

Sugarcane and Sugar (甘蔗與糖)

1. Different Terms Related to Sugar in Old China.....	3
2. Uses of Sugarcane and Sugar.....	3
3. The Development of Sugarcane and Sugar in Different Dynasties.....	4
3.1 Warring States (B.C 403 – B.C 221)	4
3.2 Han Dynasty (Western Han 202 – 208, Eastern Han 208 – 220).....	5
3.3 Wei, Jin and Southern and Northern Dynasties (386 – 581).....	6
3.4 Tang Dynasty (618 – 907)	7
3.5 Five Dynasties (907 – 979)	8
3.6 Song Dynasty (960 - 1279)	8
4. The Origin of Sugarcane.....	12
5. The Cultivation Technology of Sugarcane.....	14
5.1 Weeding.....	15
5.2 Fertilization.....	15
6. Storing and Preserving Crystallized Sugar.....	15

7. Tai Kokuki (戴国輝) Opinion on Long-run Sugar Developmen.....	16
7.1 The Confirmation of the Existence of Sugarcane period in China (300 B.C. – 550 A.D.)	16
7.2 The Founding/Forming Period of Sugar Industry in China (550 A.D. – early 10 th).....	17
7.3 The Establishing and Consolidating Period of Sugar Industry in China (Mid 10 th – mid 14 th)	17
8. Joseph Needham’s Viewpoints.....	18
8.1 The Origin of China’s Sugarcane.....	18
8.2 The Pre-Song Period.....	18
8.3 The Song Dynasty.....	20
8.3.1 Specific Book on Sugar Appeared.....	20
8.3.2 Cultivation Technology of Sugarcane	20
8.3.3 The Places of Production and Specialization.....	21
8.3.4 The Change in Consumption.....	22
8.3.5 Sugar Became One of the Commodities.....	22
8.3.6 Other Uses of Sugar in the Song.....	23
8.3.7 The Market and Exportation of Sugar.....	23
8.4 The Yuan Dynasty.....	24
References.....	26

1. Different Terms Related to Sugar in Old China

In the history of the development of sugar in China, sugar appeared in different forms. What made them different was the way the sugar was produced.

In China, sugarcane was first made into syrup to drink¹. When the sugarcane syrup was cooked till it was as thick as malt sugar (but it was still liquid²), it became *tang* (糖). Moreover, when *tang* (糖) was made into powders, it was called *sha tang* (沙糖)³, which was crystallized.⁴ When *sha tang* (沙糖) was added water to cook again, it would be *shi mi* (石密)⁵. That is to say, when sugarcane syrup became dried, solid and hard, it was called *shi mi* (石密).⁶ There was another kind of sugar - *Ru tang* (乳糖), which was the milk with *sha tang* (沙糖).⁷ As for *tang shuang* (糖霜), it is the rock candy gained after the matrix liquid and the crystallized part separated.⁸

It is not easy to distinguish the difference of these sugars. So even Kato Shigeshi indicated that “As for what *tang shuang* (糖霜), *sha tang* (沙糖) and *shi mi* (石密) were, I am not an expert, I am not sure, either.”⁹

2. Uses of Sugarcane and Sugar

Sugarcane was mainly used as one kind of sweetener. However, in the beginning, in Warring States, sugarcane was used to make drinks.¹⁰ In the Western Han Dynasty, sugarcane syrup (蔗漿) could be used to relieve hangover.¹¹ Since Western Han Dynasty, sugar was used as medicine, too.¹² Besides, according to the ancient book 《隋書》 (Sui shu book in the Sui Dynasty), sugarcane could be used to brew wine.¹³

¹ Kato (1953) , p. 683; Tai (1967) , p. 81.

² PengPeng (1985) , p. 249.

³ Kato (1953) , p. 683.

⁴ Kato (1953) , p. 684.

⁵ Ji (1982) , p. 132.

⁶ Kato (1953) , p. 684.

⁷ Shida (1957) , p. 136.

⁸ Kato (1953) , p. 684.

⁹ Kato (1953) , p. 684.

¹⁰ Peng (1985) , pp. 248, 250.

¹¹ Shida (1957) , p. 135; Tai (1967) , p. 82.

¹² Shida (1957) , p. 135.

¹³ Ji (1982) , p. 134.

In the Song Dynasty, the remains of the sugarcanes after producing sugar were used to make vinegar.¹⁴ The book 《糖霜譜》 (Tang shuang pu, a book about sugar industry written in the Song Dynasty) also indicated that that sugar could be used as medicine¹⁵, such as curing sputum (痰)and easing thirstiness (渴).¹⁶

3. The Development of Sugarcane and Sugar in Different Dynasties

There were many books which have records about sugarcane and sugar in China. For example: 楚辭 (Chu ci, aka Songs of the South or Songs of Chu, is an anthology of Warring States period), 《廣志》(Guang zhi, an ancient book), 《本草¹⁷》(Ben Cao, an ancient book), 《南中八郡志》(Nan zhong ba jun zhi, a book written in Jin), 《齊民要術》(Qi min yao shu, a book about agriculture written by Jia Si-xie 賈思勰 in Eastern Wei 東魏 531 - 550), 《唐史》 (Tang shi, an ancient book about Tang history)...etc.¹⁸ Among all these books, 楚辭 (Chu ci, a collection of poetry of Warring States period) was considered the oldest record about sugar¹⁹. In the Song Dynasty, there was a book with the subject sugar appeared. It is 《糖霜譜》 (Tang shuang pu), which described production techniques in Sichuan.²⁰ This book was also considered the oldest and biggest specialized book on sugar in Chinese history.²¹

3.1 Warring States (B.C 403 – B.C 221):

The history of sugarcane in China can be traced back to Chu (楚國, BC 11 century – BC 223).²² According to the article *zhao hun* (招魂, written by Song Yu 宋玉) in the collection of poetry of Warring States period called Chu ci (楚辭), people already used sugarcane syrup (柘漿) as a drink to worship. This is the first record that

¹⁴ Ji (1982) , p. 131.

¹⁵ Chen (2003) , p. 65.

¹⁶ Shida (1957) , p. 135.

¹⁷ Ji (1997) , p. 72.

¹⁸ Shida (1957) , p. 126.

¹⁹ Tai (1967) , p. 171.

²⁰ Shiba (1968) , p. 215.

²¹ Tai (1967) , p. 29.

