Research Progress in Tobacco Fermentation

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Abstract

Flue-cured tobacco fermentation is one of the important processes in cigarette manufacturing production. In this thesis, the author interviewed the flue-cured tobacco fermentation mechanism, quality changes of fermentation process, environmental influences on fermentation quality, and fermentation method. By aiming at shortcomings of the current study, the author proposed the near-infrared means to judge the best period of fermentation and provided reference for cigarette enterprises.

Keywords

Tobacco, Fermentation, Near Infrared Spectroscopy, Research Progress

1. Introduction

Flue-cured tobacco fermentation is the important process in flue-cured tobacco fermentation process. Unleavened new cigarette has multiple quality defects, such as offensive odor, simulative extrusion, no fragrance of former smoke, monotonous smoking aroma quality, insufficient fragrance, no direct utilization in cigarette production [1] [2]. Fermentation can improve more offensive odor and insufficiently mellow smell, so as to improve tobacco quality [3]. At present, the relevant study on fermentation is mainly concentrated on four aspects: fermentation mechanism study, change quality study on tobacco fermentation process, relevant study of tobacco fermentation environment on quality influences, and tobacco fermentation method study.

2. The Study on Tobacco Fermentation Mechanism

2.1. Theory of Oxidation

In 1867, two Soviet Union scholars proposed the theory. They thought that organic substances take place oxidation with oxygen in air under the catalytic ac-
tion of inorganic elements (Fe, Mg etc.), resulting in changes of chemical substances in tobacco. The existing studies also support the theory of oxidation. The findings show that [4], under the aerobic conditions, transformation speed of chemical substances in the tobacco is faster than anaerobic conditions. Adding oxidizing agent ethylene oxide can speed up the fermentation progress of tobacco, while airtight oxygen reduction restrains enzymatic browning reaction of tobacco, so as to slow down speed to darken tobacco color.

2.2. Theory of Microbial Action

In 1980s, Junior Leif of the Soviet Union indicated that the initial cause for tobacco fermentation is that microorganisms participate in the fermentation activity and follow-up process is conducted under the action of inorganic catalyst. Based on it, he proposed the theory of microbial action [5]. The existing studies find that [4] [6] microorganisms in domestic redried strips mainly include bacteria, mould and actinomycyes. Bacteria occupy most of them, while mould and actinomycyes are minorities. Yeast is little or can’t be detected at all. When Di Giacomo et al. [7] did a fermentation study on Italian flue-cured tobacco, bacteria, yeast and a few lactic acid bacteria were separated. Wu Xueying et al. [8] used 16SrRNA cone library sequencing method to analyze dominant bacteria in fermentation tobacco in Qujing tobacco-growing area, finding that the dominant bacteria of bacteria include enterobacteriaceae, pseudomonas and flavobacterium. By deeply studying physiological properties of microorganisms in fermentation tobacco, it can be found that some microorganism strains have the role of reducing nicotine, Tabacco-specific Nitrosamines, proteins and cellulose contents and improving fragrance [9]-[14].

2.3. Theory of Enzymatic Action

Enzymatic theory of tobacco fermentation was proposed by Leif. In his opinions, tabacco fermentation is caused by oxidase contained in tobacco, including oxidase, catalase, and peroxidase. The existing studies find that polyphenol oxidase and peroxidase activity in fermentation process are present in the tendency of firstly rising and then reducing [15]. The activity of lipoxygenase, α-amylase, protease, cellulase and sucrose is on a declining curve. Enzymatic activity stored in high-temperature and high-wet areas has the higher enzymatic activity. Adding enzymic preparation in tobacco can promote the improvement of tobacco quality [16].

3. The Quality Change Study on Tobacco Fermentation Process

3.1. Changes in Appearance Quality and Physical Properties of Tobacco Fermentation Process

The existing studies show that [17]-[22] in the entire fermentation process, dried strips' colors are gradually darkened from orange to deep orange, reddish brown
and brown. The uniformity and saturability of redried strips gradually get better in early stage of fermentation and become worse after reaching the optimum. The brightness is gradually darkening. Oil content is increased in early stage of fermentation and then it is reduced after reaching maximum. Tobacco structure tends to be loose with the extension of fermentation time. Changes of appearance quality take place top 18 months of natural fermentation, while equilibrium moisture content is on a declining curve.

3.2. Changes of Chemical Compositions in Tobacco Fermentation Process

Furthermore, the existing studies also indicate that with the increase of the organic acid content in fermentation process, pH value is present in the down trend [23] [24] [25]. Total sugar and reducing sugar contents are reduced. It has the fastest speed in 6 - 12 months of fermentation. The falling range under the different warehouse environments has the significant difference [26]. The statement on total nitrogen content is inconsistent. Partial scholars indicate that it is present in the down trend of the small amplitude [25] [27], while other scholars indicate that the changes are not obvious [28]. The alkaloid change is weak [22] [25] [26] [27]. Petroleum ether extract and plamochromic pigment (chlorophyll and carotenoid) take place a great change, thus tobacco’s fragrance gets better and fragrance is mellow [29] [30] [31] [32]. Srivastava et al. [33] found that polyphenols of tobacco in fermentation process take place oxidative degradation and turn into aroma substances and brown pigment. Among which, chlorogenic acid has the biggest falling range, reaching 50%. Rutin content basically maintains unchanged or it is slightly reduced.

