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Characteristics of traditional Chinese *shanlan* wine fermentation

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Shanlan rice wine is made by a unique method by removing the saccharified liquid from wine mash constantly since it appeared during saccharification and fermentation. The objective of this study is to find the advantages of this technique of wine making by analyzing data of _shanlan_ wine fermentation. Since the liquid was removed, the mash (rice) bed was fluffier than immersed in the saccharified liquid, under ambient condition constantly and it is favorable for starch degradation. This technique made _shanlan_ rice wine tasted sweet and slightly acidic, lower content of alcohol and higher alcohol than in other non-distilled rice wines.

[**Key words:** *Shanlan* wine; Saccharification; Fermentation; Flavor; Higher alcohol]

There have been many reports about traditional rice wine in East-Asian countries, such as Vietnamese *men* (1), Cambodian *tapae* (2), Philippine *tapuy* (2), Indonesian *brem* (3) and the Japanese *mirin* (4). These traditional fermented alcoholic beverages are popular in local place.

Most rice wines are made from glutinous rice (5). In many Asian countries, glutinous rice is preferred in the preparation of traditional rice wines.

Traditional rice wines are made without liquefaction pretreatment unlike industry process of alcohol producing. The fermentation process follows an ancient technique: Powdered starter is mixed into steamed glutinous rice. The mixed rice is then incubated under ambient conditions. After a period of aerobic fungal solid-state fermentation, the moulded mass is mixed with water, and began submerged alcoholic fermentation (6).

Chinese rice wine is a traditional non-distilled alcoholic beverage, which is consumed widely in South China. Reports said that there are more total higher alcohols detected in Chinese rice wine than in other alcoholic beverages such as grape wine, lager beer and ale beer (7). Higher alcohols are the main flavor substances in rice wine, and adequate content of higher alcohols could improve the harmony of rice wine. However, superfluous higher alcohols content would bring off-flavor and cause strongly drunk and bad headache and stomach problems (8). The wine making techniques have been developed to control the content of higher alcohols in Chinese rice wine.

In Hainan China, however, there is a kind of rice wine called *shanlan* wine, which is made by a unique method by removing the saccharified liquid from wine mash constantly since it appeared during saccharification and fermentation. The technique of wine making made *shanlan* rice wine refreshing with low content of higher alcohol.

Shanlan rice wine made by the *Li* nationality peoples, is the most popular traditional alcoholic beverage in Wuzhi mountain area of Hainan island of China. *Shanlan* rice wine is also called *biang* or *nandi* in *Li*, which has a unique aroma, subtle flavor and low alcoholicity, tasted sweet, mild in acidity and vinosity. *Shanlan* rice wine is made by a traditional process of wine making. *Shanlan* rice, is a kind of glutinous rice growing in Wuzhi mountain area, used to be food of local peoples, being used as the main materials to make wine without further distillation. After 3 d of fermentation at room temperature (25°C), the wine mash is separated by spearing the bottom of fermentor, which is usually made by banana leaves. The saccharified liquid leaking and dropping out from the fermentor is what called *biang* (fermenting wine, producing rich gas of CO_2 and alcohol) in *Li*. The *biang* is ready to be consumed after 7 d fermentation, and the residual mash is ready to be ate or stored up in a sealed jar, aged under ground for 3–5 years.

Since the *biang* is removed from the wine mash, it must be drank within 7 d or stored in a sealed bottle at below 7°C, otherwise, its taste stronger bitter, alcoholic and acidic (9). In Hainan, *biang* provide a perfect accompaniment to the meal with rich CO_2, intense rice bouquet and sweet, sour palates, consumed by local peoples. The fresh made *biang* is main form of *shanlan* rice wine.

The aging *shanlan* rice wine can also be made by another method: the *shanlan* rice was cooked and fermented for 7 d as described above, without separating the saccharified liquid from the wine mash, and then putted into a jar with lid. During the storage of *shanlan* rice wine, alcoholicity increased till the fermentable sucrose was exhausted, followed by a long term maturing period. Since the jar was not sealed completely, the CO_2

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evaporated slowly during 3–5 years aging. Finally, the aged *shanlan* rice wine is presented with elegant flavor and mellow taste, without gas, usually drank with dilution by water. The separated, aged wine tasted like Chinese traditional yellow rice wine (10).

In traditional process, the main materials and starters play the most important roles in wine making. The starter of *shanlan* rice wine fermentation is called *qiubing* in *Li*. The starter *qiubing* is made by unique ingredients and technique. The seed, tuber, out bark, root, leaf even flower of various plants grow in Wuzhi mountain area were used to make starter (6). The main ingredients of a traditional method to make starter *qiubing* were nature growth plants and freshly picked such as red rice enriched with starch, leafs of ginger, barks of sugarcane and *xiangpi* tree, etc. These raw materials were ground into powder, mixed with water and rice-straw ash, granulated, then dried on a bamboo shelf by charcoal fire to be controlled proper moisture content in it. The dried starter granules were stored under ambient room temperature (approx. 25°C), relative humidity about 75%, protected from daylight. The starter was used to make *shanlan* rice wine after 3 months of storage.

MATERIALS AND METHODS

Materials *Shanlan* rice and wine starter (*qiubing*) were purchased from local market in Wuzhi mountain city.