²² Chen (2003) , p. 64.

proved the existence of sugarcane in China.²³

Also, in Si Ma Xiang Ru's (司馬相如, BC 179 - 117, a person in Western Han) article, it indicated that the sugarcane mentioned in the text 楚辭 (Chu ci, a collection of poetry of Warring States period) were from local places. It means that sugarcane was already existed in Warring States.²⁴

During Warring States, sugarcane spread to Hu Guang (湖廣) via Guangdong (廣東).²⁵

3.2 Han Dynasty (Western Han 202 – 208, Eastern Han 208 – 220):

There were two books, 《易林》(Yi lin, a book in Western Han) and《證類本草》(Zheng lei ben cao, a book in the Northern Song Dynasty, but the author 唐慎微 Tang Shen-wei 1086 - 1094 mentioned 張仲景 Zhang Zhong-jing, an Eastern Han man), could possibly prove the existence of *sha tang* (沙糖) in Chinese history. But both evidences were not considered powerful enough.²⁶

However, some still considered that probably the production of *sha tang* (沙糖) already started in the Han Dynasty.²⁷ In the Eastern Han Dynasty, *shi mi* (石密) also already existed.²⁸

Both sugarcane and the method of producing *sha tang* (沙糖) came from Jiaozhi (交趾, Vietnam), and *shi mi* (石密) was probably also from Jiaozhi (交趾).²⁹

By Han Dynasty, sugarcane had already spread to Liang Hu Area (兩湖地區: Hu-bei and Hu-nan 湖北、湖南).³⁰

According to 《齊民要術》(Qi min yao shu), sugarcane was planted every where during Eastern Han.³¹ Among all sugarcanes, the ones from Jiaozhi (交趾) were considered the best. This proved that sugarcane was quite widespread at that time,

²³ Kato (1953) , pp. 676 – 677; Tai (1967) , p. 6.

²⁴ Kato (1953) , p. 677; Tai (1967) , p. 6.

²⁵ Kato (1953) , p. 683; Shiba (1968) , p. 215.

²⁶ Peng (1985) , p. 249.

²⁷ Peng (1985) , p. 250.

²⁸ Peng (1985) , p. 249 ; Ji (1997) , p. 27.

²⁹ Kato (1953) , p. 683.

³⁰ Peng (1985) , p. 248.

³¹ Tai (1967) , p. 9; Kato (1953) , p. 678.

especially in Jiaozhi (交趾). Guangdong (廣東), which is near Jiaozhi, was definitely the place where sugarcane was transmitted. However, 《齊民要術》(Qi min yao shu) did not specifically mentioned Guangdong in its description. (Nevertheless, Kato Shigeshi firmly believes sugarcane first passed through Guangdong).³²

From Eastern Han to Wei and Jin Dynasties, sugarcane was planted in Jingzhou (荊州), which was the territory of Chu (楚國).³³

3.3 Wei, Jin and Southern and Northern Dynasties (386 – 581):

The earliest undisputed record to prove the existence of *sha tang* (沙糖) is the book 《本草經集注》(Ben cao jing ji zhu, written by 陶弘景 Tao Hong-jing 456 – 536 in Southern and Northern Dynasty). This book proves that in Liang Dynasty (梁 502 – 557), people already knew how to make *sha tang* (沙糖); besides, they also knew its function.³⁴ This was the first time that the term *sha tang* (沙糖) appeared in records.³⁵ It means that during Liang Dynasty, the technology existed to produce *sha tang* (沙糖) from sugarcane.³⁶

According to 《齊民要術》(Qi min yao shu), during Hou Wei (後魏/北魏 386 – 534), there were a big variety of sugarcanes in China.³⁷ Also, during Jin Dynasty (晉), there were sugarcane in farms, and people made them into syrup, which was like malt sugar (飴錫 *yi xing*), and called it *tang* (糖). At this time, *shi mi* (石密) was made in Jiaozhi 交趾, but it was probably not produced in China at this time.³⁸

In the Liang Dynasty, people in Guangzhou knew how to superfine *tang* (糖) to gain *sha tang* (沙糖). Probably this technology was learned from Jiaozhi (交趾)³⁹. That is to say, in Guangzhou, *sha tang* (沙糖) technology already existed in the Liang Dynasty.⁴⁰

During the Six Dynasties period, , sugarcane was widespread in many places, such as Jiangdong (江東, the current 江蘇 Jiangsu, 安徽南部 southern Anhui). In

³² Kato (1953) , p. 678.

³³ Kato (1953) , p. 678.

³⁴ Peng (1985) , p. 249.

³⁵ Kato (1953) , p. 681.

³⁶ Shiba (1968) , p. 215.

³⁷ Kato (1953) , p. 676.

³⁸ Kato (1953) , p. 679.

³⁹ Kato (1953) , p. 681.

⁴⁰ Kato (1953) , p. 683.

the Liang Dynasty (梁 502 - 557), Jiangdong (江東), Luling (廬凌 in Jiangxi 江西) and Guangzhou (廣州) already had sugarcanes. Although this was the first time that Guangzhou (廣州) appeared in the records, but according to Kato Shigeshi, sugarcane was likely planted there much earlier.⁴¹ Sugarcane was planted in a wide area ranged from Jiangxi (江西) to Jiangsu (江蘇), and the southern part of Anhui (安徽).⁴² Besides, in Wei, Jin and Southern and Northern Dynasties, sugarcane already spread to Jiangnan (江南) and Sichuan (四川).⁴³

3.4 Tang Dynasty (618 – 907):

Before the Tang Dynasty, sugar was mainly used as food.⁴⁴

According to Wang Zhuo's (王灼 1752 - 1819) book 《糖霜譜》 (Tang shuang pu), the method of making *tang shuang* (糖霜) was found in the Tang Dynasty⁴⁵ (during the reign of emperor Tang Dai zong 唐代宗 726 - 779)⁴⁶. It was said that there was a monk who taught the sugarcane farmers the way to make *tang shuang* (糖霜) in the Tang Dynasty.⁴⁷ However, it is considered unlikely that in the beginning there was just one person who knew this technology of making *tang shuang* (糖霜). Therefore, *tang shuang* (糖霜) was probably already produced even earlier.⁴⁸

In the Tang Dynasty, *tang fang* (糖坊 the sugar workshops) appeared. The technology applied in *tang fang* (糖坊) was from India.⁴⁹

During early Tang, in Sichuan (四川) and Jiangdong (江東), sugarcane was planted and used to produce *sha tang* (沙糖)⁵⁰, which was also produced in Guangdong (廣東). In Yuezhou (越州, in Zhejiang 浙江) *shi mi* (石密) was also produced.⁵¹ In Tang, it is also considered that, besides Shu Jun (蜀郡) and Yangzhou (揚州 in Jiangsu), sugarcane cultivation area also included Shazhou (沙州, old term of Dunhuang), Funan (扶南 in Cambodia), Jingzhou (荊州, in Hu bei) and Jiaozhi

⁴¹ Kato (1953) , p. 680.

⁴² Kato (1953) , p. 683; Shiba (1968) , p. 215.

