

Establishing a Comprehensive and Sustainable Food Concept, Showing Solicitude for Oceanic Husbandry and Developing "Aquamarine Granary"

——With an Example of Takifugu Rubripe Breeding in Caofeidian County, Tangshan City, China

Abstract

Seeking a more extensive definition of “food” in the agricultural field, there is a promising prospect and bright future for aquaculture. This paper is going to take the example of takifugu rubripe breeding in Caofeidian county, Tangshan city, Hebei province, China. By discussing the successful experience and routine of the county, which is regarded as “hometown of Chinese pufferfish”, an analysis and proof of the grand significant of a “Aquamarine Granary” will be given, so as to appeal for and promote those coastal countries worldwide, especially the developing countries, to establish a comprehensive and sustainable food concept, to show solicitude for oceanic husbandry and to develop a “Aquamarine Granary”, which is quite beneficial to food security and prospect of people.

Key words: takifugu rubripe; oceanic husbandry; Aquamarine Granary

1. Background and Significance of the Study of the Development of Aquamarine Granary based on takifugu rubripe breeding in Caofeidian county, Tangshan city, Hebei province, China

1.1 Background of topic selection and researching position

With the constant enhancement of labor force level, people’s demand for food composition and nutrition contents have increased unprecedentedly. At the same time, people’s capability of transforming nature resources have extended the food origins unprecedentedly. The source for nutrition is no longer limited to planting crops, fruits and vegetables or grazing domestic animals on land, resulting in an increase of position among all food for oceanic products. In the modern society, the definition of food includes not only crops in narrow sense, but all those ingredients and products that can be used by human beings as well. This definitely contains those oceanic products, with high nutrition value and great exploitative potential. We should establish a comprehensive and sustainable food concept, explore actively a diverse method for food accommodation, and exploit the potential of “Aquamarine Granary” so as to assure food security, promote economic development and enhance people’s well-being.

China, as the largest developing country in the world, possess an area of territorial water of more than 4 million square kilometers. Its oceanic spacial resource, water body resource and bio-resource have a broad developing potential. Compared to the food provided on land, the Aquamarine Granary in oceans has various unique characteristics, including ecological vulnerability, three-dimensional operation, rich and diverse content, and unstable valid

reserve. etc. Through national policies, the Chinese government coordinates the proportion of inshore water and open ocean and optimize the spacial system for breeding. The authority have broadened the developing space of oceanic “granary”, planned and harmonized the construction of it and prioritized the developing way. China is constructing an Aquamarine Granary that can guarantee national food security.

The takifugu rubripe , also known as pufferfish or balloonfish, belongs to Takifugu genus, tetraodontidae family, tetraodontiformes order. It is a kind of warm water carnivorous groundfish which distributes throughout Bohai Sea, Yellow Sea and East China Sea. The flesh of takifugu rubripe is so appetizing that is categorized in the top grade among all fish. With high nutrition and economical value, takifugu rubripe is an important native breeding product of the coastal area in northern China. Caofeidian county (named Tanghai county before 2012), Tangshan city, Hebei province (hereinafter referred to:Caofeidian) is a littoral county of Bohai Sea. As early as in the 1980s or 1990s, it has been one of the first places to breed takifugu rubripe, and the cultivation of akifugu rubripe has now developed into a aquaculture industry with local characteristics.

Currently, the significance of developing both fishery and oceanic husbandry has already attached great importance in governmental strategies and academic researches. Around Bohai Sea, the study of fishery products’ development has formed a relatively complete system, which contains historical development, locational advantages, technological support.etc. Takifugu rubripe breeding in Caofeidian has also gained attention and has been under research.

1.2Significance of topic selection and study content

1.2.1Value to food security of exploitation of Aquamarine Granary

Due to technology improvement of fishing and breeding, the ocean provide people with much food resources. Abundant nutrition offered by oceanic products, especially high-quality protein, are particularly beneficial to broaden food limitations.

