homemade clothing and shoes, but now there are larger factories that process fur and produce ready-to-wear garments and shoes (Figure 3).

### 3.3 Transportation

Reindeer herders accompany and guard their herds day and night with dogs, reindeer sleds, or skis. Reindeer herders are





**Figure 3** Arctic reindeer fur products. Source: <https://f.otzyv.ru/slideshow.php?id=127972:26613#a-1>.

not solitary nomads, but rather nomadize with their families. Thus, the younger generation traditionally learned the skills of living a nomadic life by accompanying the herders. They use reindeer-pulled sleds, which are installed with skis during the winter months and wheels in the summer months. There are several types of sleds, including those designed

for men, women, children, and freight. Each reindeer sled has a specially trained lead reindeer, which leads a team of four to six reindeer. All items, household appliances, clothes, tent poles, and tires are packed on sleighs, and a large nomadic family may have more than 10 sleds (Loginov, 2014).



**Figure 4** A Russian Arctic reindeer sleigh. Source: <https://sakhatime.ru/sport/22024/>.

## 4 The Russian Arctic reindeer industry

The protection of the reindeer industry is crucial not only for the survival of northern nations but also for all humankind because reindeer pastures occupy a quarter of the planet (Arctic Russia, 2020). No other animal can breed in the tundra, and only the reindeer among all domestic animals can find food here without irreparable damage to the environment.

Thus, reindeer venison can be an ecologically sustainable industry and a valuable food source for the Arctic population.

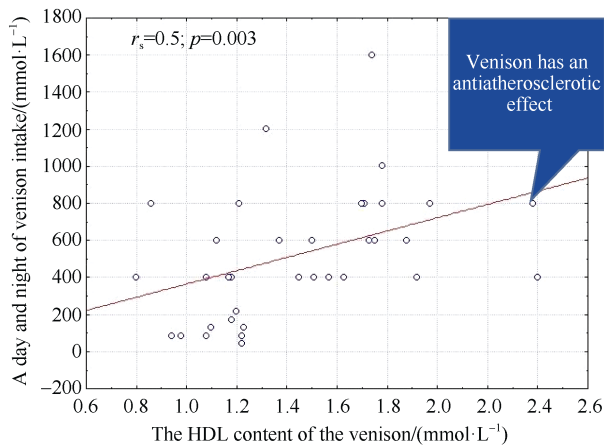
### 4.1 The basis for the formation of the reindeer industry

As abovementioned, the tundra reindeer industry is located in the Russian Arctic region of the Arctic Circle and is practiced by indigenous Arctic peoples who created a

unique culture that has enabled them to adapt to such harsh geographical and climatic conditions from time immemorial and to build solid bases on barren tundra. Tundra reindeer grazing is a unique form of life.

Reindeer are well adapted to the northern environment and are not fed antibiotics or heavily vaccinated during their growth. Thus, reindeer meat is considered a truly healthy food, and demand for it is growing rapidly worldwide, as people increasingly accept it and recognize its health benefits (Belkina et al., 2020).

Reindeer meat contains one-sixth less fat of lamb or pork, and 1.5 times more protein and minerals than lamb or pork. Unlike beef, it is rich in vitamins, and its optimal combination of protein, fats, essential amino acids, vitamins, trace elements, and constant elements makes it an ideal choice compared with other meats for baby food and for overweight people (Figure 5). Thus, reindeer meat is highly valued (Lobanov et al., 2017).



**Figure 5** High-density lipoproteins (anti atherosclerotic ingredients) from venison consumption (drawn by authors partly from Lobanov et al., 2018).

Reindeer milk has bactericidal and medicinal properties. Reindeer blood is used to produce drugs. The most valuable product is the antlers because antler-based preparations can enhance human immunity, improve mental state, reduce human susceptibility to infectious diseases, stimulate gastrointestinal peristalsis (promote digestion), and normalize sexual function. Indeed, the benefits of antlers can be compared with ginseng, which has attracted much attention in traditional eastern medicine (Li, 2016).

In general, products used by reindeer breeders are environmentally friendly. Reindeer grazing occurs far from large industrial cities, factories, and highways, and reindeer derive their nutrients directly from tundra plants without the need for compound feed that contains genetically modified additives.

## 4.2 Current status of the Russian Arctic reindeer industry

Reindeer animal husbandry occupies an important position

in the lives of northern indigenous minorities, who rely on this industry for their livelihoods. Therefore, reindeer herding is the most common industry among the northern indigenous minorities, and is a racially protected industry, has special significance for indigenes. Russia has the largest reindeer grazing area in the world, accounting for approximately 70% of the world's share of reindeer (Loginov, 2014).