⁴³ Peng (1985) , p. 248.

⁴⁴ Dong and Fan (2000) , p. 370.

⁴⁵ Ji (1997) , p. 175; Ji (1997) , p. 175.

⁴⁶ Chen (2003) , p. 64.

⁴⁷ Peng (1985) , p. 250; Dong and Fan (2000) , p. 371.

⁴⁸ Peng (1985) , p. 250.

⁴⁹ Tai (1967) , p. 172.

⁵⁰ Kato (1953) , p. 681.

⁵¹ Kato (1953) , p. 683.

(交趾).⁵²

3.5 Five Dynasties (907 – 979):

During Hou Zhou (後周 951 – 960), *ru tang* (乳糖) from Hunan (湖南)⁵³ already existed. It was milk that contains *sha tang* (沙糖).⁵⁴

3.6 Song Dynasty (960 - 1279):

Concerning the production of sugar, the biggest difference between the Tang and the Song was that in the Song, a specific book on sugar appeared but in the Tang there was not one.⁵⁵

The development of sugar industry in Song had some features: The area of sugarcane cultivation increased. And there was an increase of the variety of sugarcane types.⁵⁶ Besides, *tang shuang* (糖霜) became popular in Song, and it was even a tribute dedicated to the emperor Song Hui zong (宋徽宗 1082 - 1135), who was notorious for his extravagant habits. Su Dong-po (蘇東坡 aka 蘇軾, 1037 - 1101) even ever made a poem about *tang Shuang*⁵⁷.

Comparing the technology of producing *sha tang* and cultivating sugarcane in Tang and Song, the Song Dynasty had much more obvious improvement. Especially in producing *sha tang*, the Song Dynasty had greatly improved.⁵⁸

In the Song Dynasty, the farming area of sugarcane increased.⁵⁹ Besides, the variety of sugarcane also obviously increased. Moreover, the variety of sugarcanes also increased.⁶⁰ Besides both quality and quantity of sugar increased during this period.⁶¹

⁵² Chen (2003) , p. 64.

⁵³ Shiba (1968) , p. 216.

⁵⁴ Shida (1957) , p. 136.

⁵⁵ Ji (1997) , p. 123.

⁵⁶ Chen (2003) , p. 64.

⁵⁷ Shida (1957) , p. 126.

⁵⁸ Ji (1997) , p. 109.

⁵⁹ Chen (2003) , p. 64; Ji (1997) , p. 171.

⁶⁰ Ji (1997) , p. 173.

⁶¹ Chen (2003) , p. 64.

Sugarcane was planted in Jiangnan (江南 means Jiangnan dongxi lu 江南東西路, Liangzhe 兩浙, Fujian 福建, Guangnan dongxi lu 廣南東西路) and Sichuan (四川).⁶² In addition to Jiangnan (江南), another author argues that sugarcane production also spread to Jiangsu (江蘇/蘇), Hubei (湖北/鄂), Hunan (湖南/贛) and Anhui (安徽/皖) during the Song Dynasty.⁶³

Sha tang (沙糖) was produced in Quanzhou (泉州 in Fujian), Fuzhou (福州 in Fujian), Jingzhou (荊州 in Jiangxi 江西), and Guangzhou (廣州 in Guangdong, since Liang).⁶⁴

Shi mi (石密) was produced in Sichuan (四川).⁶⁵

Tang shuang (糖霜) was produced very widely in Song, for example, Futang 福唐, Siming 四明, Fanyu 番禺, Guanghan 廣漢, and Suining 遂寧. [Note: These 5 places are taken from a Song text *tang shuang pu* (糖霜譜). The modern regions corresponding to the 5 places listed are reported differently by three authors. Both Kato Shigeshi (1953), p.682 and Needham (1996), p. 89 consider that these places are supposed to be Fujian (福建), Zhejiang (浙江), Guangdong (廣東) and Sichuan (四川). However, Shida (1957), p.25 indicated that these 5 places are the area around Fujian (福建), Guangdong (廣東), Guangxi (廣西), and Jiangxi (江西). Shida did not mention Sichuan but suggested two more locations: Guangxi (廣西), and Jiangxi (江西).] Suining's *tang shuang* (糖霜) was considered the best.⁶⁶ It is considered that the *tang shuang* produced in Suining created a whole new world in China's history of sugar industry.⁶⁷ In Suining (遂寧 in Sichuan 四川), the biggest *tang shuang* (糖霜) could even weigh 20 to 30 *jin* (斤).⁶⁸ *tang shuang* (糖霜) was also produced in Liangzhe (兩浙). Fujian later became China's leading sugar producing region, but the foundation for this subsequent development was laid during the Song Dynasty.⁶⁹

Tang shuang (糖霜) was a specialty of Sichuan.⁷⁰ In Sichuan Mt. Sanshan (緞山), there was a county named Xiaoxi (小溪縣), where 4/10 farms were sugar farms. In addition, 3/10 of the farmer households were *tang shuang* (糖霜) farmer

⁶² Kato (1953) , p. 682; Shiba (1968) , p. 215.

⁶³ Peng (1985) , p. 248.

⁶⁴ Kato (1953) , p. 683.

⁶⁵ Kato (1953) , p. 683.

⁶⁶ Shida (1957) , p. 125; Kato (1953) , p. 682; Ji (1997) , p. 125; Dong and Fan (2000) , p. 371.

⁶⁷ Ji (1997) , p. 175.

⁶⁸ Peng (1985) , p. 250; Tai (1967) , p. 95.

⁶⁹ Kato (1953) , p. 683; Shiba (1997) , p. 215.

⁷⁰ Shida (1957) , p. 127.

households.⁷¹ In the Northern Song Dynasty, it is considered that there were many *sha tang* farmers.⁷² During the Song Dynasty, there were capitalists or owners of sugar factories who did business for profit. They bought inputs and hired workers to produce sugar. Workers were given specialized tasks in the production process – e.g. peel (削), crush (碾), steam (蒸), pour (灌甕), etc. In some factories the peeling stage of production alone required 10 to 20 workers.⁷³

The distribution of sugar industry in Song corresponds to that of the present.⁷⁴

From Tang to Song, the development of product economy was more obvious. For example, in the Song Dynasty, Fujian was one of the main places of production. Thus, the product economy in Fujian was prosperous. The quantity of the sugar Fujian sold to Jiangnan and northern market was very large.⁷⁵ Besides, in the town Fengtai (鳳台鎮) in Jiangxi (江西), the production of sugar was very considerable. There were over 300 sugar producing households. Production of *sha tang* (沙糖) varied from small units producing a couple urns of sugar to large factories capable of producing 10s of urns (less than 100).⁷⁶ In Guangxi (廣西), the situation was similar.⁷⁷

As for the aspect of consumption, prior to Song, sugar was not used widely among common people. It was used mainly inside the palace and consumed by high officials and noble lords. Since Song, Sugar became a popular new product.⁷⁸

The first records of the commercial exchange of raw sugarcane appeared in the Song Dynasty.⁷⁹ One example of Song raw sugarcane business is given next: In county Xian You (仙遊縣, Fujian), there were 10s thousand (幾萬) of *Tan* (壇 earthen jar or jug) of sugarcane delivered to Zhe (浙) and Huai (淮).⁸⁰

In the Song Dynasty, sugar had been widely applied into foods.⁸¹

In the capital city of the Northern Song Dynasty, sugar-products like candies (打

⁷¹ Shida (1957) , p. 126; Chen (2003) , p. 65; Tai (1967) , p. 96.