At the same time, an Aquamarine Granary builds a solid ‘moat’ for food security. As for a single nation, an Aquamarine Granary strategy eases food supply pressure, optimizes the spacial arrangement of territory exploitation pattern, coordinates proportions between areas, utilizes land, water and ecological resources scientifically and efficiently and brings about effective productiveness. The ocean is a new strategic area with broad space for development and bright prospects, especially for developing countries like China.

1.2.2Significance of the reference of studying takifugu rubripe breeding in Caofeidian

Table 1 Comparison of nutrition value in different body parts between takifugu rubripe and other common fish species

bodyparts	species	moisture/%	protein/%	Crude fat/%
	takifugu rubripe	81.2	84.3(dry weight)	0.54
muscle	Acipenser sinensis[96]	72.59	15.38	7.15
	Sebago salmon[97]	-	55.44 (dry weight)	39.42
	pseudosciaena[98]	74.28	61.58 (dry weight)	11.15

	Fish skin of takifugu rubripe	66.99	27.93	0.44
	Ictalurus punctatus[99]	65.41	21.32	12.38
Fish skin	Sebago salmon[100]	-	58.28 (dry weight)	24.31 (dry weight)
	Fish liver of takifugu rubripe	35.13	5.71	60.82
	Takifugu fasciatus[27]	28.811	0.32	63.86
Fish liver	fish liver of anglerfish[101]	55.88	10.36	31.26

Generally, the edible parts of takifugu rubripe almost all have more nutrition than other fish species in the food market. This makes it a high-quality and popular product in marine aquaculture.

The sea water and mud flat conditions in Caofeidian are specially appropriate for breeding pufferfish, leading to the development of breeding industry of takifugu rubripe according to circumstances. Since the end of last century, Tangshan city of Hebei province has become the largest producing base of takifugu rubripe at home and abroad. With constant expansion of internal market, takifugu rubripe in Caofeidian has been increasingly welcomed by the public. And as reform and opening up strategy continues and deepens, pufferfish from Caofeidian has also been exported to the market of Japan and South Korea, which has become a unique representative of the fishing in Bohai Sea. Breeding takifugu rubripe continues to promote rural revitalization and economic growth in the area.

This paper is going to concentrate on the special advantage and future prospect of takifugu rubripe breeding in Caofeidian. By analyzing those beneficial factors, and concluding effective measures, it is going to clarify the significance for studying, at the same time propose improvement measures and direction for further development. It is expected to draw a flourishing blueprint for a aquaculture industry.

1.3 Study Methods

1.3.1 Literature Research Method

This paper is going to make comparisons and analysis of former papers, study about the research results of breeding takifugu rubripe, ocean development sustainability, rural revitalization and so on. And then make a conclusion on the differences and similarities, so as to provide bibliography and theoretical basis for this paper.

1.3.2 Field Survey

Field survey with observation and interviews contributes to deepened comprehension of the condition of takifugu rubripe breeding and its effects in rural revitalization.

2. Current situation analysis of takifugu rubripe breeding in Caofeidian

2.1 Current situation of takifugu genus breeding in China

There have been a proverb in ancient China which goes “ Never can one know the true taste of fish before trying balloonfish. Nothing can food be appetizing after balloonfish been tasted.” There had been many widely praised stories and myths about cooking and eating the once toxic fish. It is said that the history of cooking takifugu can date back to the time of King Yu, a suppositional ruler in the late Neolithic Period. Despite its long history, for long takifugu has been widely welcomed. A complete marketing chain of importation and sales is also formed in the neighbouring countries of Japan and South Korea.

Today, takifugu genus species breeding in Southern China is mainly takifugu fasciatus, whereas takifugu rubripe breded in northern China (especially in the Pan-Yellow Sea area) is the most popular species home and abroad, with both output and sales ranking high. Now the dominant base for rearing is in Dandong city, Liaoning province, while the largest breeding base is in Caofeidian county, Tangshan city, Hebei province.

