

Research Development of Ultra-High Pressure Processing on Fruit Juice

Wu Han Zhang Yunchuan Han Qinghua Zhao Youbin

Chinese Academy of Agriculture Mechanization Sciences, Beijing, china (paley366@sina.com)

Abstract

Ultra-high pressure processing (UHPP) technique is a new technique in food cold sterilization, which has a broad application prospect. This paper summarized the effect of ultra-high-pressure processing technique on micro-organism, enzymes, and quality of the juice. At present, the Ultra-high-pressure processing of usual static 500-700MPa can basically reach the inquiry of the juice sterilization in commerce, and some of the effect is effective in enzyme deactivated. The ultra-high-pressure processing technique has already used and applied in production on a large scale, as the good processing quality makes destructiveness very small in the nature nutrient component, flavor, and the color which turns brown. However, the effect of ultra-high-pressure processing in sterilization of bacterial spores and inactivation of peroxidase is not good, and which cannot be improved simply by enhances the pressure. Based on the influencing factors of analyzing kinds of effects through ultra-high-pressure, the direction and method of next research are propounded and prospects are gave for its future development. As the research of next step, we can carry on the work as follows. Some enhancement methods of Ultra-high-pressure processing, such as magnetization and ultrasonic wave, are carried on fruit juice. Research of dynamics model about Sterilization and enzyme inactivity of Ultra high pressure processing on fruit juice are also needed.

Key words: Ultra-High Pressure , Fruit Juice, Sterilization, Deactivating Enzyme.

INTRODUCTION

Ultra high pressure (UHP) technique subjects liquid and solid food to pressures between 100 and 1000MPa with exposure times ranging from a few seconds to over 30min, which is on the aim of microbial inactivation. UHP technology as a non-thermal preservation technique to ensure high quality food products, compared with the traditional thermal processing, which has its advantages as following: (1) Base on the principle of compressing instantaneously in UHP processes, it has the result of homogeneous sterilization, and low energy consumption; (2) UHP is one kind of cold sterilization, which will not destroy the effective component a lot in food a lot such as the nutrition, the flavor, the luster and so on; (3) UHP improves the inherent structure of certain food material, which has the possibility of obtaining new character food^[1]. The use of UHP for food processing has been developed extensively and has a broad application prospect.

Ultra high pressure food processing technique is an important application branch of high pressure technology, which is also developed in high pressure technology. Earlier in 19 century's end, H.Royer (1895), Bert H.Hite (1899) et al. carry out experiment of microbial inactivation on milk, fruit juice and vegetables juice with the high pressure technology^[2,3]. It is P.W.Bridgman a US physicist who was recognized as the pioneer of modern UHP research, who captured Nobel physics prize in 1946 by the research of ultra high pressure^[4]. Since 1906, he carried out a series of systemic research about macroscopic physical behaviours in UHP, such as the compressibility of solid, the phenomenon of

melting, the properties of mechanical, the changing of state, and so on. In 1912, Bridgman reported the state diagram of water under UHP, and established the physics of UHP; In 1914, the phenomenon of protein about coagulating under 500MPa and turning hard gelatinous under 700MPa were found^[5]. These achievements lay the foundation of the UHP applied in food processing. In 1924, Cruss pointed out explicitly in his book that the UHP can use in the fruit juice commercial processing^[6]. At that time, the domestic refrigerator technology was popularized rapidly with the development of industrial refrigeration technology. So for a long time, no-one applies the UHP technology to the research of food processing. Until the 1980s, the UHP technique was used by Japanese scholars to solving difficult problem in the food processing, which could not solve by heating treatment. And in 1990, the UHP food (jam) was produced for the first time in Meidi-ya^[7]. Afterward in 1995, fresh orange juice “spot squeeze” were sold commercially as the compression food in France. High-pressured food aroused a bigger interest by its unique effect of Sterilization and enzyme inactivity, and the superiority which the heat sterilization does not have. The studies on the UHP technology as one of food processing methods were carried out widely on a lot of food materials^[8-11]. At present, many countries have paid great attention on the UHP technique, also the scope of research and application about the UHP has been expanded unceasingly.

Since beginning, the research about the UHP technique was mainly used for food preservation. And the sterilization is the primary intention of research about the UHP technique all the time, where there are three primary factors of preservation treatment: sterilization, enzyme inactivity and the quality. In addition the development of UHP technique research is based on the breakthrough of the UHP equipment technique. So it is important to make summaries of the UHP technique in all aspects, such as sterilization, enzyme inactivity, the quality and the UHP equipment.

STERILIZATION OF UHPP ON FRUIT JUICE

The principle of sterilization about UHP technique is inactivation of microorganism by pressure. The high pressure may cause various change such as the structure, the biochemical reaction, the gene mechanism and the cell membrane. Thus original physiological activity functions of microorganism are influenced. And the original functions of microorganism are destroyed or change irreversibility. Then the microorganism has been inactivated^[12]. Recently many researches about sterilization of the UHP were carried out^[13-16]. Their materials were as follow: orange juice^[17], apple juice^[18,19], tomato juice^[20], watermelon juice^[21], pear juice^[22], Hami melon (*Cucumis Melo L.*) juice^[23] and so on. The researches indicated that the sterilization effects of fruit juice by the UHPP concerned with the pressure size, the time pressed, the quantity of microorganism in fruit juice, the microorganism type, the material PH, the temperature of processing and so on many factors.