As the most extensive form of agricultural production, Russian reindeer animal husbandry requires a large number of seasonal pastures located in tundra, forest-tundra, and coniferous forests, which covering 335.2 million  $\text{hm}^2$  or 28% of the Russian Northern Territory, and 19.6% of the total Russian territory. The region was home to a reindeer-grazing, nomadic, and semi-nomadic civilization for centuries, including the northern indigenous minorities (including Koryaks, Mansi, Nenets, Khantys, and Evenki) and other northern peoples, such as the Komi and Yakuts (Volzhanina, 2013).

Reindeer breeding is the basic livelihood of these indigenous peoples—it provides them with the necessary materials for food, housing, and clothing. Excess products can be exchanged for external goods. Reindeer are chattel capital, and their value determines the welfare of nomadic families.

As Table 1 indicates, current reindeer breeding in the Russian Arctic has not yet reached the level it was at before the collapse of the Soviet Union. Only the Yamal Nenets and Krasnoyarsk regions have shown significant increases in reindeer breeding, but it is decreasing in remaining regions. In terms of geographic regions, the amount of reindeer breeding in the western permafrost area has continued to increase since 1990, whereas in the eastern permafrost area and the Taiga region it has decreased significantly.

## 4.3 Factors affecting the development of the reindeer industry

### 4.3.1 Climate change

Climate change has a significant impact on the Russian Arctic reindeer industry. Owing to the warming of the climate and the thawing of the permafrost, a large area of tundra has become swamp, which is no longer suitable for reindeer grazing, and extreme weather has become more frequent. During summer, high temperatures over  $30^\circ\text{C}$  are often recorded on the Arctic tundra. The number of harmful insects has increased, and diseases are epidemic, which is not conducive to the healthy reproduction of reindeer.

### 4.3.2 Population migration

Compared with tundra reindeer grazing, other land uses in the northern coniferous forest belt are relatively limited. Currently, the trade value of the industry has declined, with decreases in the social population and a significant increase in new immigrants. However, the social significance and

**Table 1** Dynamics of reindeer numbers in various regions of the Russian Federation from 1990 to 2015 (Antonov et al., 2018)

Subjects of the Russian Federation	Reindeer numbers in different year/( $\times 10^3$ individuals)					
	1990	1995	2000	2005	2010	2015
Yamal-Nenets Autonomous District (YANAO)	490.5	507.8	504.7	537.2	665.2	733.5
Krasnoyarsk Territory	107.4	58.1	46.2	54.9	77.6	116.3
Nenets Autonomous Okrug (NAO)	186.3	179.6	122.1	147.9	172.9	177.5
Khanty-Mansi Autonomous Okrug	47.1	38.1	26.5	28.3	35.5	40.6
Murmansk region	77.3	78	61.3	59.8	58.9	56.2
Komi Republic	123.6	122.2	110.1	89.5	83.8	85.8
Republic of Sakha (Yakutia)	361.5	246.9	156.2	153.6	200.3	156.0
Arkhangelsk region	4.4	4	2.9	2.2	1.8	1.78
Chukotka Autonomous Okrug	467	235.5	92.5	154.3	195.4	156.1
Western tundra zone, total	882.1	891.6	801.1	836.6	982.6	1054.78
Eastern tundra zone, total	1715.5	717.1	348.5	416.4	533.5	489.6
Taiga zone, total	130	86.3	47.2	45.5	55.1	61.6
Russian Federation, total	2260.6	1695	1196.7	1298.5	1571	1606.2

importance of reindeer as food to the indigenous population has increased; as merchantability declines, reindeer products must meet the herders' own needs to a greater degree.

#### 4.3.3 The negative impacts of industrial development

There are negative impacts of industrial development, such as modern industrial mining, that are particularly prominent in certain areas of the Russian Arctic and subarctic regions (tundra, forest-tundra, and northern taiga). Mining

adversely affects 40% of the reindeer pastures and hunting grounds (Figure 6). Every new oil or gas extraction facility and pipeline forces reindeer herders to change their grazing sites. Almost all 103 Nenets and Komi surveyed in 2008 reported that the presence of industrial facilities had damaged the quality of pastures, hunting areas, and fisheries, and had negative effects on berries and other wild plants. The vegetation cover in the tundra will not recover for 50 years (Degteva and Nellemann, 2013).