⁷² Shida (1957) , p. 126.

⁷³ Chen (2003) , p. 65.

⁷⁴ Tai (1967) , p. 172.

⁷⁵ Chen (2003) , p. 65; Shida (1957) , p. 216.

⁷⁶ Shiba (1968) , p. 217.

⁷⁷ Chen (2003) , p. 65;

⁷⁸ Chen (2003) , p. 65.

⁷⁹ Tai (1967) , p. 172.

⁸⁰ Tai (1967) , pp. 40 – 41.

⁸¹ Ji (1997) , p. 153.

嬌惜、蝦鬚、糖宜娘、打鞦韆、稠錫、西川乳糖⁸²), sweet foods (灌藕、雞頭穰沙糖⁸³、辣餡糖餡饅頭、糖肉饅頭、四時糖食點心⁸⁴、糖豆粥⁸⁵), sugar-preserved fruits (問道糖荔枝、香糖果子、蜜木瓜、蜜金桃、蜜棗、蜜李⁸⁶), sweet ice (冰糖冰雪冷元子、沙糖綠豆甘草冰雪涼冰) were sold along the road in front of the city gate. Even in night markets, sugar products could be found. In the Song Dynasty, sugar was widely used and very close to the daily life of common people.⁸⁷ In the cities, there were peddlers carrying jugs of sugar for sale. Besides, in Lin'an (臨安), there were shops selling Fujian Sugar (福糖蜜 *fu tang mi*) and Linping (臨平 Hangzhou, Zhejiang) sugarcanes as products of specialty.⁸⁸ Sugar obviously became a common food, and was often used to make food toys. For example: Milk-sugar lions, *Jian dao tang* (問道糖)⁸⁹. It was quite different from the Tang Dynasty, when sugar was mostly used as a medicine.⁹⁰

The candies in the Song Dynasty reached a very high standard and had a great improvement if compared with that of the Tang Dynasty.⁹¹

During Song festivals, Sugar was consumed in the countryside as a food preference.⁹² Besides, there were also candy shops appeared in the Song Dynasty.⁹³ In the Song Dynasty sugar was used to make many goods and used for many purposes. Prior to the Song Dynasty, consumption of sugar was limited to nobles and the use of sugar was primarily for medicinal purposes, not for food. But in the Song Dynasty, the consumption of sugar began to penetrate into the life of common people, which can be seen in the records of many books.⁹⁴

4. The Origin of Sugarcane

⁸² Ji (1997), p. 143.

⁸³ Tai (1967), p. 32.

⁸⁴ Tai (1967), p. 33.

⁸⁵ Ji (1997), p. 150.

⁸⁶ Tai (1967), p. 32.

⁸⁷ Chen (2003), p. 65.

⁸⁸ Shida (1957), p. 216.

⁸⁹ Tai (1967), p. 32.

⁹⁰ Chen (2003), p. 65.

⁹¹ Ji (1997), p. 177.

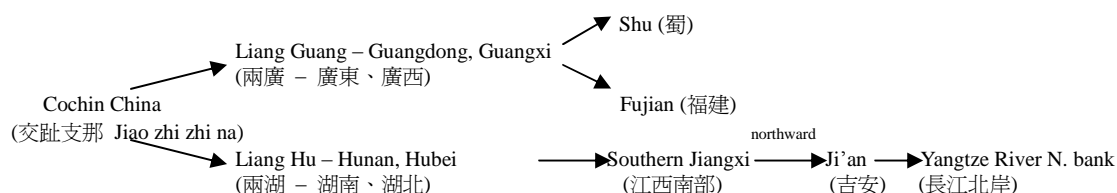
⁹² Shida (1957), p. 216.

⁹³ Tai (1967), p. 32.

⁹⁴ Tai (1967), p. 39.

The origin of sugarcane is controversial. Some people regard the source of sugarcane is from China, Some think the source is supposed to be India and French Indochina (L'Indochine française)⁹⁵, and the others think the origin is south pacific area.⁹⁶ However, Kato Shigeshi considers that originally sugarcane was not an indigenous plant in neither China nor south pacific area but India and French Indochina.⁹⁷ According to Tai Kokuki 戴国輝 (this author wrote a book on sugar in China). In most scholars' view, the origin of China's sugarcane is from India.⁹⁸ But some say sugarcane came to China from an area stretching from Cochin China to the Bay of Bengal roughly from India to south Vietnam.⁹⁹

According to Tai's view, he explains the path of the transmission of sugarcane in China as below:



Figure¹⁰⁰

In China's history, sugarcane had a lot of different names in many places. These names were quite similar both in sounds and characters. According to Hui-lin (慧琳, 737 - 820)'s book “一切經音義 (Yi qie jing yin yi, written in the Tang Dynasty)”, it says “this is the language from the west, that is why there was not a definite name of it”. The reason above was considered a quite sufficient evidence to prove that “甘蔗 (gan zhe, sugarcane)” is a borrowed word.¹⁰¹

Some people, however, think that the fact above still can not be enough to prove that China is not the place of the origin of sugarcane. In ancient China, like Warring

⁹⁵ French Indochina (1887 – 1954) was the part of the French colonial empire in Indochina in southeast Asia; consisting of a federation of four protectorates (Tonkin; Annam; Cambodia and Laos) and one directly-ruled colony - Cochin China (it is a name used for various southern regions of Vietnam under French's reign). The capital of French Indochina was Hanoi.

⁹⁶ Peng (1985) , p. 247.

⁹⁷ Kato (1953) , p. 676.

⁹⁸ Tai (1967) , p. 5.

⁹⁹ Kato (1953) , p. 676; Tai (1967) , p. 5.

¹⁰⁰ Tai (1967) , p. 172.

¹⁰¹ Ji (1982) , p. 127; Ji (1997) , p. 97.