At present the prominent problem of the UHP technology is the resistance of pressure- resistant spore in sterilization. It is some bacterial spores that still could survive under the pressure of 1200MPa^[24]. Therefore experiments were carried out on various materials by the cooperated processing methods of sterilization, which are the UHPP and the temperature, the PH value or the ultrasonic wave processing work together. And good effects have been obtained^[25]. It is difficult to carry out the cooperated processing methods outside, where the UHPP needs a strict pressurizing in processing tank. So finding cooperated processing methods is still the direction of research in recent years. At the same time foundational researches about UHPP are needed such as: individual UHP treatment parameters (pressure, process time, temperature and so on) on each material of fruit juice, sterilization effects about microorganism (total microbial count, mould, yeast and so on) by the UHPP, study on dynamic

model of microbe lethality by UHP treatment.

ENZYME INACTIVITY OF UHPP ON FRUIT JUICE

The enzyme is any of numerous proteins or conjugated proteins, which produced by living organisms and functioning as biochemical catalysts. The UHP treatment mainly takes effects on the tertiary structures of enzyme, which make the inhibition of enzyme activities. Researches indicate that the inactivation of enzyme is the causation of secondary bond's breakage and protein structure destroyed^[26]. When studies about sterilization on the UHP treatment were carried out, many researches about inhibition of enzyme activities were reported^[27-29]. It is similar with the UHP sterilization which has many influencing factors, the enzyme inactivity effects of fruit juice by the UHPP concerned with the pressure size, the time pressed, the quantity of enzyme in fruit juice, the enzyme type, the material PH, the temperature of processing, the enzyme inhibitory and so on many factors^[30]. The enzyme inhibitory by the UHPP has its particularity. It will activate some enzyme, when many enzyme activities were inhibited^[31]. Some enzymes, such as pectin methyl esterase, peroxidase, polyphenol oxidase, or lipoxygenase, are specially resistant to pressure. The peroxidase has the strongest resistance to pressure, which might maintain 90% activeness under the UHP treatment of 30min at 600MPa and 60°C^[31].

In view of the fact that some enzymes cannot inactivated completely with simple high pressure, study of new technical coordination UHPP is still one of solution methods. Otherwise foundational researches about enzyme inactivity of UHPP are needed such as: inactivity effects about enzyme (Polyphenol oxidase, PPO, Pectin methyl esterase, PME, Lipoxygenase, LOX and so on) by the UHPP on each material of fruit juice, study on dynamic model of enzyme inactivity by UHP treatment.

QUALITY OF UHPP ON FRUIT JUICE

In recent years, there are a lot of researches about processing quality on fruit juice by the UHP treatment, which concern the colour^[32,33], texture^[34,35], flavor^[36,37], nutrient^[38-40] of fruit juice. Many researches indicate that the fruit juice treated by UHPP may have storage more than a half year, moreover it has much less change in nutrient, flavor and colour compared with the heat-treatment method. This is the latent superiority of the UHPP in fruit juice processing^[41]. Regarding the different kind of material juice, the UHPP also have different influences about quality. Therefore a part of basement researches about the UHPP are studies about the changes of the colour, texture, flavor and nutrient on single material juice by UHPP compared with the heat-treatment method.

EQUIPMENT OF UHPP

Although high pressure processing technique has been used in metalwork and ceramic industry at the beginning of 20 century, this technique has been used in food processing until Japan mad the first high pressure food processing testing facility at the end of 1980s. At present, America and Japan, and the others have got achievement of research and development, standardization and mass production in high pressure processing facility, such as the Flowing Company and Wenger Company of America^[10], Meidi-ya food Company of Japan, which all has its own characteristic productions. The processing capacity of high pressure processing of food facility has got 275mpa, 24.6kg/min serialization production. In china, the leading high pressure processing of food facility manufacture----Baotou High Pressure Technique Co; LTD that the facility capacity in sold is only 15L at the maximum working pressure 800mpa; and the facility capacity is just 500L at the maximum working pressure 600mpa.

Currently, as most of the high pressure testing technique use the static sterilization and use the oil as

the pressed medium in china (the foreign use the water as the pressed medium), and the investment of the high pressure material is huge, the equipment is heavy, the production is very limited, high cost, and hard to accomplish the optimal serialization production, which cause the difficulty in application and extension of the UHPP products of high pressure technique. But, with the breakthrough of technology in high pressure processing facility, serialization production is necessary. And the industrial development of UHPP technique has unlimited potential after reducing the cost of equipment and processing.

Final Remarks

Ultra-high pressure processing (UHPP) technique is a new technique in food cold sterilization, which has a broad application prospect. The ultra-high-pressure processing technique has already used and applied in production on a large scale, as the good processing quality makes destructiveness very small in the nature nutrient component, flavor, and the color which turns brown. However, the effect of UHPP in sterilization of bacterial spores and inactivation of peroxidase is not good, and which cannot be improved simply by enhances the pressure. As the research of next step, we can carry on the work as follows. Some enhancement methods of Ultra-high-pressure processing, such as magnetization and ultrasonic wave, are carried on fruit juice. Research of dynamics model about Sterilization and enzyme inactivity of Ultra high pressure processing on fruit juice are also needed. In shot, UHPP is a promising technology that could eventually replace many heat treatments in food processing.

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