**Figure 6** Effects of industrial development on reindeer migration in Yamal, Russia (Naykanchina, 2012).

The environment in the north is changing rapidly owing to industrial development. Consequently, the reindeer industry is forced to adapt and the survival strategies of the

indigenous peoples are also changing. In the early 1990s, indigenous organizations received public and media attention when industrial development caused the deaths of

reindeer. Large areas of reindeer pastures became impassable mud marshes as a result of pipes; many reindeer drowned when they encountered these marshes on their traditional nomadic routes.

#### 4.4 Development of the Russian Arctic reindeer industry

Reindeer grazing has traditionally been considered a prerequisite for the protection of indigenous and minority cultures in the north. The languages of these ethnic groups are the main source of professional terminology and associated technologies for reindeer herders, hunters, and fishermen. Without reindeer breeding or other regular industries, their native languages would be gradually lost, customary lifestyles destroyed, and culture forgotten, whereupon the people will no longer exist as a group. The reindeer industry is an important component of the Russian Arctic socioeconomic system.

##### 4.4.1 Development status quo

Most farms in the Russian Arctic have the necessary conditions required for developing the reindeer industry. First, these ranches are extensive, with high-quality veterinary services and fences with optimized placement of animals. In tundra and forest areas, reindeer animals use nomadic grazing. The herd gradually moves hundreds of kilometers forward, periodically stopping on the way. The employees of their reindeer farms and their families, like their employers, live a nomadic lifestyle, and employees are provided with production equipment and mobile home complexes. During the movement of the herds, herders can replenish their food supplies and, if they need to leave briefly to settle personal matters, they are permitted to find substitutes to enable them to do this.

Observations via road and air transport ensure the safe movement of the reindeer through coniferous forest areas and allow advance exploration of the route to find marshes, impassable areas, and areas with predators. Reconnaissance brigades use portable radio stations to communicate with herders and between themselves. Mobile communications are not used typically because cell phones are virtually useless in the tundra and coniferous forests.

From an economic perspective, there are high profits to be gained from venison exports. In Russia, the price of 1 kg of reindeer meat is 150–250 rubles (around 2.4–4.0 US dollars), whereas in other countries, the price is 500–600 rubles (around 8.0–9.7 US dollars) for ordinary and minced meat, or more if the meat is high quality. Recently, prices have soared, reaching 1000 rubles (around 16 US dollars) per kg, or even 2000 rubles (around 32 US dollars) in some areas as recorded at the Huntsman company's online store (<http://baikal-dich.ru/>) in 2022. The advantage of venison over beef and pork is that its fat barely accumulates in the body. This is significant for those pursuing a healthy lifestyle, athletes, and those with obesity,

metabolic disorders, cardiovascular diseases, and gastrointestinal problems.

Several companies in Yamal export venison to the European Union (EU); Yamal is the only region in which Russia supplies venison to the European Union. Therefore, reindeer products must meet certain standards set by the EU. The farm itself must collate all relevant documents, and then the state agency must submit an application to the departments of the relevant country within the EU.

Antlers, especially growing antlers, are in great demand in China, but the lack of necessary documentation and production facilities makes it difficult to arrange exports. In Russia, only approximately 60% of the venison is processed, and procedures for collecting and processing licenses have not been approved because of the lack of international standards for deer antler raw materials (Priemskaya, 2019).

##### 4.4.2 Existing policies

All welfare and subsidies provided to farms and reindeer herders in reindeer grazing areas is included in the framework agreement of the Northern Indigenous and Minority Representative Support Program (Mishustin, 2021).

The Russian government supports the industry by buying deer meat, antlers, and reindeer skins from reindeer herders at fixed prices. For example, in Yamal, the government price of reindeer meat has risen to 450 rubles (around 7 US dollars) per kilogram from the year 2020. In Krasnoyarsk, a large region in Siberia where approximately 127500 domesticated reindeer are raised, the government provides approximately 220 million rubles (around 3.6 million US dollars) to support reindeer herders. However, reindeer herders believe that some of this support has not been well considered. Subsidies were allocated according to the size of herds with the intention of improving the quality of deer meat, but instead they led to increases in herds and serious overgrazing by Yamal reindeer; pastures cannot accommodate many animals, leading to massive epidemics and even endangering the tundra ecosystem (Kokolova, 2017).

Reindeer herders need stable communication systems to ensure that they receive timely medical or other assistance under special circumstances, as well as snowmobiles and all-terrain vehicles, reindeer veterinary services, and a modern system for processing and purchasing reindeer skins and wild deer. These are highly complex issues that need to be addressed to develop an appropriate infrastructure in the northern indigenous residential and migration areas.