States, there were already several terms that presented “sugarcane”. This proves that since over 2400 years ago, Chinese already knew how to make use of sugarcane. Those who insisted that “甘蔗 (*gan zhe*, sugarcane)” was originally a borrowed word all refer to Hui-lin’s book, because Hui-lin mentioned “the language from the west”. However, Hui-lin did not indicate which western language it was at all. In fact, there were even more ancient terms of sugarcane being used in China before Hui-lin’s era, maybe several hundred, or even several thousand years ago. Many ancient terms of sugarcane in China were created from the way sugarcane was made use of, which explains why the ancient terms of sugarcane in China were usually with similar sounds and characters. Besides, this also proved that before characters were invented, Chinese already planted sugarcane.¹⁰²

There were a big variety of sugarcane in India¹⁰³, and people there knew how to produce sugar since very long time ago.¹⁰⁴ In Sanskrit, “sarkara” means sugar (semi-thick raw sugar 半稀的生糖)¹⁰⁵. The Sanskrit term “sarkara” influenced the contemporary English word “sugar”, French word “sucre”, German word “zucker”, and Russian word “caxap”. Even the word “candy” in English came from the Sanskrit word “khandā”,¹⁰⁶ which means the solid and shining *shi mi* (石密).¹⁰⁷

Some people also believe that the character *sha* (沙) from the term “*sha tang* (沙糖)” was also translated from Sanskrit because of the sound of “sarkara”. However, those who believe sugarcane is an inherent plant in China think that the character *sha* from the term “*sha tang* (沙糖)” actually stands for “sand (沙 *sha*)” in Chinese, which was simply used to describe the forms of sugar. Therefore, the fact that the emperor Tang Tai zong (唐太宗 599 - 649) sent ambassadors to India for learning *sha tang* (沙糖) technology could not be explained as: “Not until Tang Dynasty, *sha tang* (沙糖) appeared in China”, because the technology brought from India only made the quality of *sha tang* (沙糖) better since then.¹⁰⁸ In other words, it is considered that the technology of producing *sha tang* already existed in the Tang Dynasty.¹⁰⁹

There is another argument related to the origin of sugar - *sha tang* (沙糖).

In Song, Lu You (陸游 aka 陸放翁 Lu Fang-weng, 1125 - 1210, a poet in the

¹⁰² Peng (1985) , p. 247.

¹⁰³ Ji (1982) , p. 127.

¹⁰⁴ Ji (1982) , p. 128.

¹⁰⁵ Ji (1982) , p. 132.

¹⁰⁶ Ji (1982) , p. 130.

¹⁰⁷ Ji (1982) , p. 132; Ji (1997) , pp. 1 – 2.

¹⁰⁸ Peng (1985) , p. 250.

¹⁰⁹ Ji (1997) , p. 100.

Southern Song Dynasty) had the following records in his book: “During Tang Dynasty, the emperor Tang Tai zong (唐太宗 599 - 649) received some exotic tribute – sugar, and since then China had *sha tang* (沙糖).”¹¹⁰

According to Lu’s article, the term *sha tang* (沙糖) had never appeared until Tang Dynasty when the emperor received the exotic tribute. However, it does not mean *sha tang* (沙糖) did not exist prior to Tang.¹¹¹

Kato Shigeshi has presented his viewpoints on this. Kato reviewed Hirth and Rockhill’s book, and it has statements as the following: in early 7th century, sugarcane was planted in Yangzhou (揚州), but at that time Chinese still did not know how to make *sha tang* (沙糖). The emperor Tang Tai zong sent ambassadors to Mid-India (摩揭陀國 *mou jie tuo guo*) to learn how to make *sha tang* (沙糖).¹¹² However, according to Kato Shigeshi, this may be wrong, because he thinks that the original statements in Lu You’s texts simply means that the sugar was made much better than before.¹¹³

5. The Cultivation Technology of Sugarcane

There is no concrete record about the history of the cultivation of sugarcane in China before Han.¹¹⁴ In Tai Kokuki’s (戴国輝) book, he indicates that there was only few records about the cultivation technology of sugarcane in Chinese history, thus he only introduced the cultivation technology of sugarcane described in the Song book 糖霜譜 (Tang shuang pu)¹¹⁵. From Warring States to Tang Dynasty, there were only a few trivial records. After Song and Yuan, the status of sugarcane in agriculture was raised, and the cultivation technology of sugarcane also rapidly developed.¹¹⁶

5.1 Weeding

The Song book 糖霜譜 (Tang shuang pu) also recorded that people were willing to weed often – “no matter how many times weeding, it does not cause

¹¹⁰ Kato (1953) , p. 684.

¹¹¹ Shida (1957) , p. 136.

¹¹² Kato (1953) , p. 684; Dong and Fan (2000) , p. 371.

¹¹³ Kato (1953) , p. 684.

¹¹⁴ Peng (1985) , p. 248.

¹¹⁵ Tai (1967) , p. 63.

¹¹⁶ Peng (1985) , p. 248.

boredom”.¹¹⁷

5.2 Fertilization

In the Song Dynasty, grains and sugarcane were planted in rotation in order to keep the land fertilized and avoid bugs that hurt the plants. The richness of soil is very important for the cultivation of sugarcane.¹¹⁸ According to the Song book 糖霜譜 (Tang shuang pu), if a piece of land was used to cultivate sugarcane this year, then the next year this land would be used to plant grains. However, for some people who had more or bigger lands, they would not plant sugarcane again until planting grains on the same land for three years. This is aimed to keep the richness of soil.¹¹⁹

As for fertilizers, according to the Song book 糖霜譜 (Tang shuang pu), farmers fertilized the land with ashes (灰) and excrements of pigs and cows and twice a year (Tomb sweeping festival 清明節 – around 4/5 or 4/6 and Dragon-boat festival 端午節 around June)¹²⁰ They also knew not to water the plant too much, otherwise the structure of soil would be destroyed.¹²¹

6. Storing and Preserving Crystallized Sugar

Moisture and humidity ruin crystallized sugar. During the Song Dynasty, people found ways to control moisture when storing or transporting urns of crystallized sugar. Barley and wheat were placed at the bottom of storage urns, with a bamboo disk placed on the top of the grain. Bamboo barks (outer skin) was placed on the top of the bamboo disk and the crystallized sugar was then poured in the urn. Finally cotton was placed on the top of the crystallized sugar and then the urn was closed with a lid. This technique for preserving crystallized sugar was most common. If the sugar urn was to be transported to a very distant location, limestones were placed at the bottom of the urn to provide additional protection from moisture.¹²²

¹¹⁷ Tai (1967) , p. 65; Ji (1997) , p. 127.

¹¹⁸ Shiba (1968) , p. 218; Tai (1967) , p. 65.

¹¹⁹ Tai (1967) , p. 65.

¹²⁰ Tai (1967) , p. 65; Ji (1997) , p. 127.

¹²¹ Peng (1985) , p. 248.

