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Review

Research progress on the brewing techniques of new-type rice wine

Aiquan Jiao, Xueming Xu, Zhengyu Jin *

The State Key Lab of Food Science and Technology, School of Food Science and Technology, Jiangnan University, Wuxi 214122, China
Synergetic Innovation Center of Food Safety and Nutrition, Jiangnan University, Wuxi 214122, China

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ABSTRACT

As a traditional alcoholic beverage, Chinese rice wine (CRW) with high nutritional value and unique flavor has been popular in China for thousands of years. Although traditional production methods had been used without change for centuries, numerous technological innovations in the last decades have greatly impacted on the CRW industry. However, reviews related to the technology research progress in this field are relatively few. This article aimed at providing a brief summary of the recent developments in the new brewing technologies for making CRW. Based on the comparison between the conventional methods and the innovative technologies of CRW brewing, three principal aspects were summarized and sorted, including the innovation of raw material pretreatment, the optimization of fermentation and the reform of sterilization technology. Furthermore, by comparing the advantages and disadvantages of these methods, various issues are addressed related to the prospect of the CRW industry.

Contents

1. Introduction

Chinese rice wine (CRW), broadly distributed in the Shaoxing city, Yangtze River Delta and Shandong province, is one of the oldest drinks in the world like beer and wine (Xu, Wang, Fan, Mu, & Chen, 2010). CRW made from cereal grain (mainly sticky rice, round-grained rice, millet and some pigment rice/corn) includes many renowned types, such as Shaoxing rice wine, black rice wine and North China rice wine etc. As the gem of wines in China it enjoys the highest reputation as the "National Wine". CRW has a long, time-honored brewing history: 7000 years ago, first created by our ancestors in the period of Yangshao Culture and their

* Corresponding author at: The State Key Lab of Food Science and Technology, School of Food Science and Technology, Jiangnan University, Wuxi 214122, China.
E-mail address: jinlab2008@yahoo.com (Z. Jin).

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traditional production methods are still in use today (Chen & Xu, 2010). However, as a result of the complexity of utilizing traditional rice winemaking techniques, which continues to walk in the old steps of the traditional rice wine industry, CRW is now facing multiple crises. These include, but are not limited to low degree of industrialization, decline of sales volume and grim market prospect (Baks, Kappen, Janssen, & Boom, 2008; Xu, Wu, Wang, et al., 2015). Encountering the difficulties present in the rice wine industry, the elder winemakers of CRW have pointed out the great significance and promotion of science and technology to rice wine production. The future development of rice wine lies in the improvement and perfection of the production techniques. Meanwhile, the new drinking concepts of health, nutrition, safety and palatability advocated by modern people, have also brought hopes and opportunities for expanding a new-type of CRW market (Wang & Xu, 2005). Therefore, the present paper makes a comparison between new and traditional rice winemaking techniques, and has undertaken an analysis in terms of the transformation and innovation of cooking technique including the optimization of fermentation technique and the innovation of sterilization technology. The main purpose of this study was to find new breakthroughs for the development of the CRW production industry.

2. Development of new-type rice wine

Traditional CRW is typically fermented from sticky rice, millet and so forth as the main raw materials (Luo, Fan, & Xu, 2008). These raw materials are made through the steps of steeping, cooking, starter addition, fermentation, squeezing, filtration, boiling, storage and blending. Although traditional brewing techniques are struggling with each passing day to retain their positions, the technology and experience can nevertheless be employed to bring forth novel techniques. The new types of CRW are mostly based on innovating traditional rice wine brewing techniques. Considering the lack of an explicit definition of new-type rice wine in the CRW making area, we will refer to rice wine that differentiates itself from traditional rice wine in vinosity and flavor, meets consumer demands and new drinking concepts, which generally has a relatively high nutritional value.