4-L fermentor Stainless pot (4 L) with a horizontal division sieve (the mesh is small enough to exclude rice) in the middle of the pot. The sieve is movable. On the bottom of the fermentor, drill a tinny hole (4 mm in diameter) and connect a silicone tube for liquid exit and sample.

***Shanlan* rice pretreatment** In the pretreatment, *shanlan* rice was washed and soaked in water for 12 h at room temperature (25°C). After soaking, the *shanlan* rice was drained and put into a steam pot, then was cooked by steam for 30 min at 100°C. The gelatinized rice was cooled to 40–45°C. The starter (*qiubing*) was ground into powder.

***Shanlan* rice wine fermentation** Cooked rice (1 kg) was collected in 4-L fermentor and then 1 L water and 5 g *qiubing* (starter) were added into the fermentor on the sieve. The rice was then stirred to make the *qiubing* well-distributed, and was incubated for 3 d at 25°C (main fermentation). The saccharified liquid was removed from the mash by the sieve. The wine mash and removed liquid were kept fermentation for 7 d at 25°C (post-fermentation). After that, the fermented mash was centrifuged at 5000x*g* for 20 min. The supernatant and the removed saccharified liquid previously in the fermentor were amalgamated, sterilized for 15 min at 85°C. Finally, the rice wine was stored in a pottery.

Glucoamylase activity, residue of starch, alcohol content, pH, total acid, total sugar, reducing sugar, total ester, amino nitrogen, juice yield, soluble solids and higher alcohols analysis Glucoamylase activity was determined by acid hydrolysis method (11). Residue of starch was determined by polarimetric method (11). Alcohol content and total acid were determined by the method of Wang et al. (12). The pH meter was used to determine pH value. The total sugar and reducing sugar was determined by Fehling reagent method (13). The total ester was determined by saponification titration method (11). The amino nitrogen was determined by potentiometric titration method (11). The soluble solid was determined by weighting method (11). The higher alcohols were determined by gas chromatography (14).

RESULTS AND DISCUSSION

Characteristics of saccharification and fermentation It was reported that 5.9% (w/v) fermentable sugar was transferred when 0.25% starch hydrolyzing enzyme was used in the liquefaction process of corn for 2 h at 48°C (15). During 35–45 h of fermentation, glucoamylase activity increased rapidly in this study (Fig. 1). At 50 h of fermentation, glucoamylase activity had reached the maximum value of 27 in enzyme activity unit mg/g·0.5 h. However, prolonged fermentation to 75 h made a decline of glucoamylase activity. There was a clear decline trend in residual starch changes in fermentation. Corresponded to the changes of glucoamylase activity, the significant degradation of starch appeared from 40 h to 45 h, the level of residual starch dropped from 33% to 23%. It is favorable for starch degradation during entire process of fermentation (Fig. 1). Especially since the third day, when the saccharified liquid was removed from the solid medium, the mash bed was fluffier than immersed in the Saccharified liquid under ambient condition constantly during fermentation. The fluffier mash might help the growth of mould and was favorable for starch saccharification.

In Chinese wine making or alcohol producing industry, yeast cells are known to experience high osmolarity stress under high fermentable sugar in the initial period of fermentation. The total sugar concentration must be controlled within a proper value to avoid sluggish fermentation. In this study, the beginning total sugar was measured at 27.5% (Fig. 1). Total sugars was linearly decreased during 75 h and kept constantly during prolonged fermentation. Fermentation during 40–60 h, alcohol content increased rapidly from 2.5% (v/v) to 5.5% (v/v). With the sugar was taken in, the alcohol, produced by yeast, retarded the efficiency of alcohol

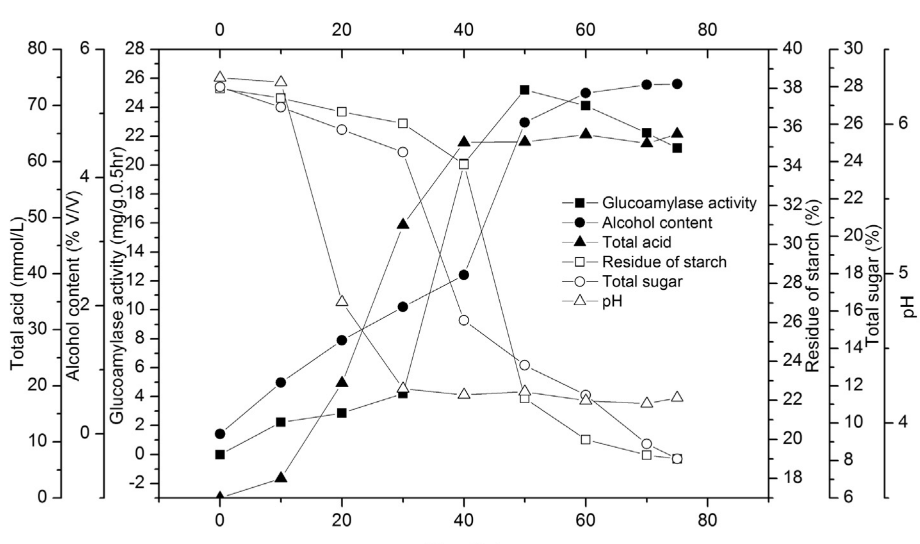

FIG. 1. Time courses of *shanlan* rice wine fermentation: solid squares, glucoamylase activity; open squares, residue of starch; solid circles, alcohol content; open circles, total sugar; solid triangles, total acid; open triangles, pH.