Table 2 Distribution of different breded species of Takifugu genus in China

species	provinces
Takifugu Rubripe	Liaoning,Hebei,Tianjin,Shandong
Takifugu Fasciatus	Jiangsu,Fujian,Guangdong
Takifuqu Flavidus	Fujian

According to historical documents, the earliest origin of eating and breeding takifugu in China was in the ponds and lakes in the plain of middle and lower reaches of the Yangtze River area in southern China. Now people in these areas breed takifugu fasciatus or takifugu flavidus. Takifugu rubripe which occupies the largest market share at home and abroad, is dominantly breded in large-scale in the Pan-Yellow Sea area in northern China, prioritizing Hebei province and Liaoning province.

Table 3 Output of takifugu rubripe of each province in the past 20 years (Unit:tons)

Year	Method	The whole Nation	Hebei	Liaoning	Fujian
2003	Sea Water	10141	1640	4873	470
	Fresh Water	1404	10	80	70
2008	Sea Water	15518	4172	5236	846
	Fresh Water	2115			182
2013	Sea Water	14394	1903	3511	2357
	Fresh Water	4860		3069	575
2018	Sea Water	23054	1988	2922	9572
	Fresh Water	12710			244
2020	Sea Water	15841	2152	1815	10198
	Fresh Water	10916		1	270

(Data Source: China Fishery Statistical Yearbook)

In the past 20 years, the figure of Hebei province has increased constantly, and it has gradually reached and remained the largest share nationwide. Among the entire provinces, sea water output in Caofeidian allocates more than four thirds of the whole output.

2.2 Development of takifugu rubripe breeding in Caofeidian county

2.2.1 Advantageous natural factors

2.2.1.1 The locational superiority of Bohai Sea

① Bohai Sea is mainly at the latitude of 40°N, which is generally acknowledged to be

the most suitable latitude for sea creatures to grow.

②Lots of rivers, like the Yellow River, the Haihe River and the Luanhe River, pour in Bohai Sea, bringing abundant fresh water and nourishment. The sea water there has rich nutrients and low salinity.



Image 1(right) Location pattern of Caofeidian county in Bohai Sea area

③Furthermore, Bohai Sea is located between Liaodong Peninsula and Shandong Peninsula to be an inland sea of China. It provides fishermen from China an appropriate location to fish or breed, and a good transporting routine.

④There cannot be a better term than a seabed with sediment deposition for small fish and shrimps, which are qualified and sufficient bait-animals for takifugu rubripe.

2.2.1.2 The superiority of the circumstances of Caofeidian

①In ancient times the ancient Luanhe River had poured into Bohai Sea at a spot in Caofeidian. The sediments under the sea form various submarine sea barriers. As a result, the wind and wave there are relatively stable, which is beneficial for aquaculture.

②At the east of Caofeidian there is an area where shellfishes thrive. These shellfishes are favourable food sources for takifugu. Stable sea condition and advantageous climate together offer best terms for breeding pufferfish in Caofeidian.

Table 4 biological parameters of takifugu rubripe bred in three different areas

Biological parameter	Breeding module		
	DL	HB	DD
Solo mass	433.02±50.61a	1062.14±152.57c	668.34±177.61b
size	22.68±0.47a	30.42±2.22c	27.28±1.96b
hepatopancreas somatic indices/%HSI	0.15±0.01	0.15±0.02	0.12±0.02
Relative fatness/%RF	3.77±0.28	3.85±0.85	3.25±0.43

In the graph, DL, HB and DL respectively refer to the breeding modules in three different spots: Dandong city (in Liaoning province), Caofeidian (HB actually refers to Hebei province) and Dalian city (in Liaoning province). As the graph illustrates, comparing with the ones in Dalian city or Dandong city in Liaoning province, takifugu rubripe bred in Caofeidian is significantly much heavier, which is beneficial for retaining freshness. At the same time, there is no much difference between their hepatopancreas somatic indices and relative fatness. Takifugu rubripe in Caofeidian is better in both cost performance and market popularity.