3. Innovation of rice cooking

The traditional immersion of rice in water and steam cooking steps in the brewing of rice wine can break the tissue structures of cereal raw materials and accelerate starch gelatinization with high-temperature (Xu, Wu, Wang, et al., 2016). However, once industrial production of CRW is concerned, there are also many defects to consider: a long period of time (3–5 days) and large energy consumption are inevitable (Li, Jiao, et al., 2013); the wastewater generated by immersion adds the environmental pollution severely (Zhu, Zhang, Shi, & Mao, 2004); half-boiled, overcooked or ageing (retrogradation) rice are frequently observed when cooking occurs in large pots, further affecting the subsequent fermentation; the low yield of CRW makes it difficult to expand the scale of production; they occupy a large production area that creates difficulties in rice transport thus incurring a high cost of production. Thus, researchers have developed a series of new technology and combined techniques (extrusion, liquefying method, roasting method and uncooked materials method, etc.) to replace these traditional steeping and cooking techniques (Chen & Xu, 2012; Li, Jin, & Xu, 2013; Xu, Wu, Long, et al., 2015; Xu, Wu, Wang, et al., 2015).

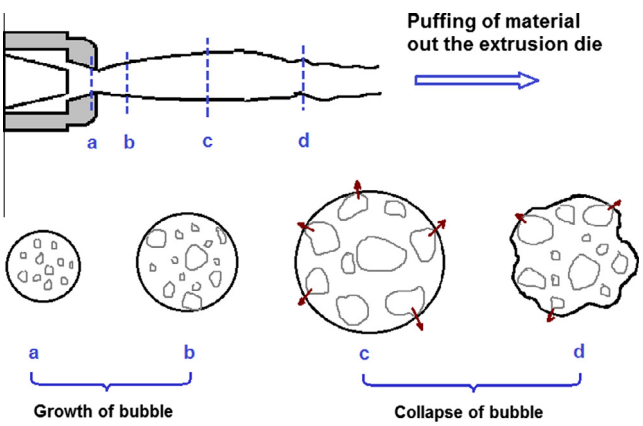

Fig. 1. Generation and collapse of bubbles during extrusion puffing.

3.1. Research on the production of new-type rice wine by puffing method

Since the first patent for food puffing technology was awarded to an American named Ward, many researchers have applied puffing technology to the processing of cereal food (Chouvel, Chay, & Cheftel, 1983; de Mesa-Stonestreet, Alavi, & Gwirtz, 2012). Interestingly, the food industry has been paying increasingly closer attention to the research on the puffing mechanism and has gradually applied it to the winemaking industry. In winemaking with the puffing method, the processing of cereal raw materials plays a dominant role: first the cereal raw materials are put through high temperature and high pressure (150 °C, 1 MPa) as well as physical shearing, then are abruptly depressurized at the die orifice to a normal state, after which the internal moisture experiences a phase change and provides the energy conditions for completing the final abrupt puffing molding (Lu et al., 2003), with the change of bubble shown in Fig. 1. This method allows for several advantageous conditions, it can enlarge the interaction zone between raw materials and enzyme thus shortening the fermentation period; make it easier for starch granules, protein and fat to decompose therefore improving fermentation efficiency, wine yield and stability; provides a strong high-temperature and high-pressure sterilization action, and reduces the rate of rancidity in fermentation. It also features a simple procedure with high energy-conservation and emission-reduction performance.

Depending on the puffing method used, puffing technology can be divided into extrusion puffing and explosion puffing. Extrusion puffing uses a mechanical screw to provide the driving force while explosion puffing uses superheated steam to provide energy for rice ground or smashed to flour. Considering the brewing of rice wine, extrusion puffing has a wider applicability and universality than explosion counterpart. Jin et al. (Wu et al., 2015; Xu, Wu, Pan, et al., 2016) compared the performance of extrusion puffing with that of traditional cooking in the brewing of rice wine, and found that the saccharification liquid yield of the former was 40% higher than that of the latter. Besides, according to the comparison between extrusion puffing and the traditional cooking method, it was found that the extrusion puffing increased the wine yields of millet and corn respectively by 12.1% and 21.7% in comparison to the traditional cooking method. Yang (1988) studied the puffing mechanism of cereals and found that extrusion puffing more significantly increased water-soluble components than explosion puffing. Then, Wei and Wang (1995) optimized the extrusion puffing conditions of rice, and discovered that this method achieved a higher degree of gelatinization than traditional techniques. Xu et al. (2015) brewed a new type of rice wine with light taste through studying the extrusion puffing of glutinous rice. Zhao (2010) summarized foreign mechanism research, and revealed the