¹²² Shiba (1968) , p. 218; Tai (1967) , p. 96; Ji (1997) , p. 128.

7. Tai Kokuki's (戴国輝) Opinion on Long-run Sugar Development

According to Tai's book, he breaks sugar development in China into three periods¹²³:

1. The Confirmation of the Existence of Sugarcane period in China (300 B.C. – 550 A.D.)¹²⁴
2. The Founding/Forming Period of Sugar Industry in China (550 A.D. – early 10th century)¹²⁵
3. The Establishing and Consolidating Period of Sugar Industry in China (Mid 10th – mid 14th)¹²⁶

7.1 The Confirmation of the Existence of Sugarcane period in China (“戰國時代的 300 B.C.前後 – 南北朝時代的 550 A.D.左右”)¹²⁷:

The oldest text that proves the existence of sugarcane in China is 楚辭 (Chu ci, a collection of poetry of Warring States period). Besides, the oldest ancient text that illustrated most clearly about the cultivation of sugarcane is 《齊民要術》(Qi min yao shu) and Tao Hong-jing's (陶弘景) 《本草經集注》(Ben cao jing ji zhu).¹²⁸

During this period, sugarcanes were used to make syrup for drinking or to cure disease as some kind of medicine.¹²⁹

7.2 The Founding/Forming Period of Sugar Industry in China (“南北朝中期 <6 世紀中葉> - 唐、五代 <10 世紀初葉>”)¹³⁰:

¹²³ Tai (1967), pp. 171 – 173.

¹²⁴ Tai (1967), p. 171.

¹²⁵ Tai (1967), p. 172.

¹²⁶ Tai (1967), p. 172.

¹²⁷ Tai (1967), p. 171.

¹²⁸ Tai (1967), pp. 171 – 172.

¹²⁹ Tai (1967), pp. 171 – 172.

¹³⁰ Tai (1967), p. 172.

Tai regards the Tang Dynasty as the prototype of sugar industry in Chinese history.¹³¹

The book 《本草經集注》 (Ben cao jing ji zhu) written by Tao Hong jing (陶弘景 in the Liang Dynasty) illustrated more about the cultivation of sugarcane. Besides, the sugar product such as *sha tang* (沙糖), *xi sha tang* (稀沙糖), *shi mi* (石蜜) ..etc appeared during this period. There were some types of sugarcanes during this time, such as *fu nan zhe* (扶南蔗), *zhu zhe* (竹蔗), *di zhe* (荻蔗), and *kun lun zhe* (崑崙蔗), these four types.¹³²

In this period, the sugar workshop *tang fang* (糖坊) also appeared, and its sugar production technology was from India.¹³³

7.3 The Establishing and Consolidating Period of Sugar Industry in China (“宋 <10 世紀中葉> - 元 <14 世紀中葉>”)¹³⁴

From the Five Dynasties to the Northern Song Dynasty, in Wuzhong (吳中, around Jiangsu) sugarcane cultivation was especially popular, records about more variety of sugarcanes appeared, too. These types of sugarcanes had never been found before, such as *kun lun zhe* (崑崙蔗), *jia zhe* (夾蔗), *miao zhe* (苗蔗), *qing hui zhe* (青灰蔗), *guang lang zhe* (桄榔蔗), *bai yan zhe* (白岩蔗) ...etc.¹³⁵

The sugar industry in China got consolidated during the Southern Song Dynasty to the Yuan Dynasty, and sugar production places moved from the interior area to the coastal areas such as Fujian and Guangdong.¹³⁶

Pre – Song : consumption of sugar was limited to part of the nobles as luxury, and the use of sugar was primarily for medicinal purposes.¹³⁷

Song – Yuan: consumption of sugar penetrated into the life of common people.¹³⁸

¹³¹ Tai (1967) , p. 22.

¹³² Tai (1967) , p. 172.

¹³³ Tai (1967) , p. 172.

¹³⁴ Tai (1967) , p. 172.

¹³⁵ Tai (1967) , p. 173.

¹³⁶ Tai (1967) , p. 173.

¹³⁷ Tai (1967) , p. 173.

¹³⁸ Tai (1967) , p. 173.

8. Joseph Needham's Viewpoints

8.1 The Origin of China's Sugarcane

“An India/South-East-Asian origin was proposed by Carl Ritter¹³⁹ as a major centre of origin. Alphonse de Candolle¹⁴⁰ discussed the work of Ritter and subsequent authors and came to the conclusion that ‘it’s primitive range extended from Bengal to Cochin China’. This statement was widely cited, and the Japanese economic historian of China, Kato Shigeshi, agreed with the theory of an Indian/Indo-China origin and subsequent dispersal to south China via Vietnam and Guangdong. Kato shigeshi dated such an introduction as occurring from the late Warring States period (-480 to 221).”¹⁴¹

8.2 The Pre-Song Period

Prior to the Song chewing cane was a subsistence crop.¹⁴²

“Next let us consider the agriculture methods that caused chewing cane to remain a subsistence crop until the Song period.”¹⁴³

In the 2nd century BC, inhabitants of south China and Vietnam boiled amorphous sugar. Sugar was not traded in central and north China and only found its way to the Chinese court as an article of tribute.¹⁴⁴

“As demonstrated below, the ethnic peoples of south China and Vietnam boiled amorphous sugar, *shi mi*, from the – 2nd century. Such sugar was not produced for trade with central and north China, and found its way to the Chinese court as an article of tribute.”¹⁴⁵

From the 6th century consumption of imported sugar medicines was confined to the higher echelons of society.¹⁴⁶

¹³⁹ Daniels (1996), p. 533.

¹⁴⁰ Daniels (1996), p. 519.

¹⁴¹ Daniels (1996), p. 138.

¹⁴² Daniels (1996), p. 65.

¹⁴³ Daniels (1996), p. 65.

¹⁴⁴ Daniels (1996), p. 88.

¹⁴⁵ Daniels (1996), p. 88.

¹⁴⁶ Daniels (1996), p. 88.

“Pharmacopoeias mentioned various types of sugars from the 6th century onwards, but being imported medicines their consumption was confined to the higher echolons of society.”¹⁴⁷

Despite the introduction of a new sugar-making technology from India in the mid-7th century, there was no development of commercial sugar.¹⁴⁸

One reason for the lack of commercial production of sugar in the pre-Song era was that it was not until the decentralization of political power during the late Tang that strict state control over commerce, merchant, the rural population and the currency ended.¹⁴⁹

“The mid-7th-century technological mission to India, which we examine in detail below, introduced the method of making *sha tang* or beaten sugar, and muscovado or drained sugar (*shi mi*).”¹⁵⁰

“Despite the introduction of these sugar-making technologies in the +7th century, social and economic conditions did not allow the development of commercial sugar, as with other agricultural products, for the following reasons. First, it not until the decentralization of political power during the late Tang that strict State control over commerce, merchant, the rural population and the currency ended.”¹⁵¹

8.3 The Song Dynasty

“The late Tang and Song periods marked the commencement of the commercial production of both sugarcane and sugar.”¹⁵²

8.3.1 Specific Book on Sugar Appeared

There exists a specialized treatise on sugar, “Monograph on Sugar Candy” (Tang

¹⁴⁷ Daniels (1996), p. 88.

