Effect of microwave treatment on functional properties of soybean protein phospholipid complex system

The effects of different microwave power treatments on foaming properties, emulsifying properties and gelation properties of soybean protein isolate phospholipid complex system were studied. Foaming activity, foam stability, emulsifying activity, emulsifying stability, flocculation index, milk chromatography index of soybean protein isolate phospholipid complex system were studied. The water holding and textural properties of the gels were measured and the microstructural changes of the gels were observed by scanning electron microscopy. The results showed that with the increase of microwave power, the foaming properties, emulsifying properties and gel properties of the composite system first increased and then decreased. When the microwave power was 900 W, the foaming properties and emulsifying properties of the composite system were the best. When the microwave power was 1100 W, the gel properties of the composite system were significantly higher than that of the control group, indicating that microwave treatment would promote the interaction between soybean protein isolate and phospholipid and form a more stable interface on the water oil interface. The gel properties of the composite system can be improved by the appropriate structural changes.

Soybean protein isolate (SPI) is a kind of plant protein with high nutritional value. Because of its high protein content and special chemical structure, SPI has many functional properties that can be widely used in food industry. However, single natural SPI lacks in its structure limitation and variability. It can not satisfy the demand of protein in food industry. Soybean lecithin (Lec) is a natural surfactant with emulsifying function, which is widely existed in nature. Because of its typical amphiphilic structure (hydrophilic group and lipophilic group), lecithin is often added to soybean protein to enhance the functional properties of food. The results showed that there was interaction between soybean protein and phospholipids, which affected the emulsifying system structure to some extent and improved the physical stability of the system. Qualitative. It was also suggested that the functional properties of soybean protein-lecithin cross-linking compound were improved significantly. The physical and chemical properties of soybean protein-phospholipid composite system were studied under different pH treatment conditions. It was found that the special amphiphilic structure of phospholipid could improve the dispersibility of soybean protein in water and prevent the formation of emulsion from flocculation and aggregation.

Microwave drying machine technology has been widely used in food processing industry, but there are few studies on the effects of microwave treatment on natural nutrients, additives and other natural compound emulsifiers. Therefore, this experiment explored the important functional characteristics of SPI-phospholipid composite system of soybean protein drying equipment under different power conditions, in order to provide a reference for the rational application of microwave technology in food processing industry.

According to the existing research methods, 100 mg SPI and 10 mg soybean phospholipids were weighed and dissolved in 0.1 mol/L phosphate buffer solution of 100 mL pH 7.2. The magnetic stirring solution was stirred for 1 h at room temperature to obtain SPI-phospholipids composite system. The output power of the microwave oven is 500, 700, 900, 1 100, 1 300 W, and the heating time is 2 minutes. The prepared SPI-phospholipid composite system is placed in the material table of the microwave oven, and the microwave button is started. After the end of microwave treatment, the emulsifying properties of the composite system were measured immediately. According to the different microwave power, the samples were recorded as SPI-Lec500, SPI-Lec700, SPI-Lec900, SPI-Lec1100, SPI-Lec1300, and SPI-lecithin composite system without microwave treatment as control group, SPI-Lec. The SPI- phospholipid composite solution after microwave treatment was accurately measured at 2 mL in 50 mL colorimetric tube. A capillary with an inner diameter of 1 mm was pumped into the air at 0.031 Pa pressure. After 20 s, the foam volume was stopped and the foam volume was measured quickly. After 5 min, the foam volume was measured again.

