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Tesis

**Design of an automated system for the
production of chicha de Jora**

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Design of an automated system for the production of *chicha de Jora*

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Abstract— This research presents the design and control of the fermentation, boiling, and straining process of *chicha de Jora* with mechatronic systems. In this work, process control is developed in the 2 tanks to monitor the procedure to optimize the resources and time of the elaboration. The development of the project shows that the application of 2 solenoid valves and sensors such as level and temperature sensors are feasible for better control of the boiling process. A mixer was also added to the first tank to ensure that the essence of the inputs remains in the liquid. In addition, it is possible to visualize an optimal operation of the system, including PLC programming as it makes the operation more autonomous, managing to accelerate the fermentation process and to be adequate according to the degree of alcohol required. The value obtained from the motor to drive the 6-blade mixer is 17,384 watts taking as a parameter the viscosity, the power number, and the appropriate rotation speed. The implemented control will help to accelerate the process of obtaining *chicha de Jora* and to monitor the degree of alcohol produced in the fermentation process.

Keywords: PLC, Control software, Automation, Mechatronic systems

I. INTRODUCTION

Chicha de Jora is one of the oldest ethnic beverages in Peru, where most Peruvian Andean populations consumed the corn as the main compound of many native foods [1] [2]. This effervescent, golden-colored beverage has an alcohol content of between 1% and 3%, very similar to that of beer, so it was used as the main source of alcoholic beverage [3].

The fermentation process that occurs in *chicha de Jora* is a natural-chemical process (NGS) [4], which shows that one of the main factors for its correct fermentation is lactic acid bacteria (LAB) and yeasts that are responsible for the organoleptic traits [5] [6] [7]. Other natural beverages in Latin America have a similar fermentation process, such as in Ecuador, where *yucca chicha* is associated with human saliva as the main microbial component [6], also in northwestern Argentina natural corn *chicha* is prepared whose fermentation process is very similar to that of *chicha de Jora*, due to lactic acid bacterial culture [5] [7] and Brazil also uses fermentation in its corn *chicha*, which also has microbial fermentation by yeasts and lactic acid [8].

Currently, this beverage has had exponential growth in its consumption by the Peruvian public, and the traditional non-industrialized and non-automated form of preparation is still in use [2]. Most of the production of *chicha de Jora* in Peru is artisanal, and its consumption is higher during festivities and cultural events [9]. The process of elaboration of *chicha de Jora* is obtained through the main ingredient known as *morocho* corn, whose preparation begins with the hydration of the corn, for which the corn is submerged in water for a period of approximately 3 to 8 days, then goes to the drying process and the period it takes is 1 to 2 weeks in the foliage of "*Sambucus nigra*" or known as elderberry, then goes through a drying process in the sun for another 2 weeks, after this process is boiled for about 2 hours and you can add other optional ingredients for their preparation as cloves, quinoa, cinnamon, fruits, and other herbs. Finally, the product is fermented for 1 to 15 days [10], this will depend on the degree of alcohol desired in the beverage.

Currently in the industry of alcoholic beverages such as beer, most craft breweries in Latin America are prepared by stoves, refrigerators, and pots [11], this is only for the preparation of the original product and the fermentation process wooden barrels are filled for the final finish. Craft beer, unlike industrial beer, takes longer to produce and this can vary from 3 to 6 weeks. For this reason, new technological options are being adapted in the market to optimize and improve all stages of the process to standardize and increase the market for craft productions, which implies a decrease in preparation times, an improvement in quality, and an increase inhomogeneous production [12].

The most time-consuming stage in the preparation of *chicha de Jora* is fermentation, which involves the temperature control process [13]. In this research, it is desired to use an autonomous system in refrigeration and temperature control, implemented with mechatronic heating equipment, under the control of a PLC.

II. MATERIALS AND METHODS

The design of the automated system consists of 2 processes to produce *chicha de Jora*. In the first process, the first tank receives the ingredients such as *Jora* corn, sugar, and other