¹⁴⁸ Daniels (1996), p. 88.

¹⁴⁹ Daniels (1996), p. 88.

¹⁵⁰ Daniels (1996), p. 88.

¹⁵¹ Daniels (1996), p. 88.

¹⁵² Daniels (1996), p. 89.

Shuang Pu) written by Wang Cho in 1154.¹⁵³

“Edge-running for juice expression followed by steaming of the residue and further expression of juice, was described in the earliest Chinese treatise on sugar, the Tang shuang pu (Monograph on Sugar Candy) if c. +1154 by the Song scholar and poet Wang Zhuo.”¹⁵⁴

8.3.2 Cultivation Technology of Sugarcane

“The rise of urban consumption in the Song initiated the cultivation of sugarcane as a commodity crop.”¹⁵⁵

During the Song, large processing plants with edge-runner mills emerged.¹⁵⁶

“In China, large processing plants with edge-runner mills emerged during the Song, probably in response to the contemporary increase in commerce”¹⁵⁷

Probably during the early Song, a large heavy wooden roller was employed to mash up sugarcane laid on a wooden board staging. The roller was cambered and drawn by humans or animals. This type of mill, know as the *khun-nien*, was the generic term for a horizontal roller traveling around a circular course drawn by animal power. It was first described and illustrated in Wang Chen’s *Nong Shu* of 1313.¹⁵⁸

“Probably beginning with the advent of the commodity production of sugar south of the ranges during the early Song, a large heavy wooden roller was employed to mash up sugarcane laid on a wooden board staging; The roller was cambered and drawn by humans or animals. This type of mill, know as the *kun nian* in Chinese, was the generic term for a horizontal roller travelling around a circular course drawn by animal power. It was first described and illustrated in Wang Zhen’s *Nong Shu* of +1313.”¹⁵⁹

“From the 10th century, we see the rise of the edge-runner mill which was superior technology. By the 12th century, the edge-runner became the dominant technology for

¹⁵³ Daniels (1996), p. 13.

¹⁵⁴ Daniels (1996), pp.12 – 13.

¹⁵⁵ Daniels (1996), p. 64.

¹⁵⁶ Daniels (1996), p. 87.

¹⁵⁷ Daniels (1996), p. 87.

¹⁵⁸ Daniels (1996), p. 285.

¹⁵⁹ Daniels (1996), p. 285.

crushing sugarcane and expressing oil.”¹⁶⁰

“The edge-runner comprised a large single disc rolled on its edge on a platform or within a race.”¹⁶¹

8.3.3 The Places of Production and Specialization

Commercial sugar production was concentrated in five specific locations, Chekiang, Fukien and Kuang-Tung and Ssu-Chhuan. Regional specialization: Sui-Ning produced high quality sugar candy.¹⁶²

“Contemporary Commercial sugar production was concentrated in five specific locations in Zhejiang, Fujian and Guangdong and Sichuan.”¹⁶³

“Sugar candy (*tang shuang*), also called ice sugar (*tang bing*), is produced in Futang [Fujian], Siming [Zhejiang], Fanyu [Guangdong], Guanghan and Suining [Sichuan]. The sugar candy manufactured in Suining is the best.”¹⁶⁴

In the Song Fukien emerged as a center of excellence in sugar production, and a large producer for the long-distance market.¹⁶⁵

“At this time Fujian emerged as a centre of excellence in sugar production, and a large producer for the long-distance market.”¹⁶⁶

8.3.4 The Change in Consumption

“The rise of urban markets during the Song Dynasty brought sugar confectionery closer to greater numbers of Chinese than ever before. During the Tang it remained the preserve of the Imperial family, aristocrats, and high officials, but during the Song confectionery, and indeed other sugar products as well, came within the reach of

¹⁶⁰ Daniels (1996), p. 292.

¹⁶¹ Daniels (1996), p. 292.

¹⁶² Daniels (1996), p. 89.

¹⁶³ Daniels (1996), p. 89.

¹⁶⁴ Daniels (1996), p. 89.

¹⁶⁵ Daniels (1996), p. 185.

¹⁶⁶ Daniels (1996), p. 185.

merchants and other well-off members of society, even if only in small quantities.”¹⁶⁷

“...we can safely say that in the Song sugar consumption increased among more wealthy and affluent urban dwellers, but this did not constitute a general trend encompassing all sections of the population.”¹⁶⁸

8.3.5 Sugar Became One of the Commodities

“The rise of large urban markets in the Song encouraged sugar production by Han Chinese immigrants living south of the Yangtse, and quickly turned sugar into a commodity.”¹⁶⁹

Descriptions of various sugar and candied fruits sold by street vendors in cities during the Song.¹⁷⁰

“Both Kaifeng and Lin’an, the capitals of the Northern and Southern Song respectively, enjoyed high acclaim for the sugar products vended on their streets. For instance, the *Dong jing meng hua lu* which depicted conditions in Kaifeng during the early +12th century, listed Sichuanese milk sugar (*Sichuan ru tang*), lion-shaped sugar (*Shi zi tang*), and a variety of other products bearing exotic sounding names that were processed with sugar, such as chicken’s head *sha tang* (*Ji tou rang sha tang*) and fragrant candied sugar (*xiang tang guo zi*). The *Du cheng ji sheng*, which described Lin’an, later known as Hangzhou, during the early +13 century recorded a similarly abundant amount of sugar consumed. Street vendors sold an array of sugar and candied fruits, and there was even a government organisation called the *Mi jian ju* or honey-boiling department which purveyed fruits boiled in sugar and honey to government officials and those of high social standing.”¹⁷¹

8.3.6 Other Uses of Sugar in the Song

During the Song Dynasty figures made by crystallizing sugar on bamboo slats and

¹⁶⁷ Daniels (1996), p. 77.

¹⁶⁸ Daniels (1996), p. 86.

¹⁶⁹ Daniels (1996), p. 88.

¹⁷⁰ Daniels (1996), p. 89.