The experimental time was 5 min, and FAI and FSI were calculated. The FAI/mL V0 V0 (1) FSI/min = V0t (V) (2): V0 is the foam volume /mL measured when the air is stopped 20 s, and the V value of V is the difference between the foam volume of 0 min and 5 min. 9 mL control sample and microwave treated SPI- phospholipid complex solution were mixed with 3 mL sunflower seed oil, then emulsified and then poured into 25 mL beaker. Emulsified 2 min with 20000 r/min high speed emulsifying homogenizer was used to prepare fresh emulsion. The homogenized fresh emulsion was diluted to 300 times with the mass fraction of 0.1% SDS solution, and the absorbance A0 was measured by ultraviolet spectrophotometer at 500 nm wavelength. After measuring 30 min, the absorbance A30 was measured, and EAI and ESI were calculated. In the formula EAI / / (m 2 / g) 2 h 2.303 A0 h 300 p h Lh Phi 10 000 (3) ESI / min = 30 A0 - A30 (4), the concentration of protein in aqueous solution before emulsion formation / (g / mL), the thickness of colorimetric cup (1 cm), and the volume fraction of oil in emulsion /. The freshly prepared and stored 24 h emulsions were respectively diluted with distilled water and 1% SDS, and the granularity of the homogenized fresh emulsion was measured by Mastersize2000 laser particle size analyzer. Each sample was repeated for 3 times. The determination parameters are as follows: determination temperature 25 C, refractive index of particle 1.520, particle 44 2016, particle absorptivity 0.001, dispersant water, dispersant refractive index 1.330. The mean diameter D4,3 of the droplet is used to characterize the average particle size of the droplet. FI is based on formula.

The phospholipid will form some milk droplets which are different from the composite system, resulting in uneven distribution of droplets and uneven particle size, resulting in migration, flow, aggregation and flocculation of droplets.

The D4,3 of SPI- phospholipid stabilized emulsion after microwave treatment was significantly smaller than that of the untreated SPI- phospholipid emulsion, and D4,3 increased after storage for 24 h, but when the microwave treatment was 900 W, D4,3 changed the smallest. This is consistent with the change of emulsion activity. It is pointed out that the emulsifying properties of emulsion are not only related to the mass concentration of SPI, but also to the properties of emulsifiers such as denaturation of protein and degree of condensation. This experiment proves that microwave treatment induces protein local denaturation, which leads to the unfolding of SPI flexible structure and helps to improve the emulsifying ability of protein. Besides the emulsifying capacity, the flocculation state and stratification state of oil droplets are also important indexes affecting the stability of emulsion, which can be expressed by FI and CI of emulsion. The FI of oil droplets in emulsion refers to the process of gathering oil droplets by emulsion polymerization and even forming floc. The SDS as a surfactant can disperse the oil droplets in the emulsion and make them exist in a single form. Therefore, the flocculation of oil droplets can be divided by water emulsion and 1% SDS. The relative change value of D4,3 in the powder was characterized. With the increasing power of microwave treatment, the value of FI and CI decreases first and then increases after 24 h. The stability of emulsion increases first and then decreases with the increase of power of microwave treatment. In SPI-Lec900 emulsion, FI and CI reach the minimum value through 24 h. Suitable phospholipid binding sites were the most stable, and the SPI- phospholipid interfacial film was the most stable. And the change trend of FI and CI after 24 h is more consistent. Therefore, the oil droplet in emulsion is involved in the floating of emulsion fat, and the phenomenon of stratification is related to the flocculation state of the new emulsion. Because the flocculation of milk droplets will accelerate the aggregation of oil droplets and form large oil droplets, the separation of oil water interface will be accelerated under the action of force. Therefore, the larger the FI changes, the easier the layering of emulsion is, and the larger the CI is.

Gel water holding capacity can affect juicy, tenderness, aroma and other sensory quality of food. The effect of microwave treatment on WHC of SPI-phospholipid composite system was studied. The results showed that microwave treatment had a significant effect on WHC of SPI-phospholipid composite system. With the increase of microwave power, the gel WHC of the composite system increased, and the WHC increased most obviously when the composite system was microwave treated for 1100 W. Gel WHC mainly depends on the charge and hydrogen bond of protein molecules. The modification of SPI by microwave treatment can destroy the hydrogen bonds inside the protein molecules in different degrees, and enhance the function of protein, protein, water and protein phospholipid in the process of heating up with phospholipids. The gel samples can promote the formation of new hydrogen bonds and increase the WHC at 4 degrees. . The most obvious reason for the 1100 W treatment is the larger microwave power, larger protein structure and more hydrogen bonds in the structure, resulting in an increase in the amount of charge. Thus, the WHC of the gel can be promoted by changing the hydrogen bond and hydrophobic interaction force. However, the interaction between SPI and phospholipids was weakened due to the formation of aggregates, which hindered the formation of colloidal lamellar network.