Scientists, social activists, and officials are increasingly considering digitization projects for nomadic areas. For example, local governments have provided reindeer herders in Yamal with satellite phones with a 250-minute limit for each phone to contact the outside world in an emergency in the absence of mobile



communication. Digitization allows the reindeer herders to remain informed about the outside world. Indeed, a strong health awareness regarding disease prevention is required in many areas. In addition, owing to global warming, ancient cemeteries could thaw, and some epidemics that threaten tundra animals could recur.

In addition to communication services, the government provides medical services to indigenous people engaged in the reindeer breeding industry and trains management officials in the tundra area, sending scientists to serve the tundra area.

## 5 Outlook for the Russian Arctic reindeer industry

Russia's Arctic reindeer industry accounts for two thirds of the global number of reindeer. Reindeer products are diverse and the animals are used for both food and transportation. With the progress in biomedical research, reindeer constitute a potentially highly innovative direction for health products.

### 5.1 Market expansion of traditional reindeer products

Reindeer meat is valued as a healthy food for weight loss as noted, and consumption of reindeer products has extended beyond the tundra to central cities and capitals in Russia, and overseas. At present, the development of this process is limited by cold chain logistics and high transportation and storage costs, raising the price of this high-quality meat such that it is a luxury good in the catering industry. However, with improvements in transportation infrastructure, there is no doubt that reindeer meat could become a more accessible and affordable high-quality product in global markets.

Reindeer fur is a high-quality material for clothing and footwear; in past centuries, it was a major source of tax revenue for the Russian government. As artificial breeding species, using reindeer fur to make daily necessities does not conflict with the concept of natural environmental protection. As noted, Russia has approximately 1.7 million reindeer, which is sufficient to support a certain scale of trade in reindeer products, including fur.

### 5.2 Innovative reindeer products have strong prospects

Reindeer products have a very high medicinal value in the traditional Chinese medical literature. As previously noted, deer antlers are widely used in China, not only as traditional Chinese medicine, but also as a health supplement. Russian scientists are producing innovations regarding reindeer products with medicinal values, processing and refining reindeer raw materials. For example, the "Heart of the North" nutritional supplement

made of reindeer blood is refined, dried, and crushed into capsules as a nutritional supplement for astronauts, athletes, and scientific research team members. One of the advertisements for the drug during the 2020 COVID-19 pandemic stated that it served "to improve immunity and resist the novel coronavirus".

Reindeer products are also used for health drinks. For example, Arctic deer antler plasma is a compound health product and a natural source of organic iron used to make iron supplements in hematopoietic bottled beverages, a compound health care product. It can help improve the hemoglobin levels in the blood for anemia symptoms, and is recommended for problems such as chronic fatigue syndrome, mental stress, low resistance, depressive symptoms, and chronic infection.

In addition to medicinal and health products, reindeer ingredients can be processed into cosmetics, such as deer antler masks, to regenerate the skin. Cosmetics products with reindeer ingredients are suitable for all skin types, they nourish and improve the elasticity of the skin, promote skin cell metabolism and regeneration, and accelerate the healing of wounds. Deer antler moisturizers are composed of pure water, reindeer blood powder, hydroxypropyl methyl cellulose, glycerol, collagen peptide complex extracted from reindeer antler, salicylic acid, hyaluronic acid, and calamus essence.

### 5.3 Support from the Russian Arctic Strategy 2035

The "Russia Arctic Strategy 2035" has three important directions: the Northern Sea Route, Arctic indigenous medical care, and Arctic economic and scientific research cooperation. The development of Arctic biological resources is not only an important part of medical treatment for Arctic residents but also contributes to Arctic economic and scientific research cooperation (President of Russia, 2020).

Reindeer and reindeer products are the primary resources of the indigenous peoples of the Arctic, and traditional medicine includes knowledge of effective medicinal material for the treatment of certain diseases, with powerful therapeutic effects owing to their unique natural growth environment, which cannot be replicated by biological resources in other regions.

As global and biopharmaceutical revenues exceeded oil revenue in 2020, this is a strong signal that biopharmaceuticals will be at the forefront of economic and scientific research competition. The "Russian Arctic Strategy 2035" demonstrates awareness of the potential for biological resources, and highlights the related medical treatment for Arctic peoples, and Arctic economic and scientific research cooperation.

