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Studies on the Texture and Tissue of Tomatoes Processed by High Pressure

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Abstract: In this study, ten tomato samples had been processed under high pressure, they were, respectively treated at the diverse pressure for different time. Furthermore, the slices of the tomatoes before and after HPP had been made and observed by microscope. The results showed that the texture and tissue of tomatoes in general could not be damaged by high pressure, visible changes just at ultra high pressure (more than 600 MPa) for 5 min or at 400 MPa for longer time (more than 20 min). The conclusion demonstrated that processing tomatoes at 400 MPa for 20 min or 500 MPa for 5 min was the practicable technology.

Key words: Texture, tissue, tomato, high pressure

INTRODUCTION

High Pressure Processing (HPP) is an advanced food processing technology. In contrast to other methods, HPP offers several advantages: reduced process time; minimal heat penetration/heat damage problems; freshness; well retaining flavor; no vitamin C loss and functionality-alterations are minimal compared with traditional thermal processing[1]. Therefore, more and more people pay more attention to the technology. At present, some products have appeared, such as syrup, confiture and so on[2].

In recent years, the overseas and domestic scholars began to research on processing and preservation fresh vegetables by HPP and had made a lot of progress[3]. In 2000, the Department of Defense once sponsored $ 2.3 million, three-year effort to develop the use of ultra high pressure technology to produce high-quality shelf-table food products, such as soups, potatoes and cheese products-for both military and consumer markets[4]. Vegetables after processed by high pressure, pathogenic microorganisms had been inactivated, their nutritional and sensory characteristics were almost completely retained and their breath was weakened, the fresh vegetables after HPP can be preserved for longer time[5].

On the other hand, HPP can sometimes affect the vegetables' qualities, because the tissues of vegetables are so tender that they can be easily damaged[6]. Therefore, to get the practicable technology, it is necessary to observe the tissue and cells of vegetables after HPP in order to know their changes under high pressure. In this study, tomatoes, as an example of fruit vegetables (stem vegetables and root vegetables will be introduced in other papers), were treated at diverse pressure for different time, the slices of tomatoes before and after HPP were made and observed by microscope. The study is important for us to well know the mechanism of HPP and to get the rational parameters of preserving vegetables by HPP.

MATERIALS AND METHODS

The tomatoes were purchased in local supermarket and were in prime condition, dimethylbenzene, distilled water, hematoxylin, ethanol, acetic acid glacial, etc.

Instruments and equipments: High Pressure Equipment (DL700-0.55×1.5, Da Long Ultra High Pressure Equipment Factory, ShangHai, China) has a vessel capacity 350 mL, maximum pressure of 700 MPa. Pressure is increased within 2 min and released within 0.5 min. Microscope with the function of taking picture. Other common tools: vacuum packaging machine, electronic balance, beakers, measuring cylinders, knife, etc.

The tomatoes were washed by flowing tap water and cut into cubes (2x2 cm), all the samples should be vacuumed and sealed with plastic bags, the samples for HPP should be sealed twice in order to isolate them from the pressurization medium (oil). The sealed samples were, respectively processed at ambient temperature at the parameters as follows:

- Group one at the pressure of 200, 300, 400, 500 and 600 MPa for 5 min.
- Group two at the pressure of 400 MPa for 5, 10, 15, 20 and 25 min.

Then, the slices of tomatoes before and after HPP would be made and observed by microscope[7].

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RESULTS AND DISCUSSION

The observation and analysis of tomatoes' tissue processed at diverse pressure: In general, the cells of vegetables are round. Because of their extrusion and collision, their shape is usually polyhedron which is composed of eight hexagons and six squares. The cells of tomato untreated by high pressure were approximately global (Fig. 1a), they also had the characteristics of polygon, their edges and corners were visible, the single cell was full and the nucleolus is in the centre.

The cellular pictures of tomatoes treated at 200, 300 MPa for 5 min were shown in Fig. 1 b and c. Their shapes corresponded to the swollen glossy appearance of the cell surfaces in raw materials and the shape and cubage had no obvious changes, which indicated that low pressure for short time could not damage tomato's tissue.

When the samples were processed at 400, 500 MPa for 5 min, the cells were still intact and keep their original shape (Fig. 1d and e), but their cubage had reduced a little. This demonstrated that pressure (400-500 MPa) couldn't obviously influence on the cellular structure.

While the pressure up to 600 MPa, we observed that the cellular structure changed and some migration of soluble components occurred (Fig. 1f), the cell damage was clearly shown, the collapsed cells appeared and their glossy appearance had disappeared. So the pressure (600 MPa) destroyed tomato's cell and tissue.

The observation and analysis of tomatoes' tissue processed for diverse time: To some extent, according to the theory of high pressure processing, the high pressure for short time has the same effect on the food materials as the low pressure for long time[8]. In order to know the processing time how to affect vegetables' texture and tissue, we respectively processed the samples at the pressure of 400 MPa for 5, 10, 15, 20 and 25 min, the pictures of their cells were shown in Fig. 2.

