Research and development of texturized soybean proteins with functionalities

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Introduction

The security of grain yields in major agricultural countries around the world was seriously jeopardized due to abnormal global climate changes or natural disasters. This situation ultimately leads to a food issue for mankind. Today, cereals used as feed in the production of meats are no longer sufficient to satisfy the nutrition demands of livestock. To solve this problem, we are looking for a direct, fast, lasting, low-carbon emission way to produce foods, such as meat analog, using agricultural grains. Our research focuses on the research and development of extrusion foods using a single screw extruder. Many new technologies have been successfully developed for making various local processing foods, including adlay powder, figrains oat powder and pregelatinized rice flour. All of these developed technologies are suitable for industrial production use. Our laboratory provides an excellent space for simulating a pilot plant for actual production of the preceding products for practical student training. Our laboratory is also devoted to developing another extrusion process technology, i.e. texturized vegetable protein (TVP) production. This research includes investigating the physical and chemical properties of raw materials and the changes in functional ingredients during the extrusion process. We further establish a set of stabilized engineering parameters for the extrusion product raw materials. We expect to provide industry with useful technologies for producing texturized plant protein. With our effort the industry can hopefully produce good quantity and good quality products.

Figure 1. Producing high moisture TVP by a single screw extruder.

Extrusion technology synopsis

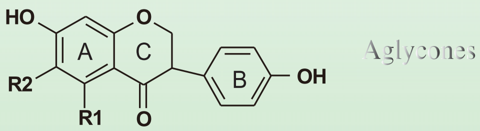
The reason extrusion technology can hold important status in global food science and technology is its continuous-type production process. It is an effective substitute for the traditional complicated batch process. An indigenous single screw extruder used in the extrusion production of high moisture-TVP is shown in Figure 1.Extrusion is classified as HTST because the mixture is pushed by external force. During this fluid process, including mixing, shearing, kneading, cooking and so on, the solid constituents melt into paste and plasticize into the die for molding or expansion. A food extruder is an instrument that restructures the raw material and forms it. During the extrusion process the raw material is mixed, heated, sheared, to force the fluid into the barrel that surrounds the screw. As the food material moves through the die it is molded, expanded and dried. The use of extrusion technology in our laboratory, as the extrudate water-holding capacity increased, the extrudate fibrotic texturized protein presents water-holding capacity as high as meat. A stable dynamic equilibrium condition is established to achieve a balanced input to output, so that the product will have uniform quality.

The synopsis of Isoflavone

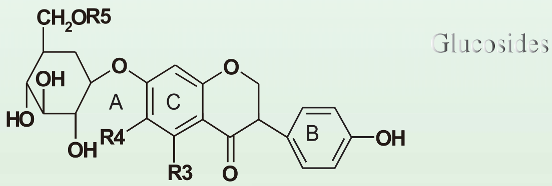
There are four types and twelve chemical configurations of isoflavone. The first type is aglycones including genistein, daidzein and glycitein. The second type is glucoside including daidzin, genistin and glycitin. The third type is acetylglucosides including 6”-o-acetyldaidzin, 6”-o-acetylgenistin and 6”-o-acetylglycitin and the fourth type as malonylglucosides including 6”-o-malonyldaidzin, 6”-o-malonylgenistin and 6”-o-malonylglycitin (table 1). The HPLC chromatogram standards for isoflavones are shown in Figure 2.

Table 1. The chemical structure of isoflavones

R1	R2	Compounds
H	H	Daidzein
OH	H	Genistein
H	OCH3	Glycitein



R3	R4	R5	Compounds
H	H	H	Daidzin
OH	H	H	Genistin
H	OCH_3	H	Glycitin
H	H	$COCH_3$	6”-o-acetyldaidzin
OH	H	$COCH_3$	6”-o-acetylgenistin
H	OCH_3	$COCH_3$	6”-o-acetylglycitin
H	H	$COCH_2COOH$	6”-o-malonyldaidzin
OH	H	$COCH_2COOH$	6”-o-malonylgenistin
H	OCH_3	$COCH_2COOH$	6”-o-malonylglycitin



