Study on the Manufacturing Technology of Guangdong Hand-made Paper

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Abstract: Traditional paper-making technology is one of the four great inventions in ancient China. The paper is made by hand and it is found in many areas of Guangdong. Guangdong hand-made paper is mostly used as gods paper, which has special requirements for quality. In order to study Guangdong paper-making technology furtherly, and provide scientific reference for its development, we combed around the factors of materials, tools and processes through experiments, summarized and checked the historical data, then analyzed thirteen processes, such as chopping bamboo, crushing bamboo, beating pulp, papermaking, loosening paper, drying paper and so on. These processes contain rich creative wisdom and are valuable historical heritage. Guangdong hand-made paper technology coexists harmoniously with local environment, and has handed over part of the process to machinery, but its industry scale is small and its economic benefits are not high. It will face the situation of no successor and technical fault. We need to develop Guangdong hand-made paper from the perspective of culture and tourism.

1. Introduction
China's paper-making technology began more than 1900 years ago in the Han Dynasty. It has a long history and profound culture. It still remains in many parts of the country[1]. Among them, there are some relics of hand-made papermaking technology in the areas of Deng Village of Sihui, Dongshui Village of Yangjiang and Qingwan Village of Dianbai. It follows the traditional process of Cailun Paper Making in the Eastern Han Dynasty, and has made some adjustments according to local conditions and using requirements. It has a good integration of tradition and modernity, and has a good significance of the times.

2. Hand-made Paper Making Process in Guangdong Province
Guangdong hand-made paper is simple in color and soft in texture, which has good aesthetic and practical value. This paper combined experiments, interviewed and checked the historical data to study the production technology of Guangdong hand-made paper. Thirteen production technologies are summarized and sorted out around materials, tools and processes, which can provide accurate technical reference for the development of Guangdong hand-made paper.
2.1. Planting bamboo
Guangdong is in the monsoon area, with abundant rainwater, long sunshine, high temperature, rich plant species. In Guangdong, there are a lot of yellow bamboo and mud bamboo which are used in hand-made paper making. These two kinds of bamboo grow fast, have long fibers and high yield, and are very suitable for paper making. In terms of planting, these two kinds of bamboo have no special requirements for the growing environment. They can be planted at the foot of the hill or by the roadside without special caring.

2.2. Cutting and breaking bamboo
The one-year-old yellow bamboo and mud bamboo can be cut down as raw materials in paper-making, but the first choice is three-year-old bamboo, because it has stronger fibers, can produce more durable high-quality paper [3]. After chopping down the bamboo, the paperworkers cut off the branches and cut them into several sections of bamboo poles about one meter long, then smashed them with hammers, and then bundled them into bundles according to the weight of about 5 kilograms.

2.3. Air-drying Bamboo
The paperworkers put the bundled bamboo in a neat stack and put them outdoors so that they can be air-dried naturally. This process is quite simple, as long as the bamboo is stacked neatly, despite the wind and rain. When stacking bamboo, they should be crisscrossed, and the height is about 1.5 meters. Otherwise, they are easy to collapse. The process of air drying takes about 30 days, and it takes longer if it is cloudy.

2.4. Lime pickling
The air-dried bamboo should be put into the lime pond and softened by the chemical action of calcium oxide (CaO), so that the bamboo fibers can be dispersed, which is easy to crush and pulp [4]. Pickled bamboo ponds are large pits which be dug out on the ground, generally about 2 meters deep, and the area can be large or small, without restrictions. The relationship between the weight of lime and bamboo and the curing time is shown in Table 1.

| Lime weight (kg) | Bamboo weight (kg) | Curing time (day) |
|-----------------|--------------------|-------------------|
| 10              | 50                 | 100               |
| 30              | 150                | 90                |
| 50              | 250                | 80                |
| 70              | 350                | 85                |

2.5. Bamboo cleaning
Bamboo can be removed and cleaned after being salted and softened. It can be repeatedly beaten in river or mountain stream to remove hydrated lime and remaining sludge. Then the bamboo is washed by the river water for five or six days, and the residual ash and impurities are further cleaned.

2.6. Air-drying after cleaning
Bamboo should be air-drying after cleaning, so that it can dry and easy to crush. It takes about five to eight days to drying. After drying, they can be stacked in the warehouse and waiting for use.

2.7. Shredding bamboo
When paper is about to be made, it is necessary to crush the dried bamboo to powder. Since the Yuan Dynasty, China has used the stone mortar to decompose bamboo. Water sources are abundant in all parts
of Guangdong Province. Water trucks have been used for a long time to drive stone mortar. The bamboo is soft and delicate after stone mortar. But at present, there are many paper mills that use machine to break bamboo, the speed is faster, but the effect is worse than using stone mortar.

2.8. Making pulp
The paperworkers put the crushed bamboo into a U-shaped tank, add appropriate amount of clean water roughly according to the weight of 1:8, and then mix it with an artificial or electric beater, so that the bamboo fibers can be fully dispersed in the water to form pulp.

2.9. Paper making
This process is the core part of making hand-made paper. The paperworkers stir pulp with bamboo curtain in a sink, then swing the pulp up, and then quickly lift the bamboo curtain. Then, the bamboo fibers floating in the water are evenly distributed and attached to the bamboo curtain, forming a layer of film. Then the paperworkers buckle the bamboo curtain back, on the paper shelf next to it. The film will be breaks away from the bamboo curtain and forms a wet sheet of paper.