2.2.2 Abundant social resources

①history of development: The Bohai sea is one of the inshore waters that have longest

exploitative history. The breeding of takifugu rubripe in Caofeidian is based on sufficient marine resources, good development foundation of fishery and aquaculture and relatively complete infrastructure construction.

②Transportation terms: Tangshan has a perfect transportation net with large port, various railways and an airport. Consequently, it is easy for the products there to be transported.

Image 2(right) A scene of fishermen catching takifugu rubripe



③Population advantage: The Beijing-Tianjin-Hebei area is a densely populated area, which not only provides sufficient workforce for local aquaculture in Caofeidian, but also helps to form a vast consuming market.

3. Measures to promote development of takifugu rubripe breeding in Caofeidian

3.1 Support from authorities

Before 2010, it was illegal to commercialize pufferfish in Chinese mainland due to its toxicity. Hence, although the fishermen in Caofeidian have began the exploration of breeding takifugu rubripe with great farsightedness since the end of the 20th century, the only outlet of takifugu rubripe is to export them to Japan or Korea. However, the foreign market utilizes this inferior position to raise standards and tariff, which badly impacted the sales of takifugu rubripe. Fortunately takifugu rubripe gradually became a non-poisonous edible fish species owing to the efforts in rearing and breeding. Thus, in 2010 the Chinese government removed the ban on eating pufferfish. From that on breeding takifugu rubripe have been energetically stood by. The vigorous exploitation of internal market ended the period when takifugu rubripe's sales had been dominated by exportation. Chinese fishermen got the rights to rearrange takifugu rubripe's prices and acquired a round and another of profits

Furthermore, the local government give forceful sustain for the regional brand or the honorary title "hometown of Chinese pufferfish". At the side of supervision, the government promotes administration with standardization and specialization. Restrictions and laws are published continuously to provide standardized guidance. At the side of governmental conduction, the authorities rely on propagation by radios and televisions, so as to better bring brand effect into play and cultivate influential brands. Also it encouraged the public by preferential assistance and financial support. The local government established a technology training team to help individuals with agricultural techniques. It innovated sales modules to amplify the marketing modes. With the contribution of leading enterprises and the assist of network technology, it has established a unified marketing platform. The platform provides new modules such as order-form-agriculture, and can construct a zero-distance product-supply service.

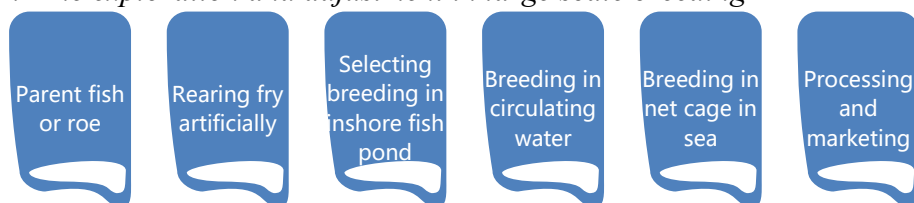
3.2 Constant effort of enterprises

3.2.1 Technological energization for modernized Aquamarine Granary

As early as in the year of 1992, the technicians in the first takifugu rubripe breeding enterprise in Caofeidian, Tianzheng Aquaculture Corporation have made a breakthrough in the technology of rearing of takifugu rubripe. Afterwards they constructed Shilihai Breeding Base. So far technology has been the most important power in the breeding industry. From

building large scale inshore fishponds to constructing a larger industry chain, from the first breakthrough to the toxin decrease, modern technology promotes the commercialization of large-scale operation. In this way takifugu rubripe from Caofeidian contributes largely to Chinese takifugu.