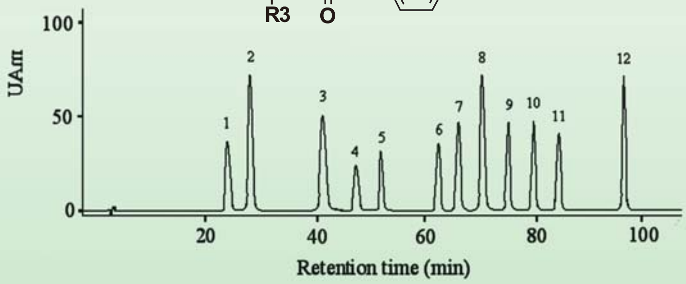


Figure 2. HPLC chromatogram of isoflavone standards.
Peak identification: 1, Daidzin ; 2, Glycitin; 3, Genistin;4, Malonyldaidzin; 5, Malonylglycitin; 6, Acetyldaidzin; 7, Acetylglycitin; 8, Malonylgenistin; 9, Daidzein;10, Glycitein; 11, Acetylgenistin; 12, Genistein.

Research Achievements

Figure 3. The appearance of TSP.

1. A study of the various physico-chemical properties of texturized vegetable protein extrusion processes:
   Texturized vegetable protein (TVP) Commonly known as artificial meat or artificial vegemeat. It can replace livestock, providing sources of rich protein. The laboratory production of texturized vegetable protein uses soy protein as the raw material. We call texturized soybean protein (TSP). To explore the TSP effects by changing different extrusion variables, different proportions of raw materials. The appearance of laboratory-made TSP is shown in Figure 3

2. Effects of soybean extract powder addition on the physical and functional properties of TSP:
   Soybean extract powder (SEP) has high levels of soy isoflavones (75.8%) , defatted soybean flour and soybean protein isolate were mixed in different ratios to TSP using extrusion. Isoflavone amplification was conducted in raw materials in this study to investigate the changes in physical and functional properties of products after extrusion processing. We found that extrusion will convert the aglycones into glycosides which are more favorable for the body to absorb (Table 2). This study also found that extrusion processing improved the mixture reducing power (Figure 4).

Table 2. Isoflavones of mixtures and TSP in different SEP ratios.

	Aglycones	Glycosides	A/G ratio
0%Mix	1.34	1.96	0.68
0%TSP	1.33	0.91	1.46
2%Mix	4.7	14.48	0.32
2%TSP	5.93	9.14	0.65
4%Mix	7.84	28.36	0.28
4%TSP	8.46	11.25	0.75
6%Mix	25.68	40.74	0.63
6%TSP	13.11	20.47	0.64
8%Mix	12.27	49.53	0.25
8%TSP	33.11	51.98	0.64
10%Mix	16.34	59.21	0.28
10%TSP	17.56	42.61	0.41

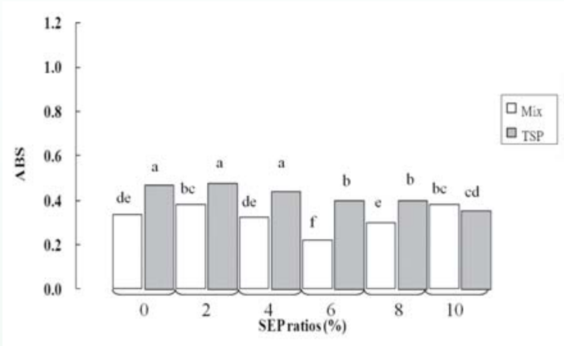


Figure 4. Reducing power of mixtures and TSP in different SEP ratios.

3. Effects of soybean hypocotyl powder addition on the functional and physical properties of TSP:
   To understand the growth and declcline of isoflavones after extrusion processing and the effect of physical properties, different ratios of soybean hypocotyl powder, defatted soybean flour and soybean protein isolated were mixed into the raw materials. This study targets functional TSP high in anti-oxidative properties and natural. We found that the TSP with high total isoflavone as 7.78 mg/g could be extruded successfully with 30% soybean hypocotyl powder added to the mixture.
4. Effects of different soybean protein isolate on TSP quality:
   How different sources of soybean protein isolate could affect TSP quality was investigated in this study. It is helpful to choose reference materials for producing TSP commercially in the future. This study found that the amount of water solution protein (WSP) and 11S globulin (glycinin) have the most correlation on TSP physical properties. In other words, WSP and glycinin content determination in the raw materials could be used to effectively judge the quality of the raw materials.
5. Commercialization of functional TSP (Vegemeat):
   At present, we produced functional vegemeat as readily packaged instant products using vacuum sterilization techniques (Figure 5); each package (50 g) the total isoflavone content of 36.5 mg, approximately equal to the recommended daily intake for menopausal women. This product can be stored at room temperature, providing a convenient food supplement.

Figure 5. The appearance of TSP products.

References

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