The greatest advance of the Strategy over previous similar government documents is its operational components, which increase the likelihood of successful implementation. For example formulate and implement state programs to support traditional economic activities of



ethnic minorities; simplify the procedures for providing land to citizens for economic activities and other activities not prohibited by law; develop digital services for users of farming areas. Government policy will play a strong role in the development of the reindeer industry and its biological resources as the core industry of the Arctic indigenous peoples.

## 6 The possibility analysis of Sino-Russian cooperation on green biomanufacturing

As China has the largest consumer market for reindeer products, Russia and China have a strong common interest in cooperating to develop the Arctic reindeer industry. Below, we explore some cooperative actions that could be taken to advance the green biomanufacturing and the reindeer industry in particular

### 6.1 Formulation of general Sino-Russian reindeer product standards

Enterprises are the main drivers of Sino-Russian cooperation on green biomanufacturing. To date, there is no standard for biological products commonly used by manufacturing and trading companies in the two countries. This impedes the smooth circulation of biological products in formal channels.

At present, the Guangzhou Pharmaceutical Holdings Limited, the largest pharmaceutical factory in China, is focusing on the biological resources in the Russian Arctic, and has established contacts with Russian Arctic biomedical experts (Guangzhou Shennong Caotang Museum, 2019). Large enterprises in China and Russia should jointly formulate general biological product standards, similar to the EU product standards, commencing with standards for reindeer products.

### 6.2 Establish industry standards and an evaluation system

The main forms of Sino-Russian scientific cooperation are a joint laboratory and mutual visit systems for scientists and joint publications. Professor Xuan Guowei of the Guangdong University of Traditional Chinese Medicine established a small Arctic medicine laboratory in 2019.

The Chinese and Russian biomedical experts are committed to establishing Arctic biological manufacturing industry and product standards, and production evaluation systems, and to providing scientific and technological support for Arctic biological resource products entering into the pharmacopoeia of both countries.

### 6.3 Biomanufacturing associations and societies supported by both governments

China's White Paper "China's Arctic Policy" emphasizes

the need to understand the Arctic, participate in Arctic activities, seek business opportunities in the region, and contribute to its sustainable development (State Council Information Office of the People's Republic of China, 2018). The articles related to the health of Arctic residents in Russia's "Arctic Strategy 2035" contain content supporting Arctic biological manufacturing (President of Russia, 2020).

The Arctic region is a sensitive area and cooperation involving the region must be promoted by both the Chinese and Russian governments. Thus, government cooperation is a prerequisite. The main forms of government cooperation include high-level mutual visits, regular telephone conferences, and the establishment of special policies.

China and Russia lack relevant policies, regulations, industry rules, and authoritative evaluation institutions for the import and export of polar biological resources, resulting in channels to the utilization of Arctic biological resources being blocked.

With the support of both governments, we will gather talent from enterprises and the scientific community, establish biological manufacturing research societies and industry associations, including the reindeer industry, and contribute to the development of green biological manufacturing in the Arctic.

Although there are many difficulties and challenges involved in Sino-Russian Arctic cooperation, the advantages and opportunities in this area are unique. The governments of the two countries have a vision of close economic cooperation, and their enterprises and people of the two countries have concrete needs for economic exchange.

With the change in global climatic conditions and the rise of the Arctic Ocean Economic circle, the strengthening of cooperation between Chinese enterprises and Russian Arctic indigenous peoples is an important part of the construction of the Silk Road on Ice, which is conducive to the economic development of the two countries and the reorganization of the world economic structure. Thus, these prospects are promising.

## 7 Conclusions

Reindeer are a renewable resource, according to the direction of the Russian government, and the beneficial effects of reindeer products in relation to human aging and diseases gives them broad market appeal. Moreover, the "Russian Arctic Strategy 2035" contains provisions on the utilization of Arctic biological resources. Finally, the development of the reindeer industry is a dual guarantee for the Arctic residents of the continuation of their way of life and economic security.

Under the concept of sustainable development, scientific development should not cause environmental pollution, but instead bring economic benefits to the Arctic

indigenous people. Arctic countries should attach importance to this and give priority to development. The development of the reindeer industry must ensure environmental protection, and sustainable development can only be achieved through extensive scientific research on environmental protection and utilization of the traditional knowledge of Arctic indigenes.

The concepts of green biological manufacturing and sustainable development in the Arctic are the directions worthy of the Chinese government's long-term support, and the traditional Chinese medicine and healthy food materials industries have a long history and a broad market. Cooperation between China and Russia in developing the reindeer industry in the Arctic will not only protect indigenous reindeer culture in the Arctic, but will also hold great significance for the development of human health.

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