Hardness and elasticity are important indicators for measuring the texture characteristics of gel samples. Hardness refers to the maximum force required for the sample to be compressed; elasticity refers to the recovery distance of the sample after the first compression. The hardness and elasticity of SPI- phospholipid composite system treated by different microwave treatments. The hardness and elasticity of SPI-Lec500, SPI-Lec700, SPI-Lec900, SPI-Lec1100 and SPI-Lec1100 were improved by 5.61 g, 0.08 mm, 7.17 g, 0.14 mm, 11.13 g, 0.18 mm, 12.26 g and 0.21 mm, respectively, compared with the control group. The hardness and elasticity of SPI-phospholipids treated by 1100 W increased significantly. _/g SPl-Lec SPl-Lec 500 SPl-Lec 700 SPl-Lec 900 SPl-Lec 1100 SPl-Lec 1300 SPl-Lec 1300_30350.40.60.7 0.8 0.3445/mm treated by microwave can not only promote hydrophobic groups to form SPI-phospholipids with strong hydrophobic effect, but also promote the formation of internal sulfur bonds and the formation of disulfide bonds. Exchange. The presence of a large amount of hydrophobic amino acids and two sulfur bonds is conducive to the formation of a stable gel of soybean protein. Higher power microwave treatment can also dissociate the subunits, resulting in protein-protein, protein-phospholipid through hydrophobic interaction to form three-dimensional network structure, a large number of sulfhydryl and disulfide bonds can strengthen the network between molecules, thereby improving the hardness and elasticity. However, the effect of 1300 W power treatment on the hardness and elasticity of SPI- phospholipid composite system is reduced. The reason may be that the excessive microwave power leads to the phenomenon of settling in the composite solution. The formation of a large number of insoluble aggregates reduces the hydrophobic interaction and hinders the formation of the gel network structure.

The gel network of SPI-Lec control group was not only arranged in disorder, but also formed irregular large holes on the gel surface, and the network structure was rough, with obvious sense of fault. The microstructure of SPI-Lec1100 sample has no obvious big holes, the network structure is compact and uniform, the grid is fine, and the degree of protein cross-linking is large; the reason is that 110W treatment can dissociate the protein subunits, expose more hydrophobic amino groups and thiols, and phospholipids can easily form more stable protein through hydrophobic interaction.

At the same time, the existence of a large number of sulfhydryl and disulfide bonds can strengthen the network between molecules, forming a clear cross-linked lamellar network structure. Compared with other samples, the structure of SPI-Lec1300 gel increased significantly, and the pore size of the samples was too large. The crosslinking structure was too chaotic. Therefore, excessive microwave power treatment leads to serious protein denaturation, loose and irregular structure, a large number of charge exposure, on the one hand will produce repulsion, on the other hand, will form aggregates or even caking.

Conclusion: microwave treatment in a certain power range can improve the foaming properties, emulsifying properties and gel properties of SPI- phospholipid composite system. With the increase of microwave power, the foaming and emulsifying properties of SPI-phospholipid composite system increased first and then decreased. The foaming and emulsifying properties of SPI-phospholipid composite system could be improved obviously by microwave power of 900 W, and the SPI-phospholipid composite system could be improved obviously by microwave power of 1100 W. Therefore, appropriate microwave treatment will significantly improve the functional properties of SPI- phospholipid complex system, which will provide reference for the production of protein in the food industry and the application of microwave technology.