AUTOMATICALLY FUZZY CONTROLLED RIPENING PROCESS OF DRY SAUSAGE - THE IDEA OF A SELF-RIPENING DRY SAUSAGE

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BACKGROUND

Nowadays the ripening of dry sausage is based on heuristical and empirical knowledge of ripening specialists. The process is daily controlled with simple sensory tests and the ripening parameters like pH-value, weight loss etc are measured from time to time. The quality of the fermentation process depends on the practical experience of the persons and on some „rules of thumb". Continous control is rare (RÖDEL und STIEBING, 1987; THUMEL, 1988) and not usual but first steps were made by:

- SCHULDT (1987): Automatically control of the air flow
- NESS et al. (1992): Ripening by weight control
- STIEBING und RÖDEL (1992); LANDVOGT (1993): Surface water activity-control (Δa_{wo})
- LANDVOGT und FISCHER (1990,1991); LANDVOGT (1993): Control of the pH-value

OBJECTIVES

The aim of this work is to develop an automatically on line ripening process for dry sausage. All important data were transferred in real time to a fuzzy controller system, which controls the process full automatically and independent of the recipe. Therefore the idea of a self-ripening process and drying is fullfilled by this new energy saving system.

CLIMATIC CHAMBER, AUTOMATION SYSTEM and METHODS

All trials were performed in a modified climatic chamber with an on line weighing system, temperature system, humidity measurement, pH-value determination and a fresh air automation system, which was developped at the University of Hohenheim (Fig. 1). This chamber is able to control the normal climatic conditions (temperature, humidity and air velocity) very exactly. Inside the chamber the sausages were placed in separate tubes with individual regulated air flow. The important fermentation parameters are transferred in a programmable controller with modular design. Intelligent units of the controller are responsible for data input and mathematical processing. These data are send to an fuzzy controller which includes the knowledge of dry sausage fermentation. Based on these informations the fuzzy controller determines the necessary climatic conditions (Fig. 2). For programming special off line ripening parameters and listing all importants process data a touch screen terminal was used. Saving and graphical presentation of the necessary values is done with a personal computer system. The important drying parameters and data were determined with a mathematical and statistical tool (SYSTAG, 1990). The received results were entered in the fuzzy controller just as some rules of thumb.

RESULTS

A typical „german salami" (analytical data at the begining of fermentation: water content 55.0 %, fat content 23.9 % and 18.0 % protein content) was used for testing this new fermentation system. The on line measurement of the pH-value is responsible for an optimal temperature control during the acidification of the dry sausage and allows good results which are reproducible (Fig. 3). A typical drying curve of a salami ripened with the new system is shown in Fig. 4. At the beginning of the fermentation, the cold, fresh sausage is heated continously to the optimal fermentation temperature. Afterwards, the speed of the drying process is controlled by comparing the measured with the determined drying rates. During ripening there are periodical changes of climate (work) and non climate (break) intervalls with an increasing climate/break-ratio because of an increase in the break time. After one week, the sausages lost about 19.0 % of weight without any quality loss (p.e. drying rim). The sausages were ripened in another climatic chamber for the next 9 days under normal conditions (14.0 °C and 75.0 % humidity) until they lost about 30.0 % of weight. Tests performed with a trained sensory panel indicated a good and typical fermentation quality of the product.

CONCLUSIONS

Advantages of the new automatically system:

- automation and therefore easier handling of the process
- saving and graphical presentation of important fermentation parameters
- maximum drying speed without any quality loss
- universal ripening system for all types of salami
- energy saving

LITERATURE

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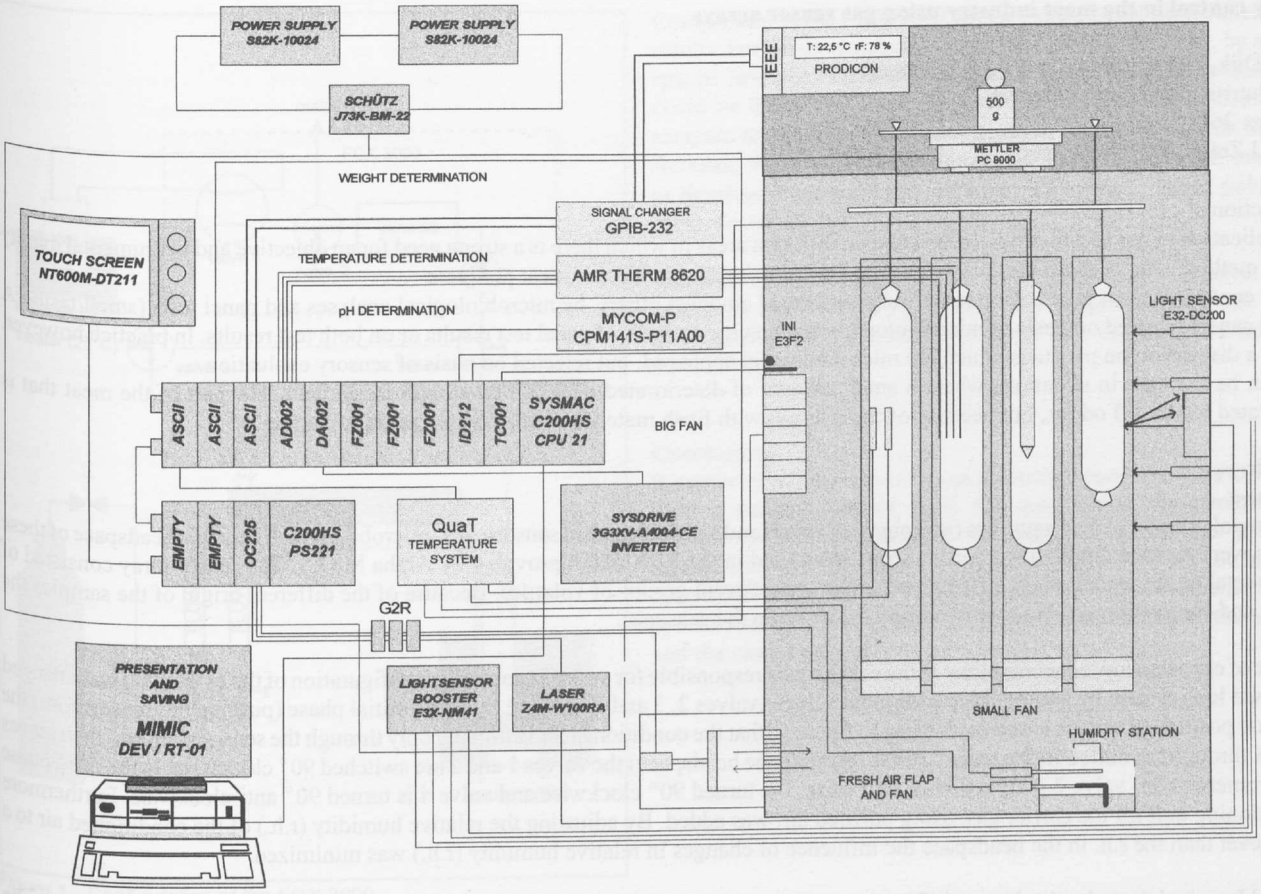

Fig. 1: modified climatic chamber

Figures:

right side:
Fig. 2: scheme of the fuzzy controller

below, left side:
Fig.3: pH and temperature control during the ripening

below, right side:
Fig.4: drying rates, weight loss and ratio between climatic- and break-time during the fermentation