¹⁷¹ Daniels (1996), p. 89.

sculpting it into animal shapes appeared. (Decorative material).¹⁷²

“Sugar uses and functions. Decorative material: In China figures made by crystallizing sugar on bamboo slats and sculpting it into animal shapes appeared. during the Song.”¹⁷³

8.3.7 The Market and Exportation of Sugar

“During the Song specialist areas in south China exported sugar to a number of places in South-East Asia, such as Vietnam, Cambodia and the Malay Peninsula.”¹⁷⁴

In the Song Fukien emerged as a center of excellence in sugar production, and a large producer for the long-distance market.¹⁷⁵

“At this time Fujian emerged as a centre of excellence in sugar production, and a large producer for the long-distance market.”¹⁷⁶

“The commercial production of sugarcane, as the term is employed here, refers to the cultivation of sugarcane as a fruit or drink for sale principally in urban areas.”¹⁷⁷

“During the Southern Song merchants transported large quantities of chewing cane to the capital Kaifeng. Urban growth during the Song Dynasty probably marked the real beginning of the commercial cultivation of sugarcane for chewing on a sizeable scale.”¹⁷⁸

8.4 The Yuan Dynasty

“The commodity production of sugar which began during the Song continued throughout the Yuan Dynasty.”¹⁷⁹

¹⁷² Daniels (1996), p. 68.

¹⁷³ Daniels (1996), p. 68.

¹⁷⁴ Daniels (1996), p. 92.

¹⁷⁵ Daniels (1996), p. 185.

¹⁷⁶ Daniels (1996), p. 185.

¹⁷⁷ Daniels (1996), p. 65.

¹⁷⁸ Daniels (1996), p. 65.

¹⁷⁹ Daniels (1996), p. 92.

“Marco Polo claimed Fukien as the largest producer of sugar in the world.”¹⁸⁰

Marco Polo commented on the large amount of sugar produced.¹⁸¹

“During the Yuan Dynasty the great Venetian traveller Marco Polo marvelled at the amount of sugar produced in China. Concerning the revenue of Hang zhou he related:

I tell you that sugar, which pays three and a third per cent, grows and is made in this city and its dependencies, which is one of the nine parts of the province of Mangi, and it is also made in the other eight parts of the said province everywhere, and so it is made in this province in very great quantity and more than double that which is made in all the rest of the world; many people say it in truth and this is again a very great source of revenue.”¹⁸²

“There may be some exaggeration in this statement, but Marco Polo was by no means the only contemporary foreigner to praise the excellence of Chinese sugar. Abu'l Abba Ahmad Shinab al-Din al-‘Umari (d. +1338), in his *Masalik al-Absar fi Mamalik al-Amsar* (Ways of the Eyes to Survey the Provinces of the Great States) spoke of the great skill of Chinese artisans in making sugar candy.”¹⁸³

A work sponsored by the Yuan court, the *Nong Sang Chi Yao* (Fundamentals of Agriculture and Sericulture), of 1273 AD, documented sugarcane agriculture and sugar-making techniques. In fact the Yuan court established a Sugar Bureau (*Sha Tang Ju*) in 1276.¹⁸⁴

“A work sponsored by the Yuan court, the *Nong sang ji yao* (Fundamentals of Agriculture and Sericulture), of 1273 AD, documented sugarcane agriculture and sugar-making techniques, which itself provides some indication of the increased importance of this crop. In fact the Yuan court established a Sugar Bureau (*Sha tang Ju*) in 1276.”¹⁸⁵

¹⁸⁰ Daniels (1996), p. 185.

¹⁸¹ Daniels (1996), p. 91.

¹⁸² Daniels (1996), pp. 91 – 92.

¹⁸³ Daniels (1996), p. 92.

¹⁸⁴ Daniels (1996), p. 92.

¹⁸⁵ Daniels (1996), p. 92.

References

Chinese

Chen Xudong 陳旭東 (2003), “Shi lun Song dai zhi tang ye de fa zhan, 試論宋代製糖業的發展.” *Xue shu tan suo*, 學術探索, 83 (11), 第 11 期 (總第 83 期), pp. 64 – 66. (This author is a graduate student at 雲南大學中國經濟史研究所).

Dong Kaizhen 董愷枕、Fan Chuyu 范楚玉 (2000), *Zhongguo ke xue ji shu shi: nong xue juan di shi er juan*, 《中國科學技術史：農學卷 v. 12》, Lu Jiayi 盧嘉錫總主編. Beijing: Ke xue chu ban she, 北京：科學出版社。

Ji Xianlin 季羨林 (1982), “Yi zhang you guan Yindu zhi tang fa chuan ru Zhongguo de Dunhuang can juan, 一張有關印度製糖法傳入中國的敦煌殘卷”, *Li shi yan*

jiu, 歷史研究, 3, 第三期, pp. 124 – 136。

Ji Xianlin 季羨林 (1997), *Zhonghua zhe tang shi*, 《中華蔗糖史》. Beijing: Jing ji ri bao chu ban she, 北京: 經濟日報出版社。

Peng Shijiang 彭世獎 (1985), “Guan yu Zhongguo de gan zhe zai pei han zhi tang shi, 關於中國的甘蔗栽培和製糖史.” *Zi ran ke xue shi yan jiu* 自然科學史研究, 4 (3), 第四卷第三期, pp. 247 – 250。

Japanese

Katō Shigeshi 加藤繁 (1953), “Shina ni okeru kansho oyobi satō no kigen ni tsuite, 支那における甘蔗及び砂糖の起源に就いて.” In *Shina keizaishi kōshō*, 《支那經濟史考証》, Katō Shigeshi cho, 加藤繁著, pp. 676 – 687. Tōkyō: Tōyō Bunko, 東京: 東洋文庫。

Shiba Yoshinobu 斯波義信 (1968), *Sōdai shōgyōshi kenkyū*, 《宋代商業史研究》. Tōkyō: Kazama Shobō, 東京: 風間書房。

Shida Fudōmaro 志田不動磨 (1957), “Chūgoku ni okeru satō no fukyū, 中國に於ける砂糖の普及.” In *Takikawa Hakushi kanreki kinen ronbunshū – Tōyō shihen*, 《瀧川博士還曆記念論文集 – 東洋史篇》, Takikawa Hakushi Kanreki Kinen Ronbunshū Kankō Iinkai, 瀧川博士還曆記念論文集刊行委員会, pp. 125 – 139. Tōkyō: Nakazawa insatsu kabushiki kaisha, 東京: 中沢印刷株式会社。

Tai Kokuki 戴国輝 (1967), *Chūgoku kansho tōgyō no tenkai*, 《中国甘蔗糖業の展開》. Tōkyō: Ajia keizai kenkyūjo, 東京: アジア經濟研究所。

English

Daniels, Christian (1996) *Agro-industries: Sugarcane Technology in Science & Civilisation in China Volume 6: Biology and Biological Technology Part 3*, edited by Joseph Needham. Cambridge: Cambridge University Press.