2.10. Pressing wet paper
There are two-meter-high iron bolts on each side of the paper shelf. When the wet paper pile is about 1.6 meters high, a board will be pressed on it. By twisting the nut above with handle, the board will create downward pressure, and the water in the wet paper will be squeezed out. This process is slowly, can not be in a hurry. It often takes 1-2 days to discharge 80% of the water in the wet paper. And the pressure applied on wet paper is different, and the thickness of wet paper is different, the time required is also different. Details are shown in Table 2.

| Paper press strength (N) | Paper thickness (M) | Time required (H) |
|--------------------------|---------------------|------------------|
| 100                      | 1.0                 | 25               |
| 150                      | 1.5                 | 27               |
| 200                      | 1.8                 | 28               |
| 250                      | 2.0                 | 32               |

2.11. Separating the sticky paper
After pressing, the paper will stick together. We need to separate them\(^5\). The main way of separating paper is to divide the paper into a stack about 5 cm thick, gently scratch and pat its edge with a wooden knife, while the other hand shakes continuously until each piece of paper is completely separated. Separate paper needs to be operated with both hands, slightly misaligned will cause damage of paper.

2.12. Drying wet paper
Separated paper is still wet. It needs to be laid on a bamboo pole in stacks and concentrated in a ventilated shed to let it dry naturally. It takes about 7 days to dry the paper. During this period, we should ensure that it does not suffer from rain, otherwise it will lead to paper damage.

2.13. Bundling and packaging
After the paper is dried, we need to tidy it up and pack it for use or sell it. In bundling and packaging, some defective products and leftovers will return to the pulp tank for recycling\(^6\).

3. The technological Characteristics of Hand-made Papermaking in Guangdong Province
At present, in the production of hand-made paper in Guangdong, there are different technological
characteristics due to different times and conditions. These characteristics are positive, closely related to the development of the times, and can promote the development of hand-made paper. There are three specific aspects.

3.1. Hand-made papermaking technology in Guangdong coexists with local environment and conditions harmoniously.
Guangdong hand-made paper takes natural materials. The local paperworkers can make full use of existing material conditions to produce paper. The tools and materials used in papermaking are also harmless to nature. For example, waste lime liquor will not pollute nature, but can treat skin diseases such as mosquito bites and boils.

3.2. Hand-made papermaking in Guangdong has handed over parts of the work to machinery.
Due to the changes of the times and the development of technology, many machines have been introduced into hand-made papermaking. For example, mortar fragments are replaced by mechanical fragments, manual pulping has also become mechanical pulping, manual wet paper pressing to semi-mechanical wet paper pressing. These changes in operation mode have improved the production efficiency of papermaking [7].

3.3. Hand-made paper in Guangdong is mostly used as gods paper, which has special requirements for quality.
Guangdong hand-made paper is mostly used for burning in worship of ancestors and gods. It has less use for painting, packaging, decorating and other purposes, which requires different quality. The gods paper requires soft to burn sufficiently. It also needs less smoke, no odor and good gray scale. In order to meet this requirement, no paper medicine can be added to the paper making process, and it must be manually manufactured.

4. Problems in the Development of Hand-made Papermaking in Guangdong
The craftsmanship of hand-made paper is the wisdom crystallization of thousands of the craftsmen in history. It is not only a craft skill, but also a traditional culture, conveying people's customs, skills, experiences and beliefs from ancient to modern. In recent years, more and more attention has been paid to the development of hand-made papermaking in China. The historical traditions, natural resources and economic development of all parts of China have influenced the development of hand-made papermaking. There are some outstanding problems in the development of hand-made papermaking in Guangdong Province. There are the following points.

4.1. Guangdong hand-made paper industry is small and its economic benefits need to be improved.
For a long time, the production of hand-made paper in Guangdong has been carried out in small family workshops. It is only used for gods paper, no other varieties. It has not got rid of a single model, lack of technological innovation and economic benefits. Although many paperworkers have buildings and cars in their homes, they do not have an advantage in the overall economic development of Guangdong.

4.2. Guangdong hand-made paper industry will face the situation of no successor and technical fault.
Because of the high labor intensity of hand-made papermaking and the exquisite papermaking technology, but the poor economic returns, many young people are unwilling to engage in this industry. At present, only some middle-aged and elderly people over the age of 50 are still supporting the development of this industry. This is a serious problem. If there is no new force to join the hand-made paper industry, it will lead to the fault of this technology and even permanently disappear.
4.3. We need to develop Guangdong hand-made paper from the perspective of culture and tourism. The value of hand-made paper lies not in how much paper it produces, but in spreading this ancient craft culture and enhancing the influence and penetration of folk craft [8]. In the future, local governments in Guangdong should start to build hand-made paper workshops into tourist attractions, support manufacturers and build cultural facilities such as hand-made paper exhibition halls, and vigorously promote the protection and inheritance of hand-made paper [9]. The Guangdong hand-made paper should play a greater role in education, culture, religion and other affairs. At the same time, we should develop differently and high-quality paper, so that it can play a greater role in inheriting folk culture and contribute more to the construction of Guangdong.

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