3.3. Sensory Quality Changes in Tobacco Fermentation Process

In fermentation process, sensory quality gradually gets better and it is basically stable and then it is reduced [17] [34] [35].

4. Relevant Study on Influences of Tobacco Fermentation Environment on Quality

Fermentation environment is the important factor in fermentation process. Temperature, humidity and air are key factors. Different warehouses have diverse properties and tobacco fermentation effects are also diverse. The findings indicate that [36] [37] [38]: the strips stored under the higher environmental temperature (>25˚C) and relatively suitable relative humidity(55% - 65%) have the better appearance quality and it is good for improving strip quality; when warehouse environment’s relative humidity is greater than 65%, it is not good for tobacco fermentation. Firstly, tobacco appearance quality is poor. Secondly, tobacco is easy to take place mould. In temperature and humidity management process, constant temperature of lower relative humidity should be maintained. As improving mould proof, it is better to reduce humidity, instead of lowering
temperature at random. This is economic, scientific and reasonable and conforms to tobacco maintenance requirements.

Predecessors studied the warehouse construction and equipment study [39]-[50]. Some of them attempted to use the air-conditioning unit intelligent control system, computer temperature and humidity measurement control system, tobacco warehouse temperature and humidity monitoring system of multi-sensor data fusion, temperature and humidity detection system of wireless communication technique, different ventilation drying dehumidification system, fully integrated automation system, air cooled heat pump water chilling unit+ combined air-conditioning unit dehumidification temperature control system, condensation heat recycling heat pump dehumidification system and liquid desiccant system, mechanical regulation warehouse environment method, controlled atmosphere storage technology and nitrogenization oxygen consumption seal technology to regulate fermentation temperature and humidity. Other scholars attempted to utilize solar thermal energy to accelerate tobacco fermentation speed, thus temperature is controlled in the suitable range. One-year fermentation is equal to three-year effect of natural fermentation. HVAC technology fumigates and kills insects of tobacco fermentation. The phosphine exhaust purification treatment system and air-conditioning system conduct optimal design to realize zero release of harmful gas.

5. The Study on Tobacco Fermentation

The fermentation method on tobacco is mainly concentrated on accelerating fermentation and restraining fermentation.

The main study on accelerating fermentation is shown as follows [51]-[57]: through warming and humidification, the artificial fermentation method is used to reduce tobacco fermentation time. Exogenous beneficial microorganisms can coordinate with and improve chemical compositions of aging tobacco, improve tobacco fragrance, and shorten aging period of tobacco. After adding enzymic preparation, tobacco fermentation is accelerated.

The main study on restraining fermentation is shown as follows [58]-[68]: sealing oxygen-consumed storage can restrain tobacco fermentation speed; after pumping nitrogen or vacuumizing during the fermentation period can prevent from tobacco mould and lengthen the best fermentation period of tobacco with proper fermentation. Nitrogen in later period of mechanical regulation method with low emission can restrain excessive fermentation of tobacco and relatively lengthen the best utilization period of tobacco. Controlled atmosphere storage lengthens the time for the best fermentation quality for strips relative to the natural fermentation.

6. Discussion

At present, the domestic and overseas scholars conduct lots of studies on the fermentation, but they have shortcomings in individual aspects. As a cigarette
company, we urgently need to know the optimum fermentation time of flue-cured tobacco. But so far, no one or any studies have shown how to determine the optimal fermentation time for flue-cured tobacco. Most companies still rely on sensory quality reviews. This is obviously not very scientific. The best fermentation period of tobacco is the best period for tobacco to enter into formula utilization. The industrial judgment method on the best fermentation period of tobacco still gives priority to sensory evaluation [17] [19] [69]. Sensory evaluation is easy to be affected by artificial subjective influences. The accuracy and reproducibility are weaknesses. It is urgent to use a chemical detection means to do auxiliary judgment on the best fermentation period of tobacco.

The NIR (Near Infrared Spectrum) is advantaged with fast analysis, simple sample pretreatment, high analysis efficiency, wide sampling range, and suitable for lossless online monitoring, so it is widely used in food [70] [71] [72], tobacco [73] [74] [75] [76], petrochemical engineering [77], qualitative and quantitative analysis of medicine [78] [79] [80] or other fields. At present, China Tobacco Guizhou Industrial Co., Ltd. has established the technical networked united lab of NIR. With Speicher portable NIR instrument, NIR analysis detection technology is used to do qualitative and quantitative analysis on the best fermentation period of tobacco. In the future, the instrument will be carried to each warehouse to judge the best fermentation period of tobacco. Therefore, we suggest that cigarette industry enterprises consider using NIR to determine the optimal alcoholization period of tobacco leaf in future research.

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