3.2.1.1 The exploration and adjustment in large scale breeding



Currently, takifugu rubripe breeding develops to larger scale and more detailed process. Automatic machines significantly increased breeding efficiency and formed a industry system. Regular breeding module lessened the requirement of workforce, leading to a release of remaining local workforce. This way they can enhance their quality and cultivate an entire industry chain. This laid a good foundation for the sustainable development of the industry, and preserving the environmen and provides a good example for the sustainable development of the surrounding marine environment.◦

3.2.1.2 Industry Coalescence and brand effect

The development of Internet opened up a new market for takifugu. Local media such as Broadcasting Station of Tangshan city promote actively the products of takifugu rubripe breeding in Caofeidian. Enterprises and individuals also utilize online shopping to sell their wares. You can find windows selling takifugu rubripe everywhere on video apps or online shopping platforms.

In hold of “hometown of Chinese pufferfish”, creative cultural designs fill Shilihai takifugu-theme tourist village. Since these years, Tangshan city has gone with the trend of developing tourism and held a takifugu-culture festival every year. The cultural activities expand the influence of takifugu in Caofeidian.

Furthermore, after decades of development, various enterprises have accumulated some brand effect around the globe, which brings positive effects on snatching internal and external market share.

Table 5 regular nutrition composition in muscle, fish liver and fish skin of takifugu rubripe (fresh weight)

Nutrition Composition	Tissue		
	Fish skin	Muscle	Fish liver
Moisture/%	66.99±0.38c	81.2±0.28a	35.13±0.76b
Crude fat/%	0.44±0.01a	0.54±0.01a	60.82±0.76b
Protein/%	27.93±0.32c	16.70±0.48a	5.71±0.23b
Ash Content/%	5.24±0.12c	1.15±0.00a	0.38±0.01b
Sugar/%	0.59±0.01a	0.62±0.01a	0.83±0.01b

Among the three tissues, the differences between moisture, ash content and crude fat are very notable. The fish skin contains most ash content and featured with high protein and low fat, which means abundant mineral. Moisture is the highest in muscle. Differences of crude fat and sugar between muscle and skin are not so significant, but the content of both in fish liver are outstandingly higher, which may be related to its metabolizing and energy supplying functions.

4. Global reference value of takifugu rubripe breeding in Caofeidian, China

4.1 Aquaculture and oceanic husbandry construction

4.1.1 Selecting species according to circumstances

Takifugu is not only a species suitable for the natural condition of Caofeidian, but also a characteristic fish species that fits the history and culture in China. This makes it fit the market of both China and other countries in east Asia, which are similar in customs. After the primary industry have made profits, the cultural significance then drives the development of tertiary industry, so that it is more likely to expand the market and encourage the coordinated development of tertiary industry.

4.1.2 Sustainability of “ocean economy”

By rational planning and strict restrictions to the breeding area, takifugu rubripe breeding in Caofeidian realized the idea of a sustainable, balanced and environmentally friendly development, or harmony between human and nature. Moreover, efforts should be made to improve the quality of development, promote the combination of seawater and freshwater aquaculture, as well as large-scale, refined, automated and sustainable development.

4.2 Food Security of Developing Countries

4.2.1 Broaden the definition of food and establish comprehensive and sustainable food concept

In the primary industry, arrange the proportion of agriculture, forestry, husbandry, handicraft, and aquaculture. Every branch industry can contribute to food security, such as protein and fat or other high-quality nutrition provided by oceanic products. Especially for developing countries with arduous geographical condition, they must break the prejudice that food supply can only rely on crop growing on plains. All countries may innovate different methods to ensure food security.

4.2.2 Expand the industry chain and improve added value of basic products

Take planting or breeding as a starting point, extending the industry chain, For instance, construction of fish pond, transportation support, product processing, online sales and so on can improve the added value of basic product, like takifugu rubripe. In this way, the products can gain more advantages in market competition and then energize economic growth of those developing countries.

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