When the processing time was 5 or 10 min, Fig. 1b and c the cells' structure had no obvious changes, the appearance of cells was turgor and glossy, the shape of cells was clear. These showed that tomatoes could keep well after high pressure treatment at these parameters.

While the processing time prolonged, the cubage of tomato cells got smaller and smaller (Fig. 2 d, e and f), this indicated that the intercellular clearance and the inner space of cells became smaller. In fact, there are lots of liquids (75-90%) and gas which fill of the intercellular and inner space of vegetable cells, the liquids contain water as well as other constituents such as salts, vitamins, enzymes and substrates. Under high pressure for longer time, the liquids had flown and effused from cell wall, the gas had been compressed. Therefore, the cells got smaller.

However, except the sample processed for 25 min whose cell wall had collapsed and shape was not clear, the other cells' shape was still intact and their appearance was glossy too (Fig. 2d and e). Therefore, we concluded that the texture and tissue of the tomatoes treated at 400 MPa for less than 20 min had no obvious changes.

Comparing Fig. 1 with Fig. 2 we discovered that pressure was the main factor to damage tomato structure and tissue, because ultra high pressure could make the cells wall collapsed to destroy tomato cells and low pressure for long time could just decrease the cells cubage, which would restore when the pressure released. So, in order to protect vegetable from damaging, low pressure for long time is the better technology parameter.

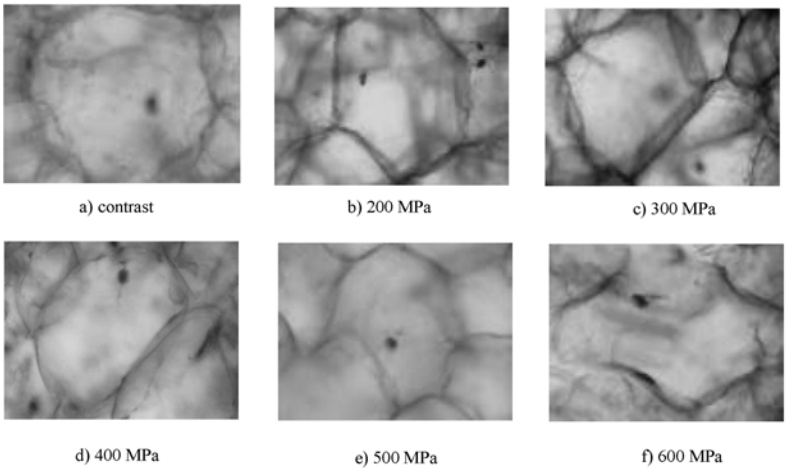

Fig. 1: The cells and tissue of tomatoes processed at diverse pressure (5 min)

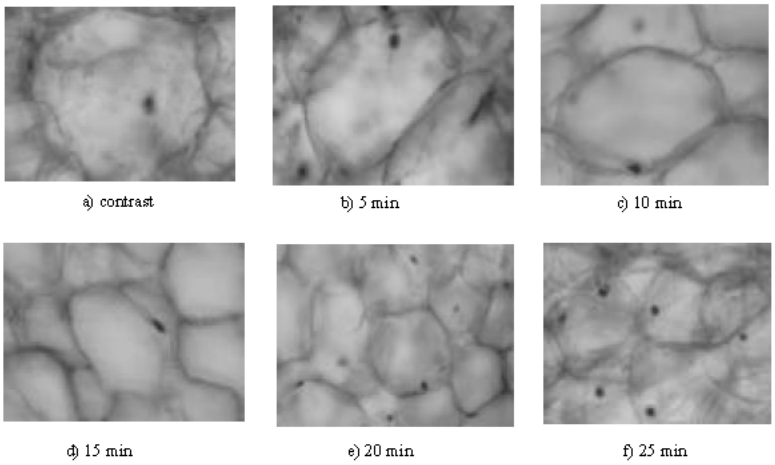

Fig. 2: The cells and tissue of tomatoes processed for diverse time (400 MPa)

However, if the pressure was too low, the pathogenic microorganisms and enzymes would not been inactivated, the vegetable's breath could not been weakened, thus the fresh vegetables after HPP couldn't be preserved for longer time[5]. On the other hand, it was inefficient to process vegetables at lower pressure for long time.

Taking pressure and time full account, we concluded that processing tomatoes at 400 MPa for 20 min or 500 MPa for 5 min was the practicable technology.

The texture and tissue of tomatoes in general can not be damaged by high pressure, visible changes just at ultra high pressure (more than 600 MPa) for 5 min or at 400 MPa for longer time (more than 20 min). Taking pressure and time full account, we concluded that processing tomatoes at 400 Mpa for 20 min or 500 MPa for 5 min was the practicable technology.

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